

## Perception of birth language tone contrasts by adopted Chinese children

Wencui Zhou<sup>1,2</sup>, Mirjam Broersma<sup>2</sup>

<sup>1</sup> Max Planck Institute for Psycholinguistics, Nijmegen

<sup>2</sup> Radboud University Nijmegen, the Netherlands

wencui.zhou@mpi.nl

### Abstract

The present study investigates how long after adoption adoptees forget the phonology of their birth language. Chinese children who were adopted by Dutch families were tested on the perception of birth language tone contrasts before, during, and after perceptual training. Experiment 1 investigated Cantonese tone 2 (High-Rising) and tone 5 (Low-Rising), and Experiment 2 investigated Mandarin tone 2 (High-Rising) and tone 3 (Low-Dipping). In both experiments, participants were adoptees and non-adopted Dutch controls. Results of both experiments show that the tone contrasts were very difficult to perceive for the adoptees, and that adoptees were not better at perceiving the tone contrasts than their non-adopted Dutch peers, before or after training. This demonstrates that forgetting took place relatively soon after adoption, and that the re-exposure that the adoptees were presented with did not lead to an improvement greater than that of the Dutch control participants. Thus, the findings confirm what has been anecdotally reported by adoptees and their parents, but what had not been empirically tested before, namely that birth language forgetting occurs very soon after adoption.

**Index Terms:** birth language, tone contrasts, perception, Cantonese, Mandarin

### 1. Introduction

International adoptees are a unique population of language acquirers. They acquire their birth language in their early childhood, but experience a sudden cut-off at adoption, and are simultaneously faced with the task of learning a new language. A common experience is that after *some time*, adoptees do not remember anything about their birth language anymore. Previous research has investigated if this means that all traces of the memory of the birth language are lost, or whether those memories might still be dormant and can be refreshed with re-exposure. No studies so far have addressed the question what 'some time' means: how long after adoption do memories of the birth language become unavailable? That is what the present study sets out to investigate.

In the current study, children are investigated who have been adopted relatively recently, between 0;3 and 9;11 years ago. They are tested on the perception of tones from their birth language, either Cantonese or Mandarin Chinese. The young adoptees' perception of those tones is compared to that of a control group of age matched non-adopted Dutch children.

So far, very little is known about the retention or forgetting of the birth language in adopted children. Two case studies have investigated changes in the use of the birth language after adoption and reported a quick decline in use. Isurin (2000) reports a case study with a Russian girl who was adopted at the age of nine, over a period of 13 months, and reports a drop of her Russian vocabulary after adoption (note, however, that the girl still maintained an accuracy of 85% in the Russian vocabulary task at the end of the investigation).

Nicoladis and Grabis (2002) report observations of a 17 months old Cantonese girl four weeks after her adoption. They observed that the girl rapidly lost her production and comprehension of Cantonese. As both are case studies, no generalizations can be made. Further, both studies assess (spontaneous or elicited) overt language use, and vocabulary knowledge. This leaves the possibility open that adoptees might retain other knowledge of their birth language that they do not show in overt language use.

An investigation by Singh, Liederman, Mierzejewski, and Barnes (2011) focuses on phonological memory, several years after adoption. They investigated eight Indian adoptees who had been in the United States for a period of 5;3-14;7 years (*mean = 10;3 years*). The adoptees were between 8;9-15;1 years old (*mean = 11;5 years*) when they were tested, and were adopted at an age of 0;6-6 years old (*mean = 1;10 years*). They were trained and tested on the perception of the Indian voiced and voiceless retroflex versus dental stop contrast. Results show that both the adoptees and a group of non-adopted control participants failed to perceive the contrast before training. This suggests that the adoptees had lost their perceptual sensitivity to their birth language contrast. However, after a brief training session, the adoptees outperformed their non-adopted peers, which suggests that they had not lost the memory of their birth language phonology completely.

