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How the experience obtained in the native language affects the perception of a foreign language

Research paper

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Running head: Linguistic and non-linguistic stimuli perception in Estonian and Chinese subjects

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Abstract

Linguistic experience determines how people perceive sounds. This research paper focuses on how Chinese and Estonian groups differ in their discrimination of the linguistic stimuli in a foreign language and its non-linguistic equivalents. Data was collected from 63 Estonian and 61 Chinese participats. In a behavioral discrimination task (AX task), three types of linguistic stimuli with levels of duration, pitch and duration + pitch changes and three of their equivalent pure tone stimuli were used. Chinese stimuli were synthesized from a word “JIDI” and Estonian from a word “SADA”. Dependent variable was d-prime which was calculated from subject’s sensitivity and response bias. The results showed that H1 and H2 were correct, which means that Estonians were better than Chinese in detecting duration changes and Chinese were better than Estonians in distinguishing pitch changes. H3 turned out mostly true, as there were no differences between two groups in distinguishing non-linguistic stimuli for pitch and duration + pitch parameters. However, Estonians were better in detecting changes in pure tones of duration stimuli.

Keywords: language perception, Chinese lexical tone, Estonian quantity, AX discrimination

Kuidas emakeeles omandatud keeleline kogemus mõjutab võõrkeele tajumist

Lühikokkuvõte

Keelekogemus määrab selle, kuidas inimesed tajuvad helisid. Antud uurimistöö keskendub sellele, kuidas Hiina ja Eesti emakeelega grupid erinevad keelelise ja mittekeelelise võõrkeelest tekitatud stiimuli eristamises. Andmed koguti 63 Eesti ja 61 Hiina päritolu osalejalt. Käitumuslikus eristusülesandes kasutati kolme keelelist stiimulit, milles muudeti kas vältust, helikõrgust või vältust koos helikõrgusega, ning kolme nendega samaväärilist mittekeelelist stiimulit. Hiina keele stiimulid sünteesiti sõnast „JIDI“ ja Eesti keele omad sõnast „SADA“. Sõltuv muutuja d-prime arvutati osaleja tundlikkuse ja vastuse tendentsi põhjal. Tulemused näitasid, et H1 ja H2 osutusid tõeseks – eestlased olid paremad kui hiinlased eristamaks vältuse muutusi ning hiinlased olid paremad kui eestlased eristamaks helikõrguse muutusi. H3 osutus peamiselt õigeks, kuna mittekeeleliste stiimulite eristuses polnud kahe grupi vahel erinevusi parameetrite helikõrgus ja vältus + helikõrgus puhul. Siiski ilmnes parameetri vältus puhul nähtus, et eestlastest grupp oli selle mittekeelelise stiimuli eristamises hiinlastest parem.

Märksõnad: keeletaju, hiina leksikaalne toon, eesti vältesüsteem, AX eristusülesanne

Introduction

Language is what makes communication between ourselves possible. Language has helped humans create civilization and culture (Hint, 2004). In our everyday life, we use it as a symbolic code to represent the world around us (Finch, 1998). Language could be analysed into its components, which are phonology, morphology, syntax, semantics, and pragmatics (Woo, 2004). The most relevant of these components for this study is phonetics, which is the study of the characteristics of speech sounds and how humans percieve and produce them (Yule, 2010). There are many different languages around the world and they differ from one another in different aspects. This paper will be focused on Chinese and Estonian language differences and specialities.

The pitch of our voice is continuously changing while speaking. All languages have the pattern of pitch changes which is called intonation, but in a tone language there is the additional function for it. The pitch of a word can also change the meaning of the word. There are around 60-70 percent tone languages in the world and Chinese is one of them (Lin, 2007). One quarter of the population of the world speak Chinese as their first language (Woo, 2004).

In Chinese language tone is lexical. It means that syllables with the same initial and final, but with different tones, are percieved as different (Woo, 2004). Tone is a specific pattern of pitch. The tone of the word depends on the pitch of the voice and therefore each tone classifies either according to how high or low is the pitch level and what is the pitch contour (Lin, 2007). However, tone should not be confused with intonation, because intonation refers to the contour and pitch of a whole clause or sentence, while tone refers to the contour and pitch of a syllable (Woo, 2004).

