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Second Language Experience Facilitates Statistical Learning of Novel Linguistic Materials

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Abstract

Recent research has begun to explore individual differences in statistical learning, and how those differences may be related to other cognitive abilities, particularly their effects on language learning. In this research, we explored a different type of relationship between language learning and statistical learning: the possibility that learning a new language may also influence statistical learning by changing the regularities to which learners are sensitive. We tested two groups of participants, Mandarin Learners and Naïve Controls, at two time points, 6 months apart. At each time point, participants performed two different statistical learning tasks: an artificial tonal language statistical learning task and a visual statistical learning task. Only the Mandarin-learning group showed significant improvement on the linguistic task, whereas both groups improved equally on the visual task. These results support the view that there are multiple influences on statistical learning. Domain-relevant experiences may affect the regularities that learners can discover when presented with novel stimuli.

Keywords: Psychology; Learning; Language acquisition; Attention

1. Introduction

Individuals of all ages are skilled at discovering regularities in their environments (e.g., Bulf, Johnson, & Valenza, 2011; Janacsek, Fiser, & Nemeth, 2012), and they do so in multiple domains (e.g., Conway & Pisoni, 2008; Fiser & Aslin, 2002; Saffran, Aslin, & Newport, 1996; Saffran, Johnson, Aslin, & Newport, 1999). Successful statistical learning (SL) depends on characteristics of both the input and the learner (e.g., Bartolotti, Marian, Schroeder, & Shook, 2011; Conway & Christiansen, 2005; Emberson, Conway, & Christiansen, 2011; Frost, Armstrong, Siegelman, & Christiansen, 2015; Kaufman

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et al., 2010; Palmer & Mattys, 2016; Siegelman & Frost, 2015). Individuals cannot track all possible relationships in their environments, and not all probabilities are tracked equally well (e.g., Fiser & Aslin, 2002; Pacton & Perruchet, 2008). The modality of the stimuli, for example, constrains learning, and learning regularities in one modality is rarely related to performance in another modality (e.g., Conway & Christiansen, 2005, 2006; Siegelman & Frost, 2015). While there is limited evidence to suggest domain-general consistency, performance on individual tasks tends to be relatively stable within learners over time, suggesting individual differences are not random (e.g., Arciuli & Simpson, 2012b; Siegelman & Frost, 2015). In addition, individual differences in statistical learning tasks are correlated with other cognitive abilities (e.g., Bartolotti et al., 2011; Kaufman et al., 2010; Weiss, Gerfen, & Mitchel, 2010).

One area in which the detection of novel regularities is crucial is language learning. It has long been assumed that statistical learning is involved in acquiring language (e.g., Gómez & Gerken, 2000; Saffran, 2003), and recent research has explored how individual differences in detecting statistical regularities relate directly to language abilities. Relationships between statistical learning and language skills have been found in a body of research that includes child and adult participants; typical and atypical language users; visual, auditory, motor, and cross-modal tasks; and measures of written and spoken language skills (e.g., Arciuli & Simpson, 2012a; Conway, Bauernschmidt, Huang, & Pisoni, 2010; Conway, Pisoni, Anaya, Karpicke, & Henning, 2011; Evans, Saffran, & Robe-Torres, 2013; Frost, Siegelman, Narkiss, & Afek, 2013; Kaufman et al., 2010; Kidd, 2012; Kidd & Arciuli, 2016; Misyak & Christiansen, 2012; Misyak, Christiansen, & Bruce Tomblin, 2010). Interestingly, many studies linking statistical learning and language abilities used visual SL paradigms, despite other evidence that statistical learning shows modality-specific effects (e.g., Conway & Christiansen, 2005, 2006; Saffran, 2002; Siegelman & Frost, 2015). These studies suggest that those who are more sensitive to statistical regularities will have an advantage in learning new languages.