Similar results have been found in studies investigating adoptees who were adopted in their early childhood, but were tested when they had reached adulthood. Pallier and colleagues present two studies that tested adult Korean adoptees who had been separated from their birth language for more than 20 years; in both studies, no traces of birth language memory were found. Pallier et al. (2003) tested eight adult Korean adoptees using behavioural tasks and fMRI. The Korean adoptees were adopted when they were between 3 and 8 years old (*mean = 5;6 years*), and were tested when they were between 20 and 32 years old (*mean = 26;8 years*). Neither the results of the behavioural tasks nor of the fMRI study show any trace of birth language memory. Ventureyra, Pallier, and Yoo (2004) investigated 18 adult Korean adoptees who were adopted when they were between 3 and 9 years old (*mean = 5;8 years*), and tested when they were between 22 and 36 years old (*mean = 29;2 years*). A phoneme discrimination task was used to test their perception of the Korean 3-way contrast of voiceless stops (namely, fortis, aspirated, and lenis), at velar and bilabial place of articulation, and the 2-way contrast of denti-alveolar voiceless fricatives (namely, plain and fortis). There was no difference between the adoptees and a group of non-adopted controls, which was striking because some of the adoptees were adopted at a rather advanced age, of up to nine years old.

Hyltenstam, Bylund, Abrahamsson, and Park (2009) tested 21 adult Korean adoptees who had received formal training in Korean as adults for an average of 2;1 years. The 21 Korean adoptees were adopted at the age of 0;3-10;6 years old (*mean = 2;4 years*), and were tested when they were

between 23 and 37 years old (*mean* = 31;4 years). A control group consisted of 11 non-adopted learners who had received Korean language training for an average of 4;1 years. Perception tests assessing the use of voice-onset-time for the 3-way stop contrast (at velar, bilabial, and labiodental place of articulation), and for the plain and fortis alveolar affricate showed no difference between the two groups. In a grammaticality judgment test, however, the control group outperformed the adoptees, suggesting that they were poorly matched on relevant characteristics.

Finally, Oh, Au, and Jun (2010) examined 12 adult Korean adoptees who had attended a Korean language course at the university. The 12 adoptees were adopted at the age of 0;3-3 years old, and tested when they were between 18 and 33 years old (*mean* = 21 years). They were tested during the second week of their Korean course. A phoneme identification task on the 3-way stop contrast (at velar and denti-alveolar place of articulation) revealed that the adoptees did not perform better than the non-adopted learners in the overall analysis, but that the adoptees outperformed the controls in certain types of phonemes.

Previous studies on birth language development have thus looked at international adoptees who varied in the period of time that had elapsed since their adoption, ranging from some weeks to several decades. Both observational and empirical studies suggest the loss of birth language knowledge after adoption. Studies assessing the birth language soon after the adoption, however, were observations of overt language use rather than tests of implicit memory, and were both case studies of a single child. Further, those studies were only concerned with vocabulary and sentences, and not with phonology. Thus, it is still unclear how quickly after adoption implicit memory of the birth language is lost. The current study aims to fill this empirical gap by investigating two large groups of Chinese adoptees relatively soon after their adoption, assessing their memory of the phonology of their birth language.

In particular, we investigate whether the adopted Chinese children outperform two groups of non-adopted control participants in perception of tone contrasts from their birth language. Experiment 1 is concerned with Cantonese Chinese, and Experiment 2 with Mandarin Chinese. Both studies investigate lexical tones, which do not exist in Dutch. We predicted that Dutch listeners would find it difficult to distinguish the lexical tone contrasts (see, e.g., Best & Tyler, 2007).

## 2. Experiment 1

Experiment 1 tested children who were adopted from the Cantonese area in China. The Cantonese tone contrast tone 2 (High-Rising) vs. tone 5 (Low-Rising) was tested. The two tones are both rising tones, but differ in the height of rise at the end of the tone contour (tone 2 rises much higher than tone 5).

Data from native children documented that both rising tones are acquired at the age of 1;3-1;11 years (So & Dodd, 1995; C.-Y. Tse, 1992; J. K.-P. Tse, 1978). Due to the absence of tones in Dutch phonology, we expected that Dutch listeners would find it hard to perceive the contrast.

### 2.1. Method

#### 2.1.1. Participants

In total, 45 children participated; 22 were Cantonese adoptees and 23 were non-adopted Dutch controls (see Table 1).

