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Language-specific Aptitude and the Role of Phonological Short-term Memory in Second Language Acquisition

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Abstract

The aim of this investigation was to address three questions: 1) does the phonological short-term memory capacity predict vocabulary learning outcomes; (2) does the phonological memory capacity vary across unfamiliar foreign languages; and (3) does language learning experience affect the phonological memory capacity? Thirty participants were tested before and after a five-hour language-learning course. We used nonword repetition tests with English, Russian and Indonesian-sounding words to measure phonological memory in these languages. We found that the phonological memory capacity in a specific language predicts vocabulary-learning outcomes in this language. Participants did not show a phonological bias toward a particular language, but homogeneously scored higher on the Russian nonword repetition test. All participants improved on nonword repetition tests across all languages after learning either Russian or Indonesian. These findings support the following conclusions. First, nonword repetition tests in specific languages can be used in aptitude batteries to detect a propensity for these languages. Second, individual bias towards the phonology of a specific language is rare and gets overridden by the phonological distance between a mother tongue and a target language. Third, phonological memory is affected by language experience and this effect can be transferred to other languages, including L1.

1. Introduction

Learning a new language is less challenging for some than it is for others. Such inconsistency can be partially explained by language learning aptitude, the concept first introduced in the 1960s [1]. Since then, aptitude research has been concerned with the effects of individual differences on learning L2, where L2 is a uniform phenomenon, i.e. any language, regardless of its unique structural properties [2]. However, as more languages have been discovered and analyzed, the idea that languages differ fundamentally on every level of description has become salient [3]. Whereas all languages on an abstract level share similar underlying principles, structural profiles of languages are so diverse that, for example, learning Indonesian might call for a different set of cognitive and perceptual skills than learning Russian would. Because of the different demands imposed by idiosyncratic properties of a language, each language offers a unique challenge to the learner.

Languages typologically similar to a learner's mother tongue are thought to be easier to acquire. The U.S. Foreign Service Institute developed a ranking list for an English native speaker, assigning every foreign language a level of learning difficulty. For example, Spanish is in level I, German in level II, Russian in level III, and Chinese and Arabic are in level IV. However, often individuals demonstrate different aptitude capacities for languages within the same level of difficulty: for example, the same learner might have a significantly higher aptitude for learning Arabic than Chinese, even though both languages belong to level IV. Thus, the learner-language idiosyncratic interaction should be taken into consideration, as well as the learner's cognitive abilities and the overall level of language difficulty.

Chan, Skehan and Gong [4] note that existing aptitude tests assume all languages place the same demands on learners. For more precise predictions, they suggest incorporating something specific about the language to be learned into the test. We follow their suggestion and introduce the nonword repetition tests that mimic Russian and Indonesian. Nonword repetition tests employ nonsense words presented in aural mode and subsequently recalled by a participant [5]. It is a commonly used test to measure phonological-short term memory (PSTM), one of the proposed components of language aptitude. PSTM plays a central role with vocabulary learning [6] and functions in a language-specific way by exploiting relevant long-term phonological knowledge from prior lexical experience [7]. One aspect of PSTM that current L2 aptitude theories have not yet addressed is the degree to which PSTM capacity varies across unfamiliar languages. In the situation where both L2s are unfamiliar to a learner, even a small perceptual bias for processing particular phonotactics can expedite vocabulary acquisition.

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In our study we concentrate on three issues: (1) the predictive power of PSTM in determining L2 vocabulary learning outcomes; (2) the variability of PSTM capacity across unfamiliar L2s; and (3) the effects of language learning experience on PSTM.

2. Method

2.1. Participants

The participants were 30 native speakers of English, students at the University of Edinburgh, U.K., who did not know either Russian or Indonesian. Five participants withdrew after the first testing session.

2.2. Stimuli and Procedures

The participants were tested on two occasions: before (T1) and after (T2) completing a five-hour language-learning course (Table 1).

2.2.1. Pimsleur language-learning audio course. *P*articipants were required to study either Russian (n=25) or Indonesian (n=5) using the Pimsleur audio course. Both courses have identical contents and consist of 10 lessons, 30 minutes each. The Russian and Indonesian languages were selected because of their relatively equal phonological distance from English; Russian and Indonesian are also phonologically distant from each other.