While we agree that detecting patterns is likely critical to learning languages, we want to explore an alternative, although not mutually exclusive, potential relationship between statistical learning and language: Language learning may change learners' sensitivity to patterns in novel input. Native language experience affects the regularities to which learners attend (e.g., Cutler, Mehler, Norris, Seguí, & Segui, 1986; Finn & Hudson Kam, 2008, 2015; Onnis & Thiessen, 2013; Toro, Pons, Bion, & Sebastián-Gallés, 2011; Vroomen, Tuomainen, & de Gelder, 1998). These biases can be observed even in infants, who use their nascent language-specific knowledge to guide learning (e.g., Thiessen, Onnis, Hong, & Lee, unpublished data; Thiessen & Saffran, 2007). Native language knowledge biases learners to attend to certain features and provides expectations about likely regularities.

Non-native linguistic experience also affects learning. Proficient second language users can exploit sound regularities in their second language to facilitate language processing (Weber & Cutler, 2006). Second language experience can also influence first language processing (e.g., Levy, McVeigh, Marful, & Anderson, 2007; Linck, Kroll, & Sunderman, 2009) and even neural structures (e.g., Li, Legault, & Litcofsky, 2014; Osterhout et al., 2008; Schlegel, Rudelson, & Tse, 2012). Furthermore, even brief experiences change learning. For example, after training with an artificial grammar, learners may be more likely to employ a strategy that is consistent with that training (Onnis, Lou-Magnuson, Yun, & Thiessen, 2015). In addition, participants who are taught an artificial language have trouble learning an additional language that is inconsistent with what they previously learned (Perruchet, Poulin-Charronnat, Tillmann, & Peereman, 2014). Even infants have more difficulty tracking regularities that differ from those presented in a brief pre-exposure phase (Lew-Williams & Saffran, 2012). The properties of known languages, including non-native languages, can exert a powerful influence on the regularities an individual subsequently learns.

Wang and Saffran (2014) explored the influences of native language and bilingual experience using an artificial tonal language. They tested participants with a range of experience with tonal languages: monolingual English speakers, monolingual Mandarin speakers, Mandarin–English bilinguals, and bilinguals who spoke English and an additional non-tonal language. The artificial language contained nine unique tones (different from the four tones found in Mandarin), each of which was consistently paired with a syllable. The tone + syllable pairs were then combined into words, resulting in units that differed from Mandarin in both tonality and syllabic structure. Monolingual English speakers failed to demonstrate learning, but monolingual Mandarin speakers performed above chance. Interestingly, the two bilingual groups were even more successful than the monolingual Mandarin speakers, suggesting that experience with multiple languages, not just exposure to tones, influenced performance. Multiple types of prior language experience can improve learners' ability to uncover patterns in new stimuli that contain components not present in their native language.

Past studies have demonstrated that language abilities are related to statistical learning performance, and that those learners who are better able to learn patterns may have better language skills. What remains unknown, however, is whether learning a new language enhances learners' ability to detect regularities in novel input. When considering this question, several issues emerge. The first is how extensive language experience must be to affect future learning. In previous studies, bilingual participants were highly proficient in their second language (e.g., Wang & Saffran, 2014; Weber & Cutler, 2006), making it difficult to assess the effect of beginning second language learning on statistical learning. Secondly, if there is an effect of learning a new language on statistical learning, how broad is this effect? One might expect the effects to be fairly narrow, such that learning a new language would only affect subsequent learning within the same (linguistic) domain. Alternatively, the cross-domain relationships observed in individual difference studies suggest that language learning might affect statistical learning in other domains, such as visual statistical learning. Lastly, it remains unclear whether changes in one domain of statistical learning also relate to performance in another domain. If there are improvements in one statistical learning task, would these be correlated with improvements in another statistical learning task?

Therefore, this study explored whether new learners of a second language would show improvements in statistical learning. We had three main questions. First, does new second language experience improve learning on a domain-relevant task, where learners are faced with stimuli that share some features with the second language they are currently acquiring? Second, does experience with a second language improve statistical learning in different modalities? Finally, is performance across these tasks related?