In Mandarin Chinese there are four basic tones. First tone has high level (T1), second one high rising (T2), third one low falling-rising (T3) and the fourth tone has high falling (T4) pitch pattern. Chinese has one level tone and three contour tones. T1, T2 and T4 are of high register, they are within the higher pitch range, and T3 is within the lower pitch range and a low register tone. For adult language learners pronouncing tone as native speakers do could be very difficult (Lin, 2007).

Estonian language has two main characteristics, which are the tone and its combination with quantity (Lippus, 2007). An important part of Estonian is its three-way quantity system. It is the most studied feature of the phonetic system of Estonian and the reason for this is that it has a unique position in the world’s languages, where more than binary length oppositions are extremely rare (Lippus, 2011). Estonian is one of the examples of languages in which complex patterns of durational relationships are a salient feature of its phonology. In these kinds of languages, the vowel and consonant in a syllable can each have an independent contrastive duration (McAllister et. al., 2002). Therefore, duration of the syllable and its classification to long and overlong play an important part in Estonian phonetic system (Hint, 2011).

There are three quantity degrees in Estonian, which are short (Q1), long (Q2) and overlong (Q3). The main carrier of the quantity is the vowel in the first syllable or the syllable-final consonant. Pitch plays an important role as well in the quantity distinction. Pitch cue is necessary for distinguishing Q2 and Q3 quantity degrees (Lippus et al., 2009). Discrimination between Q2 and Q3 is dependent on temporal or pitch cues. The primary feature of quantity is the temporal structure of the disyllabic foot. Although the main cue for perceiving quantity for the native Estonian listeners is the temporal structure of the word, falling pitch in the first syllable is an important cue for perceiving Q3 (Ross, 2012). It is the stressed vowel, syllable-medial consonants or a combination of a stressed vowel and the following consonant that carries quantity. The variation of length in unstressed syllables is vital for perceiving quantity (Ross, 2012). Furthermore, the dialectal background of the speaker varys the weight of the pitch cue. Estonian speakers from North and West Estonia rely more on the pitch cue than those from South and East Estonia (Ross, 2012).

It has been proven by many studies that linguistic experience shapes the way we perceive speech sounds. Studies have found that adult monolingual listeners are language-specific perceivers who identify and discriminate speech sounds according to the ways in which their native language (L1) organizes phonetic distinctions into phonologically relevant contrasts. L1 backgound also affects the weighting of cues that signal phonetic contrasts and trading relations between these cues. Furthermore, it causes, on a more global level, distortions of the perceptual space for speech sounds (Bohn, 2000).

There are studies that have used mismatch negativity (MMN), a frontal-central cortical event related potential (ERP) associated with automatic involuntary sound processing, to investigate the neurophysiological correlates of categorical perception of lexical tones in native listeners, learners and native speakers of Chinese (Shen & Froud, 2019). Shen and Froud (2019), using MMN, found that there were striking differences between left and right hemisphere activation for native Mandarin Chinese speakers. From these results it could be concluded that the left hemisphere favorably acitivates in response to more relevant acoustic inputs (Shen & Froud, 2019).

In the cross-language and electrophysiological study of pitch perception made by Chandrasekaran et al. (2007) it was found that language perception influences the early cortical automatic processing of linguistically relevant suprasegmental pitch contours. MMN responses were sensitive to cross-language differneces in saliency of percpetual dimensions of tone. The native group, which was Chinese, had larger MMN responses to the high dissimilarity condition than the non-native group, which was English. Dissimilarity condition consisted of Mandarin Chinese words with first and third tones (Chandrasekaran et al., 2007).

In McAllister et al. (2002) study comparing Estonian subjects with English subjects in learning Swedish quantity contrasts, Estonians were more successful than English subjects. It could be concluded from this that native language influences how successful can subjects be in learning a new language. Furthermore, depending on if one’s native language has a quantity system like Estonian has in this case, it is also easier for individuals to perceive a new quantity system.

