

# WHEN MORE IS LESS: NON-NATIVE PERCEPTION OF LEVEL TONE CONTRASTS

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## ABSTRACT

Using an ABX task, we investigated the L2 perception of 4 level tones in a Niger-Congo language by listeners with different L1s: Vietnamese (1 level tone, 6 tones total), Taiwanese (2 level tones, 6 tones total), and German (no tone). German listeners were better than both tone language groups, which differed significantly from one another in conditions involving tones that are similar to the level tones in their L1. This supports the predictions of Best's [1] Perceptual Assimilation Model, suggesting that the existing level tones can act as perceptual magnets yielding poor performance in the discrimination of level tone contrasts.

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**Keywords:** Tonal complexity, Second language tone perception, Perceptual Assimilation Model

**Scientific areas:** Cross-language Studies, Speech Perception and Production, Language Acquisition

## 1. INTRODUCTION

According to Yip [19], over 70% of the world's languages employ tone for lexical or grammatical purposes. Yet we know very little about how tone is acquired and how its acquisition is influenced by one's native language [3]. The way existing L1 phonetic contrasts modulate the perception of non-native speech has been at the heart of crosslinguistic studies on speech perception. While research has primarily focused on segmental contrasts, suprasegmentals, such as tones, have only recently received more attention. Studies on non-native tone perception have yielded conflicting outcomes regarding the role of L1 tonal contrasts. On the one hand, speakers whose L1 exhibits

more tonal contrasts have been argued to do better in the perception of non-native tones compared to listeners whose L1 has no or only a few tonal contrasts (e.g., Lee *et al.* [10], Wayland & Guion [18], van Dommelen & Husby [16], Kaan *et al.* [9]). On the other hand, So [15] and Francis *et al.* [6] showed that listeners who know (more) tones are not better at perceiving non-native tones compared to listeners who have no prior knowledge of tones. The different outcomes in these studies can be attributed to differences in experimental design, which makes a comparison difficult. Furthermore, in some studies language contact seems to play a larger role in non-native tone perception than L1 tonal contrasts (e.g., Lee *et al.* [10], Leung [11], Liang & van Heuven [12]).

The Perceptual Assimilation Model (PAM; Best [1]) predicts that listeners will assimilate non-native categories to native ones, and consequently the discrimination of novel contrasts will depend on the similarity between the L2 sounds and the L1 categories. Hence, the success at which a given non-native contrast is perceived depends on (i) whether one/both of the sounds in question is/are mapped onto a single/two different L1 sounds, and (ii) the level of similarity between the non-native and the L1 sound. Empirical support for different assimilation processes has so far come from a number of studies (Goto [8] on segments, Ou [14] on stress and, albeit restricted, from tones Lee *et al.* [10]). Here we extend the predictions of PAM to level tones in a language, which was unknown to participants tested. In the present study, we tested the extent to which experience with level tones may influence the non-native perception of a complex system.

## 2. METHOD

### 2.1 Materials

The target language was Toura (Niger-Congo, Mande, spoken in Côte d'Ivoire, Maddieson [13]), with four level tones (henceforth Tone 1 - Tone 4, Tone 4 being the highest level).

We used 6 different CV syllables that exist in all three languages ( $[p^h, t^h, k^h, m, n, l]$  combined with  $[a:, i:]$ ). These syllables were produced with four level tones, Tone 4 (240 Hz), Tone 3 (220 Hz), Tone 2 (200 Hz) and Tone 1 (180 Hz), see Gandour [7] for a similar design. The recording was made with a digital recorder (44.1kHz, 16Bit) by a trained female phonetician who is fluent in Mandarin and Taiwanese. Each syllable was manipulated to a duration of 750 ms (PSOLA resynthesis in Praat, Boersma & Weenik [2]). Intensity did not differ across tones. F0-tracks deviated maximally by  $\pm 2$ Hz from the target values. Three additional syllables  $[bu:, du:, gu:]$  with contour tones were recorded for the control condition, where the third stimulus was identical to either the first or the second item.

### 2.2 Participants

We tested 8 Taiwanese (3 male, mean age=32.7, SD=3.6), 8 Vietnamese (3 male, mean age=25.3, SD=5.7; all from Hanoi), and 8 German listeners (4 male, mean age=26.3, SD=6.7). The tone languages (Taiwanese and Vietnamese) both have six tones but differ in the number of level tones. Taiwanese has two level tones (high and mid, cf. Cheng [4], similar to Toura Tones 4 and 2), Vietnamese has only one (high or mid, cf. Dinh-Hoa [5], similar to Toura Tone 2). The control group, Standard German, has no lexical tonal contrasts. All participants were living in Konstanz, Germany at the time of the study.

### 2.3 Procedure

In each trial, participants heard three different syllables with the same vowel and had to

judge as quickly and accurately as possible whether the tone of the last syllable was identical to the tone of the first or the second syllable by pressing the left or right button of a button box. Each trial started with a centered cross which was displayed on a computer screen for 750 ms. The first two syllables were presented with a silent interval of 1000ms. The target syllable was presented 1000ms later (with a 250ms 338 Hz beep sound embedded in that interval) to avoid pure acoustic comparisons. In control trials, X was identical in segments *and* tone to A or B. There was a timeout of 1750ms.