The 22 Cantonese adoptees (15 girls and 7 boys) were adopted between 9 and 54 months old (i.e., 0;9-4;6 years) (*mean* = 26 months, i.e., 2;2 years). They had lived in the Netherlands for a period of 17-119 months (i.e., 1;5-9;11 years) (*mean* = 63 months, i.e., 5;3 years), and were 52-130 months old (i.e., 4;4-10;10 years) (*mean* = 89 months, i.e., 7;5 years) at test. Nine of them had Cantonese siblings. Ten of them had visited the Cantonese-speaking area of China after adoption (nine children visited it once for an average of 13 days, and one child visited it twice for 24 days in total). Seven of them had received music training, for an average of 11.9 months. They were recruited with the help of Dutch adoption organizations, and through informal networks of adoptive parents.

The 23 Dutch controls (12 girls and 11 boys) were born and lived in the Netherlands in their Dutch speaking birth families. They were tested at the age of 55-126 months old (i.e., 4;7-10;6 years) (*mean* = 92 months, i.e., 7;8 years). Seven of them were related to Cantonese adoptees (four had a Cantonese sibling, one a Cantonese cousin, and two a Cantonese friend). Four of them visited the Cantonese-speaking area of China once, for an average of 19 days. Nine of them received music training, for 15.8 months on average.

Table 1. Experiment 1, participants.

Participants	Age (mean)	Age of adoption (mean)	Length of residence (mean)	Cantonese sibling	Visit to Cantonese part of China	Music training
Cantonese adoptees N = 22	7;5 years	2;2 years	5;3 years	N = 9	N = 10	N = 7
Dutch controls N = 23	7;8 years	NA	NA	N = 4	N = 4	N = 9

Note. "NA": Not applicable

#### 2.1.2. Materials

Sixteen minimal pairs of disyllabic Cantonese pseudowords were created for the tone contrast, consisting of two phonotactically legal Cantonese monosyllables (Kwan, 2006). The first syllable always consisted of the open central unrounded vowel [a] in tone 1 (High-Level). The second syllable contained the crucial tone (i.e., either tone 2 (High-Rising) or tone 5 (Low-Rising)). The syllabic structure of the second syllable was CV, CVN, CGLideV, or CGLideVN.

Three female native Cantonese speakers (ages = 21, 26, and 28 years) were recorded. They read all stimuli in random order and in a clear citation style. All stimuli were recorded multiple times. For each speaker, one token of each stimulus was selected for the tests (i.e., 32 stimuli per speaker), and 10 tokens of each stimulus for 12 of the minimal pairs were selected for the 10 training blocks (i.e., 240 stimuli per speaker). Recordings were made in a sound-proof booth and were segmented with the software package PRAAT (Boersma & Weenink, 2001).

To make sure that participants understood the task, an instruction block with practice trials was prepared. Fifty-two Dutch sentences were recorded for instructions, and 10 minimal pairs of disyllabic Dutch pseudowords were created for the practice.

Three female native Dutch speakers (ages = 27, 35, and 36 years) recorded the practice stimuli (in citation style) and one of them also recorded the instructions (in a child-directed style). Stimuli were recorded and segmented in the same way as the Cantonese stimuli.

### 2.1.3. Procedure

The experiment consisted of three tests (pre-, intermediate-, and posttest) and 10 training blocks. The three tests were identical except that the stimuli were presented in a different randomized order. There was no feedback for the tests. Each test consisted of 16 trials and lasted 4 minutes. The ten training blocks contained the same stimuli but different tokens of the stimuli, which were presented in different randomized orders. To help the participants learn, after every trial, they received feedback about the correctness of their response. Each training block contained 24 trials and lasted 7 minutes.

Data were collected during four visits at the participants' homes over a period of two weeks. There was a two or three days' gap between every two visits. Each visit consisted of a test and several training blocks, except that the third visit contained only training blocks. There was a short break (10 minutes) after each block. Thus, each visit lasted around 45 minutes.

To motivate the young participants to complete the tasks, an animated video game was developed for the current study. A panda family, including a mother and two babies, was created with Adobe Photoshop and Flash CS 5.