To address these questions, we tested college students who were in the process of learning Mandarin in a classroom setting. To test domain-relevant learning, we used the tonal statistical learning task designed by Wang and Saffran (2014) because lifelong language experience had been shown to contribute to learning in this task. To test learning in a different modality, we used the visual statistical learning task developed by Fiser and Aslin (2002). We tested these learners twice, the first time shortly after they enrolled in Mandarin classes, and again 6 months later, after two semesters of classroom instruction. We also included a control group with no exposure to Mandarin.

If language learning impacts statistical learning, we would expect that learning a new language would increase learners' sensitivity to regularities, particularly in related domains. Therefore, we predicted that Mandarin Learners would show greater improvement on the tonal statistical language learning task after 6 months, compared to control participants. We also hypothesized that Mandarin Learners would also show greater improvement on the visual statistical learning task, as visual tasks have been correlated with language learning. Finally, we predicted that performance among the tasks would be related. We expected to see high within-task correlations at the two time points, as well as weaker cross-task correlations between the two different tasks.

2. Method

2.1. Participants

Two groups of participants were tested twice in a pre–post design, 6 months apart, as a part of a larger study on classroom language learning. All participants were students at a large Midwestern university and reported normal hearing. *Mandarin Learners* (n = 26, 10 males) were enrolled in introductory Mandarin classes with no prior exposure to Mandarin. They were recruited in the first weeks of their first semester of classroom instruction in the fall and tested again in the spring at the end of their second semester. *Naïve Controls* (n = 12, 6 males) had no experience with Mandarin or any other tonal language and were recruited through introductory Psychology classes (see Table 1 for details about participants' language experience). An additional 57 participants were tested at the first time point, but excluded for experience with another tonal language (n = 1), not completing all the tasks (n = 7), or not returning for the second session (n = 49[1]). Participants received extra credit for the first session and \$15 if they participated in both sessions.

Table 1
Participants' language backgrounds[a]

	Mandarin Learners	Naïve Controls
Native English monolinguals	15	7
Native English bilinguals	7	5
Non-Native English bilinguals	4	0

Notes. [a]Participants filled out the Language Experience and Proficiency Questionnaire (Marian, Blumenfeld, & Kaushanskaya, 2007) and were classified according to their self-reported comprehension ability on a 1–10 scale. Participants who reported their comprehension skills for all non-English languages as 5 or less were considered monolingual. Bilingual participants reported significant comprehension in Spanish (8), Korean (4), Czech (1), Esperanto (1), French (1), and Japanese (1).

2.2. Stimuli. Tonal language statistical learning task

The materials used in the tonal language SL task were identical to those used by Wang and Saffran (2014). Participants listened to an artificial language consisting of nine syllables and nine tones. Tones were defined by contours (flat, rising, and falling) and registers (high, middle, and low). Although the shapes of contours were taken from three of the four Mandarin tones (i.e., with the exception of the third tone in Mandarin, which has a dipping contour), when combined with the registers, the nine tones did not resemble Mandarin tonal system, and the tonality in this artificial language sounded distinct from Mandarin to native speakers. There was a one-to-one mapping between tones and syllables. Three trisyllabic words were constructed (*tadugu, bidatu,* and *tibadi*) and combined into a continuous stream. Syllables and tones provided redundant cues to word boundaries. Importantly, while the materials mimicked some features of tonal languages, they were not modeled on any specific tonal language. The stream was randomized such that a word never repeated immediately, meaning that the transitional probability (TP) between words was 0.5. The exposure stream was just over 10 min long.

In the test phase, all syllable and tone pairings from exposure were maintained, and three additional non-word items were constructed from the same tone + syllable pairs. The non-words consisted of one syllable from each of the three words that had never occurred together (e.g., *gu-da-ti*) and contained within-word TPs of 0. The words and non-words were exhaustively paired for a total of 18 forced-choice trials.

