OBSERVATION

Foreign Language Learning in French Speakers Is Associated With Rhythm Perception, but Not With Melody Perception

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There has been increasing interest in links between language and music. Here, we investigate the relation between foreign language learning and music perception. We administered tests measuring melody and rhythm perception as well as a questionnaire on musical and foreign language experience to 147 monolingual French speakers. As expected, we found that musicians had better melody and rhythm perception than nonmusicians and that, among musicians, there was a positive correlation between the total number of years of music training and test scores. Crucially, we also found a positive correlation between the total number of years learning foreign languages and rhythm perception, but we found no such relation with melody perception. Moreover, the degree to which participants were better at rhythm than melody perception was also related to foreign language experience. Results suggest that both music training and learning foreign languages (primarily English, Spanish, and German in our sample) are related to French speakers’ perception of rhythm, but not to their perception of melody. These results are discussed with respect to the rhythmic properties of French and suggest a common perceptual basis for rhythm in language and music.

Keywords: music perception, language learning, rhythm, French

Shared cognitive processes may underlie music and speech processing (Patel, 2011, 2014). For example, numerous studies show that musical ability is associated with better performance in perception tasks involving speech sounds (Magne, Schön, & Besson, 2006; Marques, Moreno, Castro, & Besson, 2007; Moreno et al., 2009; Slevc & Miyake, 2006; Strait, O’Connell, Parbery-Clark, & Kraus, 2014; Zuk et al., 2013), and positive associations between musical ability and foreign language pronunciation are reported in children and adults (Milovanov et al., 2009; Milovanov, Huotilainen, Välimäki, Esquef, & Tervaniemi, 2008; Milovanov, Pietilä, Tervaniemi, & Esquef, 2010; Milovanov & Tervaniemi, 2011).

Previous studies often use variability in music experience as a predictor of language abilities. Patel (2011, 2014) proposed that music processing places higher demands on auditory systems than speech processing in terms of pitch and rhythm precision, which could suggest why variability in musical ability is more often used as a predictor of speech processing than vice versa. This asymmetry could also be a result of current Western norms, in which music has become a formalized, spectatorial activity (Mithen, 2006, p. 16): Individuals vary more in their experience creating music than speaking a language; therefore, effects of language experience on music perception are more difficult to quantify than the inverse (see also Asaridou & McQueen, 2013). Here, we ask whether and how variability in language experience can be used as a predictor of musical abilities.

Almost all studies that have used natural variability in language experience to predict musical abilities have compared across groups—that is, they have investigated how native speakers of different languages perceive musical stimuli differently (although see Elmer, Meyer, Marrama, & Jäncke, 2011, discussed below). For example, speakers of Chinese languages must use pitch contours (tones) to differentiate words and show higher prevalence of absolute pitch than English speakers (Deutsch, Henthorn, Marvin, & Xu, 2006) as well as better melody discrimination than speakers of Canadian French and English (Bidelman, Hutka, & Moreno, 2013; Wong et al., 2012), although this is not the case for rhythm discrimination (Wong et al., 2012). Moreover, Mandarin speakers show different brainstem responses to musical pitch changes compared with English speakers (Bidelman, Gandour & Kristman, 2011a, 2011b), although previous research has not shown clear tone language advantages in pitch discrimination (Bidelman, Gandour, & Kristman, 2011b) or long-term memory for pitch (Schellenberg & Trehub, 2008).

Outside of the study of tone languages, examples of language experience as a predictor of music perception are even rarer: One
report showed that simultaneous interpreters (extremely proficient bilinguals) have different brain activation relative to monolingual subjects in a pure tone task (Elmer et al., 2011), although there were no behavioral differences between groups. A second report showed that French musicians and Finnish nonmusicians (for whom vowel duration is linguistic) exhibited greater behavioral and neural responding to duration cues compared with French nonmusicians, whereas pitch perception was affected mostly by musical training rather than by linguistic experience (Marie, Kujaala, & Besson, 2012). A third report showed that native speakers of Turkish scored higher on a test of rhythm perception than native speakers of German, but melody perception was equivalent between groups (Roncaglia-Denissen, Schmidt-Kassow, Heine, Vuust, & Kotz, 2013).

Together, comparisons of Mandarin versus English (Wong et al., 2012), Finnish versus French (Marie et al., 2012), and Turkish versus German (Roncaglia-Denissen et al., 2013) suggest selective linguistic and cultural influences on music perception: Either rhythm or melody perception are implicated, depending on the linguistic groups studied. This underscores a need to identify how certain linguistic properties are linked to specific aspects of music perception. However, because previous studies compared distinct populations, it is also possible that nonlinguistic differences contributed to these results (i.e., culturally linked exposure to certain music styles; see Hannon, Soley, & Ullal, 2012). Here, we examine a homogenous population sharing the same native language and culture (i.e., monolingual Parisian adults), testing the specific relation between learning foreign languages and music perception.