The task used in both tests and training was an XAB discrimination task. Participants heard three stimuli, one from the panda mother, and two from the panda babies. They were asked to judge which panda baby (A or B) said exactly the same word as the panda mother (X). Participants indicated their response with a button press.

### 2.1.4. Results and discussion

Perception scores were analyzed with Repeated Measures Analyses of Variance, with the variables Group (Cantonese adoptees vs. Dutch controls), and Test (Pretest vs. Intermediate test vs. Posttest), and with current age, whether or not the participant had any Cantonese siblings, whether or not they had visited China (after adoption), and whether or not they had received musical training as covariates.

Figure 1 shows that the Cantonese adoptees and Dutch controls performed similarly, before and after training. Further, there was no improvement from the pretest to the intermediate test and to the posttest. The analysis confirms that there was no significant effect of Group or of Test, and no interaction between them. There was a significant effect of age,  $F_1(1, 39) = 8.134, p < .01, \eta_p^2 = .173$ : The older the participants were, the better they performed. There were no other significant effects or interactions.

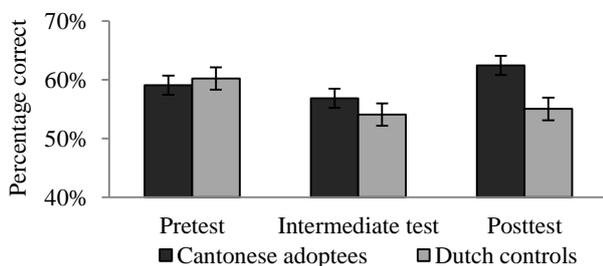


Figure 1. Percentage correct at pretest, intermediate test, and posttest (error bars represent standard deviations).

## 3. Experiment 2

Experiment 2 investigates the perception of the Mandarin tone contrast between tone 2 (High-Rising) and tone 3 (Low-Dipping). Tone 2 has a smooth rising contour, whereas tone 3 consists of two movements, i.e., falling and rising. Both tones have been reported to be acquired around 1;4-1;10 years by

native children (Zhu, 2002). American English listeners have been reported to confuse the two tones in perception, even after extensive training (Wang, Spence, Jongman, & Sereno, 1999). Therefore, we expected the contrast to be difficult for Dutch listeners to perceive as well.

### 3.1.1. Participants

52 children participated; half were Mandarin adoptees and half were non-adopted Dutch controls (see Table 2).

The 26 Mandarin adoptees (15 girls and 11 boys) were adopted between the age of 10 and 68 months (i.e., 0;10-5;8 years) ( $mean = 28 months, i.e., 2;4 years$ ). They had lived in the Netherlands for a period of 3-118 months (i.e., 0;3-9;10 years) ( $mean = 60 months, i.e., 5;0 years$ ), and were 49-130 months old (i.e., 4;1-10;10 years) ( $mean = 88 months, i.e., 7;4 years$ ) at test. Three of them had Mandarin siblings. Six of them had visited the Mandarin-speaking area of China after adoption (five visited it once, for an average of 14 days, and one visited it twice, for 35 days in total). Six of them received music training, for an average of 19 months.

The 26 Dutch controls (13 girls and 13 boys) were between 50 and 128 months old (i.e., 4;2-10;8 years) ( $mean = 87 months, i.e., 7;3 years$ ). Six of them were siblings of Mandarin adoptees. Two of them had visited the Mandarin-speaking area of China before participation (one visited it once for 21 days, and one visited it twice for 35 days in total). Nine of them had received music instructions, for an average of 27 months.

Table 2. Experiment 2, participants.

Participants	Age (mean)	Age of adoption (mean)	Length of residence (mean)	Mandarin sibling	Visit to Mandarin part of China	Music training
Mandarin adoptees N = 26	7;4 years	2;4 years	5;0 years	N = 3	N = 6	N = 6
Dutch controls N = 26	7;3 years	NA	NA	N = 6	N = 2	N = 9

Note. "NA": Not applicable

### 3.1.2. Materials

Following the same procedure as in Experiment 1, sixteen minimal pairs of disyllabic Mandarin pseudowords were created and recorded by 3 female Mandarin speakers (ages = 21, 26, and 29 years old). In this experiment, the crucial tone on the second syllable was either Mandarin tone 2 or tone 3.