2.3. Visual statistical learning task

The visual SL task was adapted from Fiser and Aslin (2002). Stimuli consisted of 12 abstract shapes, combined to form 4 triplet "words" (ABC, DEF, GHI, and JKL). Shapes appeared individually in the center of the screen, with each shape appearing for 1 s with 200 ms between shapes. There were no additional pauses or other cues to indicate the items were grouped in triplets. Triplets never repeated immediately; TPs within triplets were 1.0, and TPs between triplets were 0.33. Each triplet was presented 18 times. The exposure phase was shorter than that of Fiser and Aslin (2002) because pilot testing revealed that participants were highly successful in segmenting the stream.

Participants were tested on pairs of shape word and part-word items (e.g., BCD or CDE). On each trial, participants saw a set of three shapes presented using the same timing as the exposure phase. However, unlike the exposure phase, the shapes appeared in a left-right-left configuration (consistent with Fiser & Aslin, 2002). There were 32 forced-choice test trials.

2.4. Procedure

Participants performed identical tasks at each of two visits, 6 months apart. Because the larger study was designed to explore individual differences, the order of tasks was the same for all participants. Each visit began with the tonal language SL task. Participants were told they would listen to a made-up language and that they would later be asked about what they had heard. After exposure, they were presented with pairs of test items (words vs. non-words) and asked to report which sounded more similar to the exposure language.

They then performed a series of tasks unrelated to statistical learning for 30–40 min, followed by the visual SL task. Participants were told that they would see a series of images on the computer screen and would later be asked about what they had seen. Participants were tested on their ability to distinguish triplet shape words from part words and asked to report which item in each pair was more similar to the exposure sequence.

3. Results

We began by testing whether Mandarin Learners and Naïve Controls differed on the tonal language SL task at their first visit, using a general linear model. We regressed accuracy on Group and found no difference in performance at Time 1 [$t(36) = 0.295$, $p = .77$]. Consistent with Wang and Saffran (2014), neither group was significantly above chance [Learners: $t(36) = 1.89$, $p = .07$; Controls: $t(36) = 0.93$, $p = .36$].

Our main question was whether learning Mandarin would facilitate domain-relevant learning. To test this question, we asked whether the two groups differed in their improvement when they performed the same tonal language SL task 6 months later. Because there was no difference in their performance at Time 1, we performed an ANCOVA where we regressed Time 2 accuracy on Time 1 accuracy and Group, using a general linear model. We found a significant difference between groups [$t(35) = 2.18$, $p = .036$, partial η^2=0.09]. To better understand this effect, we calculated difference scores (Time 2 accuracy—Time 1 accuracy) and regressed that difference score on Group. For Mandarin Learners, the difference score was significantly different from zero [$t(36) = 3.19$, $p = .003$, partial $\eta^2 = 0.20$], indicating that performance on the tonal language SL task improved significantly after two semesters of Mandarin. The Control group, on the other hand, showed no change [$t(36) = -0.20$, $p = .85$]. An additional linear model confirmed that the Mandarin Learners performed above chance at the second session [$t(36) = 4.52$, $p < .001$, partial $\eta^2 = 0.34$], whereas the Control group still did not demonstrate learning [$t(36)=.62$, $p = .54$]. See Table 2 and Fig. 1.

Finally, we asked whether there was a correlation in performance across the two visits. Accuracy at Times 1 and 2 was significantly correlated [$r = .52$, $t(36) = 3.67$, $p < .001$], demonstrating that there was consistency in how participants performed across 6 months.

For the visual SL task, we performed parallel analyses to see if learning Mandarin influenced domain-general learning. Our first model again revealed that the groups did not differ at Time 1 [$t(36) = 0.864$, $p = .39$], although unlike the tonal language SL task, both groups demonstrated learning [Learners: $t(36) = 7.38$, $p < .001$, partial $\eta^2 = 0.60$; Controls: $t(36) = 3.97$, $p < .001$, partial $\eta^2 = 0.30$].