Lee et al. (2021) researched how Japanese and Cantonese native speakers perceive the Estonian quantity. In Japanese duration is the primary acoustic cue, and in that specific study the results were that Japanese learners of Estonian could distinguish between Estonian long vs. overlong consonants, but not long vs. overlong vowels. This could be in support of the feature hypothesis which states that if a particular feature is used in one’s L1, the benefit of L1 transfer can be exploited in L2. Therefore, Japanese lack of relevant cues in the orthography is why they were not able to distinguish between long and overlong vowels. Comparing Japanese and Cantonese listeners, they found that Japanese listeners outperformed Cantonese in both discrimination and identification of Estonian vowels and consonants. From these results it could be concluded that having systematic two-way length contrasts in their L1 could help listeners discriminate alike two-way length contrasts of a non-native language (Lee et al., 2021).

The aim of this study is to compare Estonian and Chinese subjects in perceiving the non-native linguistic stimuli and their non-linguistic pure tone equivalents. In perceiving Estonian language, Chinese subjects may have a harder time because Chinese does not have a quantity feature like Estonian has. Therefore, Estonian subjects could be better in distinguishing duration change, which is necessary part in their quantity system. Chinese however have tones in their language which vary from each other in changes of pitch. Thus, Chinese subjects could be better in distinguishing a pitch change. Because these differences in perception are caused by linguistic differences, perception of non-linguistic pure tones should not vary between Estonian and Chinese subjects.

Hypotheses

H1: Estonian subjects are better than Chinese subjects in distinguishing duration changes.

H2: Chinese subjects are better than Estonian subjects in distinguishing pitch changes.

H3: There are no differences between Estonian and Chinese subjects' perception of non-linguistic pure tones (non-language stimuli).

Method

Participants

There were altogether 61 Chinese and 63 Estonian subjects. All subjects were volunteers. Participants were found through social media platforms, e-mail lists and personal correspondence. Firstly, the Chinese sample was collected and then the Estonian sample was matched as much as possible based on the age and gender. Recruitment criteria were that subjects had to be aged 18 - 26, right-handed and they had to be healthy. They also could not be professional musician or have long-term musical experience, including singing in a choir. For Estonian subjects their native language had to be Estonian and for Chinese it had to be Chinese. Mean age for Chinese subjects was 22.1 (*SD* = 1.77) and they were aged between 18 - 25, with 28 male and 33 female participants. Mean age for Estonian subjects was 21.2 (*SD* = 1.96), aged between 18 - 26, with 28 male and 35 female participants. All but one participant from Chinese sample were right-handed. That one participant had been left-handed as a child and then corrected-to-right-handed. There were no left-handed subjects in the collected data.

Stimuli

Chinese stimuli were synthesized from the Chinese word “JIDI” and Estonian stimuli from the word “SADA”. The first and the second tone of the Chinese language were used in this experiment. The Chinese stimuli were *jidi* “base” (T1) and *jidi* “polar area” (T2). For Estonian stimuli the long (Q2) and overlong (Q3) quantities were used. The base words were *saada* “to send” (Q2) and *saada* “to get” (Q3). All words were recorded by a female native speaker in the respective language as a natural speech with a sampling frequency of 44100Hz. The stimuli were re-synthesized in Praat, which is a system for doing phonetics by computer (Boersma, 2001). The re-synthesized stimuli used for the experiment were all normalized to an intensity of 80dB.

There were four parameters of Chinese and Estonian stimuli. For Chinese stimuli only the length of the sound in the first vowel of the word was changed – it was either 150ms or 250ms (see Table 1). For Estonian stimuli the length of the consonants and the second vowel were same and the length of the first vowel differed in the same quantity parameters (see Table 2). There were also non-linguistic pure tones which were created based on the physical parameters of the JIDI and SADA stimuli respectively. Altogether there were three parameter type levels for linguistic stimuli and the same three for the non-linguistic stimuli. For linguistic stimuli they were duration, pitch and duration + pitch, and for non-linguistic stimuli they were pure tone equivalents of duration, pitch and duration + pitch.

Table 1

Parameters of Chinese stimuli JIDI (ms)

Parameter	Consonant 1	Vowel 1	Consonant 2	Vowel 2
	J	I	D	I
T1_150	90	150	40	240
T1_250	90	250	40	240
T2_150	90	150	40	240
T2_250	90	250	40	240

Note. T1 is first tone, T2 second tone.