Table 1. *The layout of the experiment*

Tasks	T1 (45 min)	T2 (45 min)
PSTM	*English NWR* *Russian NWR* *Indonesian NWR*	*English NWR* *Russian NWR* *Indonesian NWR*
Nonverbal ability	*The Raven Advanced Progressive Matrices*	
L2 performance		*Receptive Vocabulary in Russian or Indonesian*

2.2.2. Nonword repetition tests. Three nonword repetition tests (NWR) were administered: Russian, Indonesian, and English. The nonwords from each test conformed to the phonotactic rules of a corresponding language. The performance of the participants was measured in terms of nonword span, which is the highest number of nonwords that a person could repeat correctly. Two native speakers of each language evaluated the responses ($k = 0.65$).

2.2.3. Nonverbal ability. The short version of the Raven Advanced Progressive Matrices Test [8] was administered to measure nonverbal intelligence [9]. The test consists of a series of homogeneous images of abstract patterns with each image missing a piece. Selecting from the eight options provided, participants were required to choose the piece that best completed the image.

2.2.4. L2 performance measure. To measure L2 performance we designed a receptive vocabulary test containing 30 words randomly taken from the Pimsleur course. The participants heard each word spoken once and then had to select the corresponding English equivalent from the four options provided on screen.

3. Results

3.1. Descriptive statistics

Table 2. *Summary of performance across all tasks*

Task	Scoring	n	min	max	mean	median	s.d.
English NWR	Max = 14						
1) Pretest		30	8.25	14.00	11.92	12.00	1.33
2) Posttest		25	9.00	14.00	12.63	13.00	1.26
Russian NWR							
1) Pretest		30	7.00	13.50	10.14	10.00	1.82
2) Posttest		25	5.75	14.00	10.91	11.00	1.86
Indonesian NWR							
1) Pretest		30	4.50	11.50	7.49	7.38	1.89
2) Posttest		25	4.50	12.00	7.87	7.00	2.23
Nonverbal ability	Max = 12	30	7	12	10.60	11.00	1.45
Vocabulary (Ru + Ind)	Max = 30	25	17.00	30.00	24.36	25.00	3.71

3.2. General connections

The Pearson and Spearman correlations were performed to investigate the associations between the predictors and the lexical outcome variables. There were significant positive correlations between Russian NWR and the Russian vocabulary score (r = .43, ρ = .45, p < .05). Since we had only three participants who studied Indonesian, the Indonesian results lacked statistical power. Pearson's correlational analysis revealed that nonverbal ability was related significantly to the performance on the vocabulary test (r = .0.44, p < .05), however, this was not the case when the Spearman test was applied.

3.3. Relationships between skills

To answer the first research question, a linear trend analysis was conducted, in which the NWR and nonverbal ability measures were entered into the model. Russian NWR accounted for 25.7% of the variance in vocabulary learning (R^2 = 0.257, F (2, 19) = 6.929, p < .01). The nonverbal ability scores showed no significant effects.

To answer the second research question, we performed a paired Student's t-test. Having a mean score of 10.14 on Russian NWR and 7.49 on Indonesian NWR, it is clear that the participants performed better repeating the Russian-sounding nonwords. A paired-samples Student's t-test showed that the difference is significant (t(29) = 6.60, p < 0.01). It seems that, in comparison to Indonesian NWR, Russian NWR was easier. However, when the individual data was examined, the outcomes revealed that some individuals exhibited a reverse pattern. Participants 18, 23 and 28 (Figure 1) performed better on the Indonesian NWR task, than on the Russian one.

Finally, we investigated the practice effects on PSTM. The average improvement on the English NWR test was 0.71 point (t(24) = 2.69, p < 0.05), and on the Russian NWR test was 0.77 point (t(24) = 3.07, p < 0.01). The improvement of 0.38 point on the Indonesian NWR test was not significant (t(24) = 0.91, p = 0.37). A Wilcoxon signed-rank test analysis yielded the same pattern of results.