We then again performed an ANCOVA to assess whether the groups differed in how their performance changed between sessions. Unlike the tonal SL task, there was no significant effect of Group [$t(35) = 0.68$, $p = .50$] on the visual SL task, revealing that the groups

Table 2
Means and standard deviations of performance across tasks

	Tonal Language SL Time 1	Tonal Language SL Time 2	Visual SL Time 1	Visual SL Time 2
Mandarin Learners	55.8% (16.7)	66.0% (18.8)	75.0% (17.9)	81.2% (19.9)
Naïve Controls	54.2% (12.8)	53.2% (16.3)	69.8% (15.7)	82.0% (18.4)

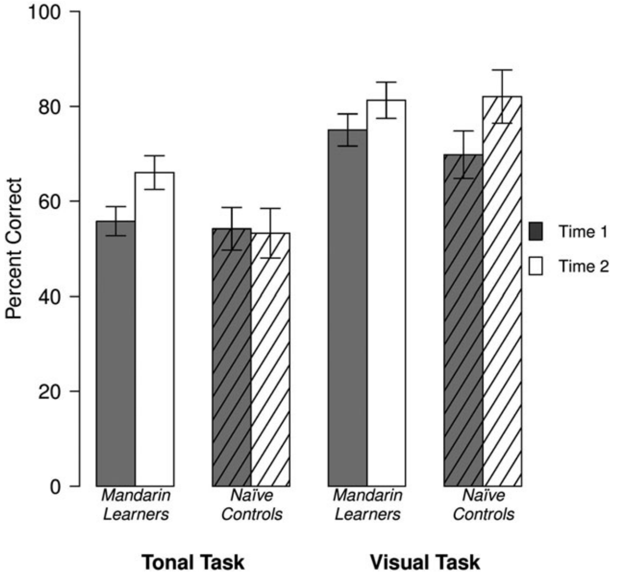

Fig. 1. Average performance on Tonal and Visual statistical learning tasks. Time 1 was at the beginning of Mandarin Learners' first semester of Mandarin classes; Time 2 was at the end of the school year when they had nearly completed their second semester. Error bars represent standard errors of the mean.

showed similar patterns of improvement. An additional model with the Time 2—Time 1 difference score revealed that the Mandarin Learners showed marginal improvement [$t(36) = 1.80$, $p = .08$], and the Control group improved significantly [$t(36) = 2.40$, $p = .02$, partial $\eta^2 = 0.13$].

As with the tonal task, we tested whether performance was correlated between the two visits and again found a significant relationship [$r = .53$, $t(36) = 3.80$, $p < .001$]. We also asked whether performance was correlated between the two tasks at either time point, but we found no significant correlations between the tonal and visual SL tasks (all $p > .25$).

4. Discussion

This study explored whether experience with Mandarin as a second language affected both domain-relevant (linguistic) and domain-general (visual) statistical learning. We found that beginning Mandarin Learners did not initially differ from Naïve Control participants on either the tonal language or visual statistical learning tasks, when they were just starting to study Mandarin. However, 6 months later, the Mandarin Learners improved significantly more on the tonal language SL task than Controls; the two groups did not differ in their improvement on the visual task. Furthermore, while performance was significantly correlated across time points within the same task, there was no relationship between performance on the tonal and visual tasks.