Table 2

Parameters of Estonian stimuli SADA (ms)

Parameter	Consonant 1	Vowel 1	Consonant 2	Vowel 2
	S	A	D	A
Q2_170	90	170	74	115
Q2_290	90	290	74	115
Q3_170	100	170	90	68
Q3_290	100	290	90	68

Note. Q2 is long quantity, Q3 is overlong quantity.

AX paradigm

In speech research it is common to use the *same – different* design (called the AX design, where A and X mark the stimuli to be compared). In this design two stimuli are presented in each trial and they are separated by a specific amount of time, which is called ISI (interstimulus interval). Subject's task is to identify if the two same or two different stimuli were presented. The number of same stimuli pairs and different pairs is the same, otherwise discrimination between the pairs could get difficult for the participant. That is because the subject expects to perceive the same and different pairs same number of times (McGuire, 2010). The stimuli were presented at normal hearing volume (18-22% of the computer volume level at the Estonian laboratory and 28-32% in the Chinese laboratory). The software for the stimulus presentation in China was E-prime 3.0 and in Estonia E-prime 2.0 (Psychology Software Tools, Pittsburgh, PA, United States).

Procedure

The experiments were conducted in China and in Estonia, respectively. Participants were asked to come to the specific laboratory where the experiments took place. The Estonian subjects had to fill in the Kaemus questionnaires beforehand and in the lab, they had to answer questions about their age, eyesight and if they had recently smoked or drank coffee. In China, the participants filled the questionnaire on-site and after that they were also asked about their age, eyesight, coffee consumption and smoking habits. However, in this research paper the questionnaire data was not analyzed.

The experiments were conducted in a quiet, dimmed, and electrically shielded room. Participants were given headphones and they were told to sit still and avoid bigger movements, especially during the recording of the EEG. In the Estonian laboratory the subject's hearing levels were measured with an audiometer (Interacoustics AS608). Then in the main experiment, different parts (in China, the EEG experiment and the AX experiment; in Estonia both former and in addition the dichotic listening experiment) were conducted in a row, while the subjects had the EEG electrodes attached for the whole time. After the EEG experiment participants conducted the AX experiment. Altogether the laboratory visit lasted about two to three hours. Again, in the current research paper only the data of the AX experiment was analyzed.

In AX discrimination task participants had to choose if the sounds that they heard from the headphones were same or different from each other. The instructions were first given orally and the whole procedure were thoroughly explained. The experiment started with 10 practice trials with non-word "tada" for the subjects to get used to the experimental procedure and answering logic. All the stimuli were divided into four series for subjects to have short breaks in between. Subjects were able to choose the length of the break themselves.

Participants were handed a keyboard to answer the question by clicking button "F" for "same" and "J" for "different". Two sounds were separated from each other with length of 300 ms (ISI) and participants had a time of 1000 ms for responding. There were 12 different pairs with 5 repetitions and 4 same pairs with 15 repetitions for both JIDI and SADA parameters. Altogether there were 120 pairs of JIDI and 120 pairs of its pure tone equivalents for the Estonian subjects, and 120 pairs of SADA and 120 pairs of its pure tone equivalents for the Chinese subjects. Participants had to discriminate them in randomized order.

Ethics

In the beginning of an experiment participants were asked to sign a consent form in which the experiment and its purpose were explained. Participants were told that they could stop the experiment at any time. The study in Estonia had an approval from the Research Ethics Committee of the University of Tartu (Tartu Ülikooli inimuuringute eetika komitee), number 332/T-23 (date 21.12.2020). The study in China was conducted based on the ethics requirements there. All the laboratory measurements and experiments were non-invasive. Collected data is only used for scientific purposes. For confidentiality purposes, each subject received a unique subject code and used it instead of their name in the experiment. Data that would able the identification of subjects will be destroyed the latest in March 2023. After finishing the experiment, the participants were given a gift card for their effort and the ones that take psychology courses received experiment participation points if they wanted.

Results

Three subjects from the Chinese sample were removed from the data analysis because they missed more than 50% of the trials. Therefore, the data analysis was based on 58 Chinese subjects.