**Overview of Current Study**

Foreign language learning is compulsory in France, but there is wide interindividual variability in the amount of study accumulated. Musical training is also widespread (although not compulsory), again with large interindividual variability. Here, we used French participants’ foreign language and musical experience to predict their music perception abilities, which were assessed using the Musical Ear Test (MET; Wallentin, Nielsen, Friis-Olivarius, & Höhle, 2015). Communicated by higher pitch, increased duration, and/or higher intensity for stressed syllables, stress is fixed in French (applying at the phrase rather than lexical level) whereas stress is lexically determined in most Indo-European languages (see Bhatara, Boll-Avetisyan, Unger, Nazzi, & Höhle, 2013 for a longer discussion of prosodic cues in French). French speakers correspondingly demonstrate less consistent linguistic rhythm and stress perception compared with speakers of Spanish or German (Bhatara et al., 2013; Dupoux, Pallier, Sebastian, & Mehler, 1997; Dupoux, Peperkamp, & Sebastian-Galles, 2001), and this difference extends to tasks using nonspeech sounds (Bhatara, Boll-Avetisyan, Agus, Höhle, & Nazzi, 2015). Because stress is implicated in rhythm, we predicted that increased experience learning foreign languages would be associated with increased rhythm perception abilities. Therefore, performance on both sections of the MET should be associated with increasing musical experience, but only the rhythm section should be associated with foreign language learning.

### Method

One hundred forty-seven self-identified monolingual speakers of European French (44 male, 103 female) between 19 and 30 years old participated in this experiment.

### Table 1

<table>
<thead>
<tr>
<th>Language</th>
<th>Number (and percentage) of participants who studied each language</th>
<th>Time spent learning each language averaged across all participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>147 (100%)</td>
<td>10.2 years</td>
</tr>
<tr>
<td>Spanish</td>
<td>95 (65%)</td>
<td>3.4 years</td>
</tr>
<tr>
<td>German</td>
<td>55 (37%)</td>
<td>2.3 years</td>
</tr>
<tr>
<td>Italian</td>
<td>22 (15%)</td>
<td>&lt;8 months</td>
</tr>
<tr>
<td>Mandarin</td>
<td>10 (7%)</td>
<td>&lt;2 months</td>
</tr>
<tr>
<td>Russian</td>
<td>7 (5%)</td>
<td>&lt;1 month</td>
</tr>
<tr>
<td>Portuguese</td>
<td>4 (3%)</td>
<td>&lt;2 months</td>
</tr>
<tr>
<td>Arabic</td>
<td>3 (2%)</td>
<td>&lt;2 months</td>
</tr>
<tr>
<td>Japanese</td>
<td>2 (1%)</td>
<td>&lt;1 month</td>
</tr>
<tr>
<td>Latin</td>
<td>2 (1%)</td>
<td>&lt;1 month</td>
</tr>
<tr>
<td>Polish</td>
<td>2 (1%)</td>
<td>&lt;1 month</td>
</tr>
<tr>
<td>Vietnamese</td>
<td>2 (1%)</td>
<td>&lt;1 month</td>
</tr>
<tr>
<td>Bengali</td>
<td>1 (1%)</td>
<td>&lt;1 month</td>
</tr>
<tr>
<td>Creole</td>
<td>1 (1%)</td>
<td>&lt;1 month</td>
</tr>
<tr>
<td>Duala</td>
<td>1 (1%)</td>
<td>&lt;1 month</td>
</tr>
<tr>
<td>Finnish</td>
<td>1 (1%)</td>
<td>&lt;1 month</td>
</tr>
</tbody>
</table>
years of age ($M = 23, SD = 2.6$) were recruited from a university setting. Seventeen additional participants were excluded because of persistent hearing problems ($n = 1$) or significant exposure to a foreign language or culture in early childhood, starting a new language by 3 years of age ($n = 4$), growing up outside of France ($n = 2$), or having two parents whose native language was not French ($n = 10$).

Participants completed a French-translated version of the MET. The Rhythm and Melody subtests each contained 52 trials in which participants must decide if two excerpts are identical. In the Melody subtest (completed first by 76 participants), the excerpts are short, three- to eight-tone melodic phrases, and half of the pairs contain a single pitch difference between the two melodies. In the Rhythm subtest (completed first by 71 participants), excerpts are short, 4- to 11-beat rhythmic phrases, and half of the pairs contain a single rhythmic change. A short questionnaire was also administered that asked about foreign language learning experience and whether participants had musical training and, if so, what instruments (including voice) were learned and for how long.