Why was Mandarin experience advantageous for participants in our tonal language statistical learning task? From the current data, it is not possible to determine exactly what cues learners were tracking; the task could have been solved using either tone or syllable co-occurrences, or both. Nevertheless, only the Mandarin Learners were able to demonstrate any learning, suggesting that they detected regularities that the control participants did not. One possibility is that exposure to a natural tonal language made the tones seem less unfamiliar. Tones sound foreign and are particularly challenging for non-tonal speakers (Peabody & Seneff, 2009), and typically, familiar stimuli are easier to process (e.g., Anderson-Hsieh & Koehler, 1988; Crockenberg & Leerkes, 2004; Goggin, Thompson, Strube, & Simental, 1991; see Förster, Liberman, & Shapira, 2009 for a review). However, we believe that familiarity alone is unlikely to explain the improvement we observed in the Mandarin-learning group. In other work, we have shown that very beginning Mandarin Learners, who have just a few weeks of exposure to Mandarin, already show improvements in tone discrimination, compared to Naïve Controls (Wang, Potter, & Saffran, unpublished data), and our two groups showed no difference in learning at the first time point. In addition, in the study by Wang and Saffran (2014), native Mandarin speakers, who had extensive experience with tones, performed more poorly on this task than non-tonal bilinguals, who had no experience with tones. As previously mentioned, the artificial tone + syllable structures are novel to both Mandarin and English speakers. Thus, while exposure to tonal materials may be useful, it is unlikely to be the only influence on learning in this task. Other factors such as being able to process tone + syllable elements as integrated units might also contribute to success.

Another possibility is that the improvements stemmed from the process of learning a new language, not specifically from the sound properties of Mandarin. Knowledge of multiple languages has been proposed to have many cognitive benefits including enhanced implicit learning (e.g., Bartolotti et al., 2011; Klein, 1995; Kovács & Mehler, 2009), cognitive control (e.g., Bialystok, 1999; Dijkstra & Van Heuven, 1998; Green, 1998; Green & Abutalebi, 2013), flexibility (e.g., Blumenfeld & Adams, 2014; Liu & Kager, 2014, 2016; Prior & MacWhinney, 2010), and selective attention (e.g., Bialystok, 2001; Sebastián-Gallés, Albareda-Castellot, Weikum, & Werker, 2012). However, there is currently a great deal of debate about both the existence of a domain-general "bilingual advantage," and if there is such an advantage, how it relates to individuals' linguistic experiences (e.g., Duñabeitia et al., 2014; Hilchey & Klein, 2011; Kaushanskaya & Prior, 2015; Paap & Greenberg, 2013; Yang, Hartanto, & Yang, 2016). Nevertheless, it is possible that learning a new language conferred cognitive benefits, such as more flexible attention, on the Mandarin Learners, much like the bilingual participants studied by Wang and Saffran (2014). Consistent with these observations is the fact that none of the participants in the control group were currently learning a second language, with second language experience largely limited to high school Spanish classes. Thus, the control participants did not have recent language learning experience that may have impacted their performance in this study. In future studies, the possibility that any second language experience can change performance on the tonal language SL task could be tested by including another group of participants, learners of non-tonal languages. If we observed improvements in another group of second language learners that would suggest that learning any new language might change learners' ability to attend and combine different cues.

Consideration of performance on the visual statistical learning task provides some insights into the breadth of improvement observed in this study. Unlike the linguistic statistical learning task, second language experience did not produce greater improvement on the visual statistical learning task. Practice alone allowed participants to better learn the regularities; Mandarin experience conferred no additional advantage. Language learning, therefore, may specifically improve learners' sensitivity to linguistic regularities without otherwise changing their statistical learning abilities in other modalities. Alternatively, domain-general effects may take longer to develop. Two semesters of classroom instruction in Mandarin may simply not have been enough to provide domain-general benefits. Another possibility is that the key difference between the tonal and visual tasks was not their modality, but their difficulty. Both groups were highly successful in segmenting the visual stream, even the first time they encountered the stimuli, and difficulty can influence future learning (e.g., Ball, Sekuler, & Reeder, 1982). On an easier task, it may have been easier for participants to improve, thus minimizing or eliminating the added benefit of learning a new language.