In this experiment the dependent variable was the response to the AX task, i.e., subject's ability to detect signals (d-prime). Scores of the hit rates were calculated into sensitivity and false alarm rates into subject's response bias. Signal detection theory is precisely what is used to also be aware of the listener's tendency to answer "same" or "different" when doing the experiment. Subject's sensitivity is better when the difference between hits (H) and false alarm (F) rates is larger and to measure this difference, statistic d-prime is used (d'). According to the signal detection theory: d' = z(H) - z(F), where z-scores of the H and F rates are used (Keating, 2004). This was calculated for each three levels of linguistic or non-linguistic stimuli and separately for each subject in statistics program JASP. To get rid of the extreme values like 0s and 1s, the fourth solution suggested by Stanislaw and Todorov (1999) was used, meaning that rates of 0 were replaced with 0.5/n and rates of 1 with (n-0.5)/n, where n is the number of signal or noise trials (Stanislaw & Todorov, 1999). In the current study, the n was 120 (see Method).

Mean results were calculated in linguistic and non-linguistic stimuli with three levels of parameters (duration, pitch, duration + pitch) for Chinese and Estonian groups, respectively. Chinese group mean results of d-prime for linguistic stimuli were 1.87 (*SD* = 0.87) for duration, 3.76 (*SD* = 0.70) for pitch, 3.84 (*SD* = 0.62) for duration + pitch, and mean results for non-linguistic stimuli were 1.50 (*SD* = 0.80) for duration, 3.38 (*SD* = 0.76) for pitch and 3.38 (*SD* = 0.80) for duration + pitch. Estonian group mean results of d-prime for linguistic stimuli were 3.34 (*SD* = 0.82) for duration, 3.19 (*SD* = 0.99) for pitch, 3.73 (*SD* = 0.64) for duration + pitch, and mean results for non-linguistic stimuli were 3.05 (*SD* = 0.87) for duration, 3.17 (*SD* = 0.90) for pitch and 3.56 (*SD* = 0.68) for duration + pitch.

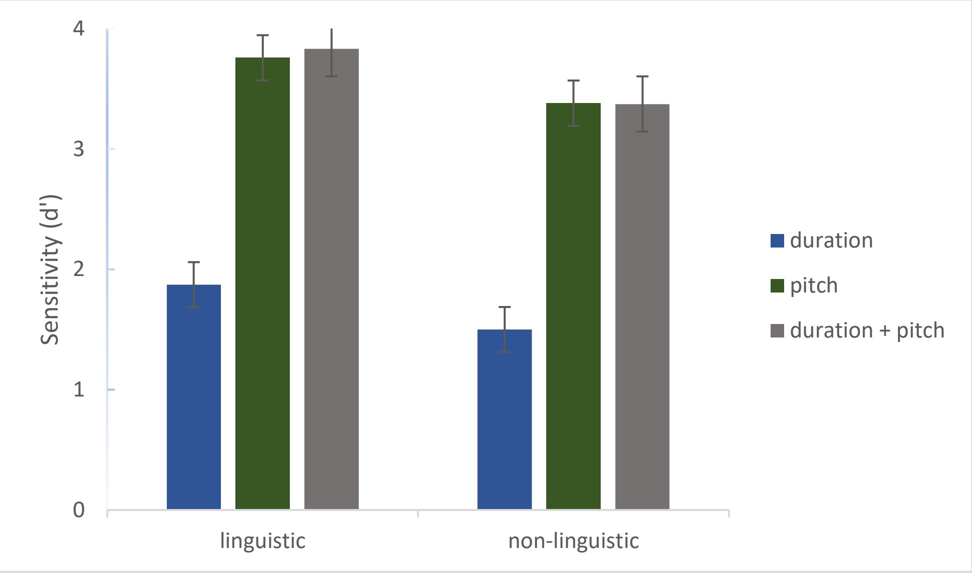

Figure 1. Mean results of sensitivity (d’) for linguistic and non-linguistic stimuli of the Chinese group (N = 58).