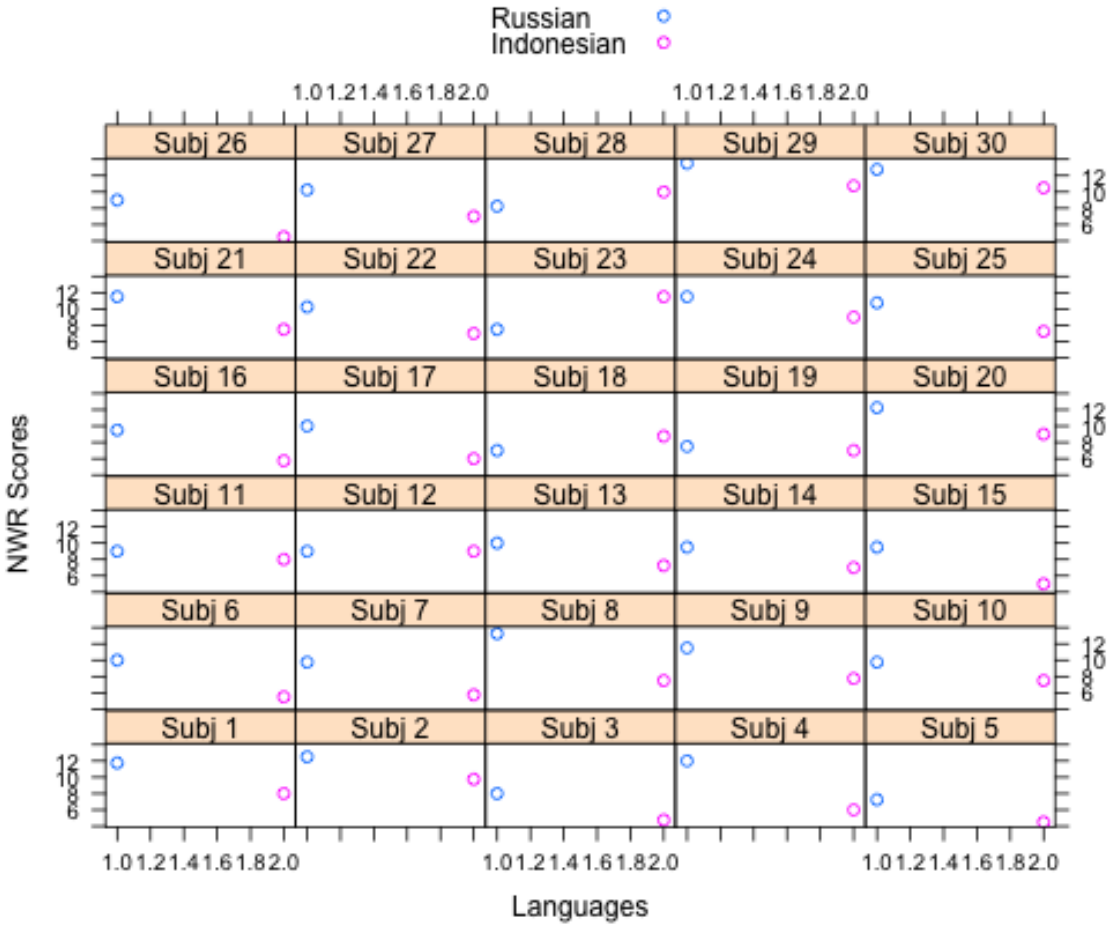

Fig 1. NWR scores for each subject.

4. Discussion

Our first research question concerned the role of PSTM in L2 acquisition. We found strong relationships between NWR performance and lexical attainment. These relationships were especially significant when the phonology of a specific language was used. Thus, the ability to repeat Russian-sounding nonwords predicted vocabulary-learning outcomes in this language better than the ability to repeat English- or Indonesian-sounding words. The construction of nonword repetition language aptitude tests that exploit the phonology of specific languages may be more predictively effective than traditional aptitude measures.

The second question had to do with the language-specificity of PSTM when unfamiliar languages are used. Our results indicate that the majority of participants perform better with the language which sound system is closer to their native one (the Russian prosodic structure resembles English). However, some individuals processed the phonotactics of Indonesian better than Russian, which might indicate the existence of a perceptual bias for the Indonesian phonology.

Our third question addressed the issue of the stability of PSTM capacity. The results show that although the NWR performance was slightly different on the two testing occasions the difference was not significant for Indonesian. Considering that most of the participants were learning Russian, these findings are not surprising. Five hours of language exposure could provide enough material for developing an abstract phonological repertoire of the Russian language, which enhanced the NWR performance in this language. It remains unclear why the English NWR performance improved even though the participants learned a different language. It could be that there is a common mechanism that governs NWR performance in all languages and, thus, a transfer is possible from language to language. In fact, recent research on bilingualism has revealed that learning a foreign language has effects on general cognition beyond the language domain [10], i.e. it is possible to see an improvement in the areas not directly related to the language of study.

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