Instructions and practice stimuli were the same Dutch stimuli used in Experiment 1.

### 3.1.3. Procedure

The Procedure was the same as that in Experiment 1.

### 3.1.4. Results and discussion

As shown in Figure 2, the Mandarin adoptees did not outperform the control group in their perception of the Mandarin tone contrast in any of the three tests. The analyses showed that, like in Experiment 1, there were no significant effects of Group or Test, and there was no interaction between Group and Test. Thus, adoptees and controls did not perform differently at any of the tests.

Further, children who had visited China (for the adoptees: after adoption) performed better than children who had not visited China,  $F_1(1, 46) = 4.389, p < .05, \eta_p^2 = .087$ , and there was a significant interaction between Test and music training,  $F_1(2, 92) = 3.251, p < .05, \eta_p^2 = .066$ . Follow-up analyses showed that children with music training performed better

than children without music training in the posttest,  $F_1(1, 50) = 7.089, p < .05, \eta_p^2 = .124$ .

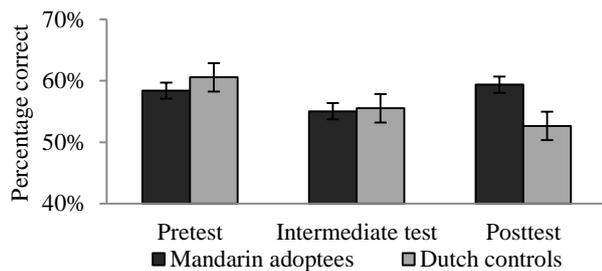


Figure 2. Percentage correct at pretest, intermediate test, and posttest (error bars represent standard deviations).

#### 4. General Discussion

The results from Experiments 1 and 2 showed that the Chinese adoptees from the Cantonese and the Mandarin regions of China were not better at perceiving their birth language tone contrasts than age-matched Dutch control participants, either before or after training. A trend towards better performance by adoptees than Dutch control participants in the post-tests of both experiments (see Figures 1 and 2) did not reach significance. Crucially, the adoptees tested in this study had been in their adoptive country for a relatively short period of time, from a few months to a few years (Cantonese adoptees: 1;5-9;11 years; Mandarin adoptees: 0;3-9;10 years). This is much shorter than the adoptees tested in previous empirical research. Interestingly, after such a short time of non-exposure to the birth language, the adoptees did not outperform the controls in discrimination of their birth language tones; thus there was no evidence that the adoptees had any remaining memories of the tones of their birth language.

Another interesting finding from this study is that the re-exposure that the adoptees received during the training did not significantly improve their perception of the tones of the birth language. Even after 10 training blocks of 240 trials in total, the adoptees did not improve their perception of their birth language tone contrasts. This finding differs from that of Singh, et al. (2011), who reported a quick improvement in the Indian adoptees' perception after one brief training session of only 64 trials. One possibility is that a relearning effect for the adoptees in our study, for which we find a small hint in the post-tests of both experiments did not reach significance because of the small number of test trials that were used due to the young age of our participants (i.e., 16 trials in each test). Another possibility is that tone contrasts are forgotten faster in a non-tonal environment than segmental contrasts, or are more difficult to re-access with training. Due to the methodological differences in both studies, however, it is unclear what caused the difference in the effect of training in Singh et al. (2011) and the present study.

Note that difficult tone contrasts were used in both experiments, which may have contributed to the lack of a difference between adoptees and Dutch control participants, and to the lack of learning in the present study. Furthermore, only a discrimination task was used in the current study. It is possible that evidence for birth language memories might be found with other experimental paradigms.

To conclude, the current study has demonstrated that it takes Chinese adoptees very little time to lose their sensitivity to their birth language tone contrasts after adoption. Our results thus confirmed what has been anecdotally reported by many adoptive parents, but what had never been scientifically tested, namely that birth language forgetting occurs very soon after adoption.

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