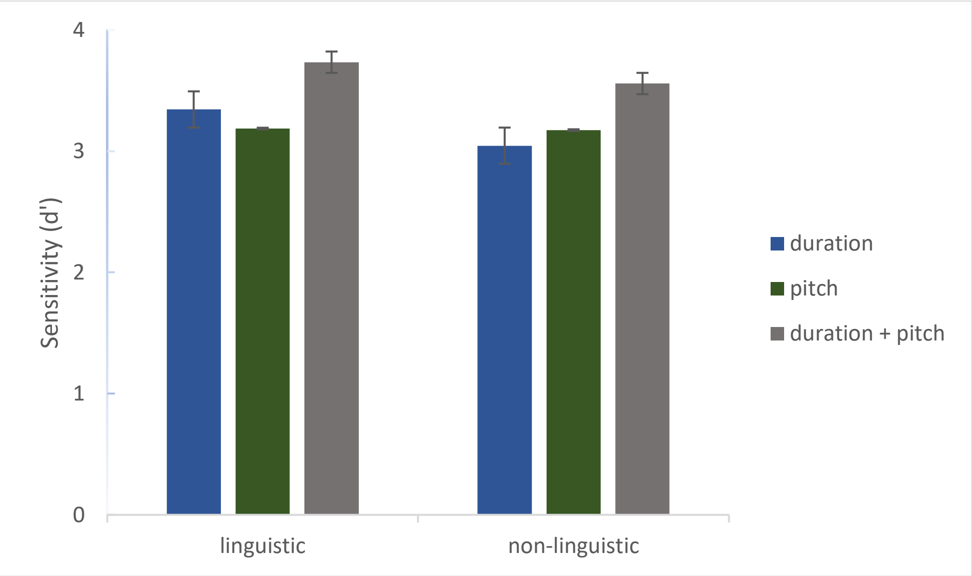

Figure 2. Mean results of sensitivity (d’) for linguistic and non-linguistic stimuli of the Estonian group (N = 63).

For further statistical analysis a three-way ANOVA was conducted. One independent variable was stimuli type with two levels, linguistic and non-linguistic. For JIDI series it was JIDI (linguistic) and JIDI pure tone (non-linguistic) and for SADA series it was SADA (linguistic) and SADA pure tone (non-linguistic). Another independent variable was Chinese or Estonian language group and a third independent variable was parameter type, which had three levels: duration, pitch and duration + pitch.

Main effects were statistically significant for all three independent variables – language group, $F(1, 714) = 42.51$, $p < .001$, stimuli type, $F(1, 714) = 22.89$, $p < .001$, and parameter type, $F(2, 714) = 148.40$, $p < .001$. Interaction between language group and parameter type was statistically significant, $F(2, 714) = 94.06$, $p < .001$. Interaction between language groups and stimuli type was also statistically significant, $F(1, 714) = 4.14$, $p = .042$. Other interactions were not statistically significant.

A post-hoc test of the language group and parameter type interaction showed that the statistically significant difference was between Estonian and Chinese groups in discriminating duration changes, $p < .001$, and pitch changes, $p < .001$. The Estonian group was better in discriminating duration changes and Chinese group was better in discriminating pitch changes. Interaction was not statistically significant between Estonian and Chinese groups in discriminating duration + pitch changes.

Furthermore, for Estonian group d-prime results were higher for duration + pitch parameter type than in duration ($p < .001$) and pitch ($p < .001$). There was no statistical difference between duration and pitch. For Chinese group d-prime results of duration + pitch ($p < .001$) and pitch ($p < .001$) were higher than d-prime results of duration. There was no statistical difference between pitch and duration + pitch results.

A post-hoc test of the language group and stimuli type interaction showed that in Chinese group there was a statistical significance in linguistic and non-linguistic stimuli, $t = 4.73$, $p < .001$. Chinese were better in discriminating linguistic stimuli than non-linguistic stimuli. However, in Estonian group difference between linguistic and non-linguistic stimuli was not significant, $p = .095$. Furthermore, there was an unexpected statistically significant difference between Chinese and Estonian groups in discriminating non-linguistic sounds, $t = 6.05$, $p < .001$, where Estonians were better at discriminating pure tone equivalents of duration stimuli.

Discussion

The aim of this research is to see how the difference in one's L1 background (e.g., Mandarin Chinese and Estonian) affects the perception of an L2 (and its non-linguistic equivalents). In Chinese language tone is lexical, which means that pitch level plays an important role in determining the meaning of the word (Woo, 2004). In Estonian language however duration of the syllable is the important part of Estonian phonetic system (Hint, 2011). Therefore, Estonians should be better in distinguishing duration changes and Chinese should be better at distinguishing pitch changes. For non-linguistic stimuli there should be no difference between the two groups, because there are no linguistic cues that would cause the difference.