There were 432 experimental trials (144 trials for each tonal contrast, i.e., 48 trials for each one-level contrast: Tones 4-3, 3-2 and 2-1; 72 trials for each two-level contrast: Tones 4-2 and 3-1, and 144 trials for the three-level contrast: Tones 4-1) and 58 control trials. Each tonal comparison was presented equally often in all possible combinations (e.g., 4-3-3, 4-3-4, 3-4-3 and 3-4-4).

## 3. RESULTS

We excluded 7% of the data because participants responded too slowly. A binomial logistic regression analysis showed that the L1 did not affect the number of timeouts ( $p > 0.7$ ). The performance in the control trials did not show cross-linguistic differences (all  $p$ 's  $> 0.2$ ). As expected, errors were more frequent in the experimental conditions compared to control conditions ( $p < 0.001$ ). Nevertheless, all participants performed above chance for all conditions (one-sample t-test:  $p < 0.05$ ).

Overall, Taiwanese participants (71.4% correct) performed significantly worse than Germans (82.4 %,  $p < 0.05$ ) who did not differ from the Vietnamese (82.1%). The difference between Taiwanese and Vietnamese scores approached significance ( $p = 0.057$ ).

Figure 1 shows participants' performance in one-level contrasts (4-3, 3-2, 2-1). Taiwanese participants (L1 has level tones similar to 4 and 2) performed worse than German participants only in comparing Tones

4-3 and Tones 3-2 ( $p < 0.01$ ), but not Tones 2-1 ( $p > 0.25$ , significance level is 0.016 after Bonferroni correction for multiple comparisons). Vietnamese participants (L1 has level tone similar to Tone 2) performed worse than Germans only in the 3-2 condition ( $p < 0.001$ ). This suggests that the target Tone 3 overlaps with Taiwanese Tones 2 and 4 as well as with Vietnamese Tone 2.

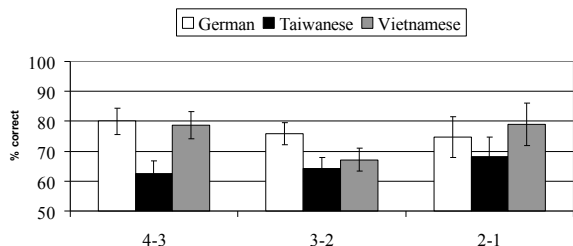


Fig. 1: Mean percentage correct in one-level comparisons. Whiskers represent standard error

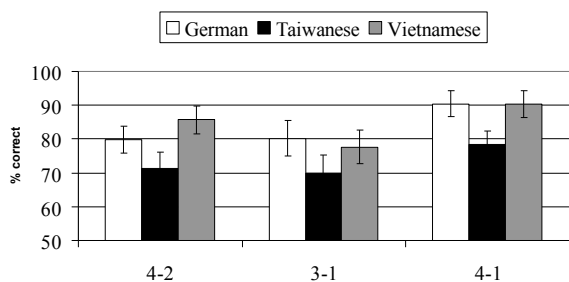


Fig. 2: Mean percentage correct in 2- and 3-level comparisons.

Regarding two-level contrasts (4-2 and 3-1, see Figure 2), neither Vietnamese nor Taiwanese differed from the German group (all  $p$ 's  $> 0.2$ ). For the three-level contrast (4-1), Taiwanese performed worse than the German group ( $p < 0.005$ ). All groups showed significantly better results in three-level comparisons (4-1) than in one-level comparisons (4-3, 3-2 or 2-1, all  $p$ 's  $< 0.01$ ).

#### 4. DISCUSSION

Our study revealed that the ability to perceive level tones in a foreign language is directly influenced by the L1 (tonal) system. More specifically, listeners with two level tones (Taiwanese: mid and high level tones) had more difficulty in perceiving all level tone comparisons than listeners with only one

level tone in their L1 (Vietnamese: mid level tone) or listeners of a non-tonal language (German). Vietnamese listeners only differed from Germans in one condition (3-2). This condition involved tones that arguably corresponded to the different exemplars of the only level tone in Vietnamese, yielding poor performance. Taiwanese, with two level tones (high and mid level), had great difficulty especially in one-level comparisons involving the three higher tones. This is presumably due to the fact that they have more categories in the higher frequency region than the other languages, which causes more confusion. Our findings parallel previous results on the non-native perception of vowel and fricatives by listeners with different vowel and fricative inventory size (Wagner [17]), and are on a par with the predictions of Best's [1] PAM. In particular, the two level tone categories in Taiwanese caused more difficulties than the single one in Vietnamese. German listeners, on the other hand, with no prior linguistic experience with tones performed very well. This is not surprising since even the one-tone comparisons differ in 1.5 to 1.8 semitones.

Our findings also accord with the results of So [15] and Francis *et al.* [6] who showed that tonal contrasts in ones' L1 do not always help in perceiving other tonal contrasts, at least in tasks that do not tap lexical representations.

#### 5. CONCLUSION

We investigated the perception of level tones, as present in some African tone languages, adding a new angle to the increasing body of research on non-native tone perception. Furthermore, we provided evidence for perceptual assimilation in differential degrees, proportional to the number of perceptual magnets in the L1 (Taiwanese two magnets: 28.6% error, Vietnamese one magnet: 17.9% error, German no magnet: 17.6% error). Hence, the presence of parallel tonal contrasts between the L1 and the target language does not necessarily have beneficial effects on the perception of non-native contrasts, a finding

that extends previous observations on the interaction between phoneme inventory size and the perception of segmental contrasts (Wagner [17]) to complex tone systems.

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