**Results**

Preliminary results showed that scores on both Rhythm and Melody subtests were highly correlated, $r(147) = .61$, $p < .001$ (see Figure 1), replicating Wallentin et al. (2010). To replicate the

### Table 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Musicians ($n = 100$)</th>
<th>Nonmusicians ($n = 47$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MET Melody (out of 52)</td>
<td>40 4.9</td>
<td>36 5.2</td>
</tr>
<tr>
<td>MET Rhythm (out of 52)</td>
<td>40 4.8</td>
<td>37 4.5</td>
</tr>
<tr>
<td>Age (years)</td>
<td>23 2.5</td>
<td>23 2.7</td>
</tr>
<tr>
<td>Foreign language experience (years)</td>
<td>11 2.5</td>
<td>11 2.4</td>
</tr>
</tbody>
</table>

*Note.* An asterisk indicates a significant difference ($p < .001$).
validity of the MET as a measure of musical ability, we followed the procedures of Wallentin et al. (2010), dividing participants into two groups: “musicians” who reported some amount of musical training \((n = 100)\) and “nonmusicians” with no history of musical training \((n = 47)\). A two-tailed \(t\) test using the Welch correction for unequal variances found that the musicians performed significantly better than the nonmusicians on both Melody and Rhythm subtests. All participants were analyzed, and we categorized musical experience because showing that increased music experience (Kolinsky, Cuvelier, Goetry, Peretz, & Morais, 2009), but not increased linguistic experience and pitch/melody perception. Moreover, the degree to which rhythm perception is better than melody perception is also associated with foreign language experience. Effects are small, but they are particularly impressive given that scores on MET subtests are highly correlated. Results also replicate those of Wallentin et al. (2010), who showed significant effects of musical experience on MET scores, as well as those of Marie et al. (2012) and Roncaglia-Denissen et al. (2013), who showed stronger links between linguistic experience and rhythm perception than between linguistic experience and pitch/melody perception.

It is interesting to note that our results diverge from studies showing that increased music experience (Kolinsky, Cuvelier, Goetry, Peretz, & Morais, 2009), but not increased linguistic experience (in Spanish: Dupoux, Sebastian-Galles, Navarrete, &

Figure 3. The relation between difference scores on the MET subtests (Rhythm–Melody) with years of foreign language experience (left) and with years of musical experience (right). Gray areas indicate standard deviations. See the online article for the color version of this figure.
Peperkamp, 2008), is related to improvements in French speakers’ performance in a rhythmic stress detection task. However, note that Dupoux et al. (2008) controlled for the participants’ experience with Spanish, but not with other foreign languages. Another possibility for this divergence is that our results are selective to certain tasks, such as the discrimination of simple sequences used in the MET.

In addition, it should be noted that this study alone cannot definitively identify a causal connection: It could be that individuals with greater rhythmic aptitude (but not melodic aptitude) are more motivated to study foreign languages commonly taught in France (see also Mosing, Pedersen, Kuja-Halkola, & Ullén, 2014 for evidence of genetic factors contributing to both musical ability and the tendency to practice music). Another possibility is that French speakers improve in rhythm perception when studying foreign languages such as English, Spanish, or German. A priority for future research should be to identify the causal direction between foreign language experience and music perception.

Future work must also explore the precise commonalities between rhythm perception and foreign language experience. As argued earlier, one possibility is that French speakers’ disadvantage compared with Spanish or German speakers in rhythmic identification (Dupoux et al., 1997, 2001) or categorization based on rhythmic cues (Bhatara et al., 2013; 2015) is related to the fixed status of stress in French (i.e., that stress is defined at the phrasal level). Thus, experience with languages containing lexical stress (which accounted for almost all foreign language experience in our sample) could be uniquely associated with improvement in rhythm perception. A second possibility relies on a rhythmic class distinction. French, along with Spanish and Italian, are considered “syllable-timed” whereas languages such as English and German are considered “stress-timed” and Japanese is considered “mora-timed” (Otake, Hatano, Cutler, & Mehler, 1993; Pike, 1945). These differences are clear enough that infants can distinguish languages if they fall in different rhythmic classes (Nazzi, Bertocci, & Mehler, 1998; Nazzi & Ramus, 2003), and exposure to these differences could also have affected musical rhythm perception in our sample (i.e., all of our participants had learned English, which has a different rhythm than French). Studies comparing differences in foreign language study will be needed to differentiate these two hypotheses (e.g., testing French adults who learned only Spanish and Italian, for which only the lexical stress hypothesis predicts improvement).

In summary, our results confirm that variability in foreign language experience within a single cultural group can be used to predict variation in music perception. Here, we find evidence that rhythm perception is selectively related to French learners’ foreign language learning, and this is not the case for melody perception. We might have found converse results using a population studying tone languages, similar to Bidelman et al. (2013) and Wong et al.’s (2012) cross-linguistic studies. However, only 15 participants in our sample had experience with a language using pitch in a lexical way (i.e., between 6 months and 6 years of Duala, Japanese, Mandarin, or Vietnamese), and excluding or analyzing these subjects separately did not change the results. In the future, larger studies on French adults who learn tone languages may reveal just such a relation.

References


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