The first hypothesis which states that Estonians could detect duration changes better turns out to be true and the effect is statistically significant. That goes together with the fact that distinguishing differences in duration is improtant to Estonians for understanding the language (Hint, 2011). For example, McAllister et al. (2002) study compared Estonian and English subjects in learning Swedish quantity contrasts and they found that Estonians had better results than English subjects, because Estonian has a similar quantity system with Swedish (McAllister et. al., 2002). In a recent study on the perception of Estonian quantity, Lee et al. (2021) compared Japanese and Cantonese native speakers. They found out that Japanese were better at discriminating Estonian vowels and consonants than Cantonese listeners. The study concluded that this could be explained by Japanese having duration as the primary acoustic cue in their language. Therefore, having had similarities in their native language with Estonian language system, Japanese did better than Cantonese listeners in distinguishing Estonian vowels and consonants (Lee et al., 2021). Results from the current research corroborate with findings from Lee et al. (2021) study that discrimination between duration changes comes easier to those who use it in their native language.

The second hypothesis also turns out to be true, as Chinese are better than Estonians in detecting pitch changes and the result is statistically significant. Chinese is a tonal language. In Chinese language pitch change is used to distinguish word meaning, which means that syllables with different tones, but with the same initial and final, are perceived as different (Woo, 2004). The research done by Chandrasekaran et al. (2007), who also studied pitch perception, found that the language perception influences the early cortical automatic processing of linguistically relevant suprasegmental pitch contours. In their experiment, Chinese group showed larger MMN responses to the condition that consisted Chinese words, and were more sensitive towards pitch than the non-native group (Chandrasekaran et al., 2007). Consistent with previous research, the current study showed that Chinese are more sensitive to pitch changes than Estonians, in whose L1 pitch only plays a secondary cue (Lippus, 2007).

The last hypothesis states that there should be no differences between the two groups in perceiving the non-linguistic stimuli. Native language should not affect distinguishing between non-linguistic stimuli. It stands true for pure tone equivalents of pitch and duration + pitch stimuli, where the difference between Estonian and Chinese groups is not statistically significant. However, statistical analysis shows that for pure tones of duration changes there is a statistically significant effect. Estonians are able to distinguish between pure tones of duration better than Chinese subjects.

A previous study by Tervaniemi et al. (2006) showed that language background might have an effect on the perception of non-language stimuli. This is called the transfer of effect across domains (i.e., language domain and non-language domain). Tervaniemi et al. (2006) found that the quantity language speakers, who were in their case Finnish speakers, could detect duration differences in short non-linguistic sounds more accurately than the non-quantity language speakers, in their case German speakers. The paper by Tervaniemi et al. (2006) offers for an explanation, that the Finnish are more experienced in the extraction of duration information of a sound per se because of their language system. In the current research paper, the non-linguistic stimuli were created based on the physical parameters of the linguistic stimuli from the disyllabic word JIDI that mimics the Estonian quantity. Therefore, it could be that Estonians are able to still pick up the changes in duration even in the non-linguistic equivalent of the duration stimuli, showing a transfer of effect from the language domain to the non-language domain.

For future studies, one thing that could be explored more is whether using different words to make the parameters of the stimuli still leads to similar results in the end. Words that were used in the experiment were already picked with a lot of consideration. If Estonian group would continiously be better than Chinese group in distinguishing duration changes in non-linguistic stimuli, then it moreover would confirm findings of Tervaniemi et al. (2006) paper, that Estonian language having a quantity system makes the discrimination of non-linguistic stimuli easier for Estonian group.

In conclusion, the current paper showed that Estonians are better in perceiving duration changes in L2 stimuli, because in Estonian language duration plays a key part in understanding the meaning of the words (Hint, 2011). Chinese on the other hand are better in distinguishing changes in pitch, because Chinese is a tonal language, where the pitch of a syllable has an important part in determining the meaning of the word (Woo, 2004). Additionally, in this study Estonians are better than Chinese in distinguishing duration changes in the non-linguistic stimuli. Taken together, it could be concluded that language background affects the perception of a foreign language and possibly also its non-linguistic equivalents.

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