Our final question concerned the relationships between tasks. The correlations between the two time points suggest that statistical learning abilities are at least somewhat stable, although they may also be influenced by experience. The lack of significant correlations between the tonal and visual tasks is consistent with other reports of modality-specific effects in statistical learning tasks, and highlights that there are likely sensory constraints on learning. However, because our tasks differed in how challenging they were, we cannot separate modality from difficulty. It is interesting to note that our participants performed unexpectedly well on the visual task compared to other studies (e.g., Arciuli & Simpson, 2012a; Fiser & Aslin, 2002). One possible explanation is that the visual task always occurred after the tonal task, which also involved triplets as target units. There is disagreement about whether participants can transfer the structure they have learned in one modality to another (e.g., Altmann, Dienes, & Goode, 1995; Conway & Christiansen, 2006; Tunney & Altmann, 2001). While we do not have a sample of participants who performed the visual task first to test this hypothesis, future studies will explore the possibility of this cross-modal transfer and how learning in one domain may affect learning in another modality.

To summarize, we have found evidence of multiple influences on statistical learning, including the domain of the stimuli, initial difficulty of the task, and practice with the task. All these factors have been shown to be important in other studies of perceptual learning (e.g., Conway & Christiansen, 2005; Green & Bavelier, 2003; Jaeggi, Buschkuehl, Jonides, & Perrig, 2008). Perceptual learning studies have also found that even when learners show dramatic improvement on a given task, it is difficult to find evidence of generalizing learning beyond the trained materials (e.g., Conway & Christiansen, 2005; Frost et al., 2015; Green & Bavelier, 2008; Johansson, 2009; Thiessen, Kronstein, & Hufnagle, 2013). In fact, learning can be so specific that minor changes, such as changing the location or orientation of a stimulus, can eliminate the effects of learning (e.g., Fahle, 2004; Fiorentini & Berardi, 1980). Although we have called our tonal task “domain-relevant,” the artificial language was by no means identical to Mandarin. The artificial tones differed from natural Mandarin, not only in the number of tones but also the specific tonal features (e.g., pitch height, tonal contour), as well as the lack of coarticulation in the artificial language. These nuances result in utterances that sound drastically different from natural Mandarin; participants could not simply have been more familiar with the specific tones. The Mandarin Learners’ improved performance suggests that they did show some form of transfer from their classroom experience.

There have been large programs of research, academic, and commercial, aimed at designing training regimens that will lead to broad transfer, and most have been unsuccessful (see Green & Bavelier, 2008, for review). Those that succeed tend to exist outside of the laboratory, such as experience playing video games or musical training, and share certain features, including that they are challenging, variable, motivating, and offer feedback during learning (e.g., Bavelier, Green, Pouget, & Schrater, 2012; Green & Bavelier, 2008; Romano Bergstrom, Howard, & Howard, 2012). We suggest that these characteristics also describe the process of learning a new language, which may be why our Mandarin Learners improved on the tonal task. Others have speculated about whether knowing multiple languages provides similar benefits to other demanding cognitive activities or offers unique effects (e.g., Costa, Hernández, & Calabria, 2015; Valian, 2015). Our data cannot adjudicate between these possibilities, but future studies could include other kinds of experience, such as musical training, that could have both domain-relevant and domain-general influences.

It is perhaps unsurprising that experience changes learning, and that learning is relatively constrained. However, what is novel about our results is that we have demonstrated that both domain-relevant (Mandarin classes) and task-specific experience (practice) can improve participants' performance on measures of statistical learning. We have also shown that participants do not need lifelong exposure or full proficiency with a new language for knowledge of that language to influence their behavior. Thus, the nature of the task as well as the prior experiences of the learner, both contribute to determining the types of regularities to which a learner will be most sensitive in a complex world.

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Note

1. There was no difference in performance between participants who returned for the second visit and those who did not on either task [tonal language SL: $t(85) = 0.37$, $p = .71$; visual SL: $t(85) = 1.43$, $p = .16$]. The attrition from the first to the second session was primarily due to logistical reasons. For the first visit, participants were contacted through classes in which they were currently enrolled and offered course credit for their participation. They were contacted via email to set up a second visit. Many participants did not respond, and those who did indicated that they were less interested in monetary compensation than the extra credit they received for the first session.

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