Learning Mandarin Chinese in the Classroom

How does the adult brain change as a result of typical classroom-based foreign language training? How are pre-training neural differences affecting learning?

Young adults (N=48) with no prior Mandarin exposure underwent an intensive month-long, half-day, introductory Mandarin course (3.5 hours per day, 5 days per week) for 4 weeks, plus an average of 2.7 hours of daily homework, equivalent to a semester-long course.

Participants completed the textbook *The New Practical Chinese Reader* (Ju, 2010) and were assessed at the end of the course with both a comprehensive oral and written final exam and the Mandarin Proficiency Test (MPT) administered by a native Chinese speaker (Liu, 2010). Participants’ long-term retention of Mandarin skills was reassessed 90 days later.

Participants completed an fMRI experiment both before and after the month-long Mandarin course, including Mandarin speech and non-speech discrimination tasks.

Brain Stimulation and Language Learning

Noninvasive brain stimulation improves learning in some low-aptitude learners

A. Daily training phase

- **Noninvasive brain stimulation** (high-definition transcranial direct current stimulation, HD-DCS) was applied over left IFG with anodal polarity at 2mA. Participants were randomly assigned to real or sham stimulation, which lasted the full course of each training and testing session (15–20 min). Locations of stimulating (anodal) and return (cathodal) electrodes and maps of cerebral current flow are shown below.

B. Daily testing phase

- **Current density** and **amplitude** of left IFG stimulation were measured using **multi-electrode arrays** (MEO; 2×2 mm). A **mapping procedure** was performed in order to achieve a **preferential stimulation of the dorsolateral prefrontal cortex**. A **3D volume** was reconstructed using a **multi-electrode array**.

HD-DCS stimulation location and current flow maps

With Zhengan Gu, Michelle Han, Yutian Wang, Carlo de los Angeles, Qi Liu, Keri Garel, Ee San Chen, Susan Whitfield-Gabrieli and John Gabrieli. Supported by DARPA. Participants’ long-term retention of Mandarin skills was reassessed 90 days later.

Learning Korean Sounds and Words

What are the specific brain changes associated with learning a new phonological contrast as an adult? How do individual differences in brain structure before training predict future learning success? What is the relationship between the structural predictors and the functional outcomes?

Young adults (N=37) with no prior Korean experience and less than 2 years of experience with any other foreign language participated in a 4-day, hour-long, laboratory-based training paradigm, in which they learned to associate 16 pseudowords with photographs. The pseudowords comprised 4 minimal triplets based on the Korean 3-way stop consonant contrast (e.g. [b] / [p] / [t] “ball” / “pig” / “floor”; [s] / [ss] “soup” / “snow”). This differs from the 2-way voicing contrast in English (pal / bil), and is particularly challenging for English-speaking adults to learn.

Before learning, participants were scanned with structural (diffusion) and functional MRI. In the scanner, they performed a stop-consonant discrimination task in English and Korean. After training, they underwent another functional MRI scan using the same task.

The Korean 3-way stop consonant contrast. Lenis stops (top panel) have a positive voice-onset time (VOT), are aspirated, and have a low onset F0. Fortis stops (middle panel) have a short positive VOT, no aspiration, and a high onset F0. Fortis stops (bottom panel) have a short positive VOT, no aspiration, and modal onset F0.

Improved perception of Korean three-way stop consonants

A. Post-training whole-brain correlation with learning attainment

B. Left IFG

C. Left SLFp

Functional responses reflect learning outcome

A. Pitch training whole-brain correlation with learning attainment

B. Language=firing rate correlation in left IFG

C. Structural-function correlation


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