Expertise vs. Inter-individual differences: New evidence on the perception of syntax and rhythm in language and music



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Introduction

- Language and music perception overlap in the realms of syntax [1] and rhythm [2,3].
- Native-speaker proficiency is subject to inter-individual variability [4] and musical aptitude is not limited to musical expertise [5,6].
- This behavioral study aimed to find individual differences in crossdomain syntax perception as a function of rhythm (organized hierarchically in a metrical structure), which are not explained by differences in musical expertise.

Methods

- 2 x 2 design: domain (language vs. music) and regularity (regularvs. irregular meter).
- **Participants:** native German musicians (14) and nonmusicians (15).
- **Task:** forced-choice discrimination between pairs of sentences or melodies (same or different syntax).
- Stimuli: 60 sentences and 60 melodies; each had a regular- and irregular-meter version, and two possible resolutions to a syntactic ambiguity (Figure 1). All stimuli were naturally recorded and presented aurally in discrete counterbalanced language and music sessions.
- **Diagnostic tests:** data collected in additional sessions, complete list in Table 3 [7-12].

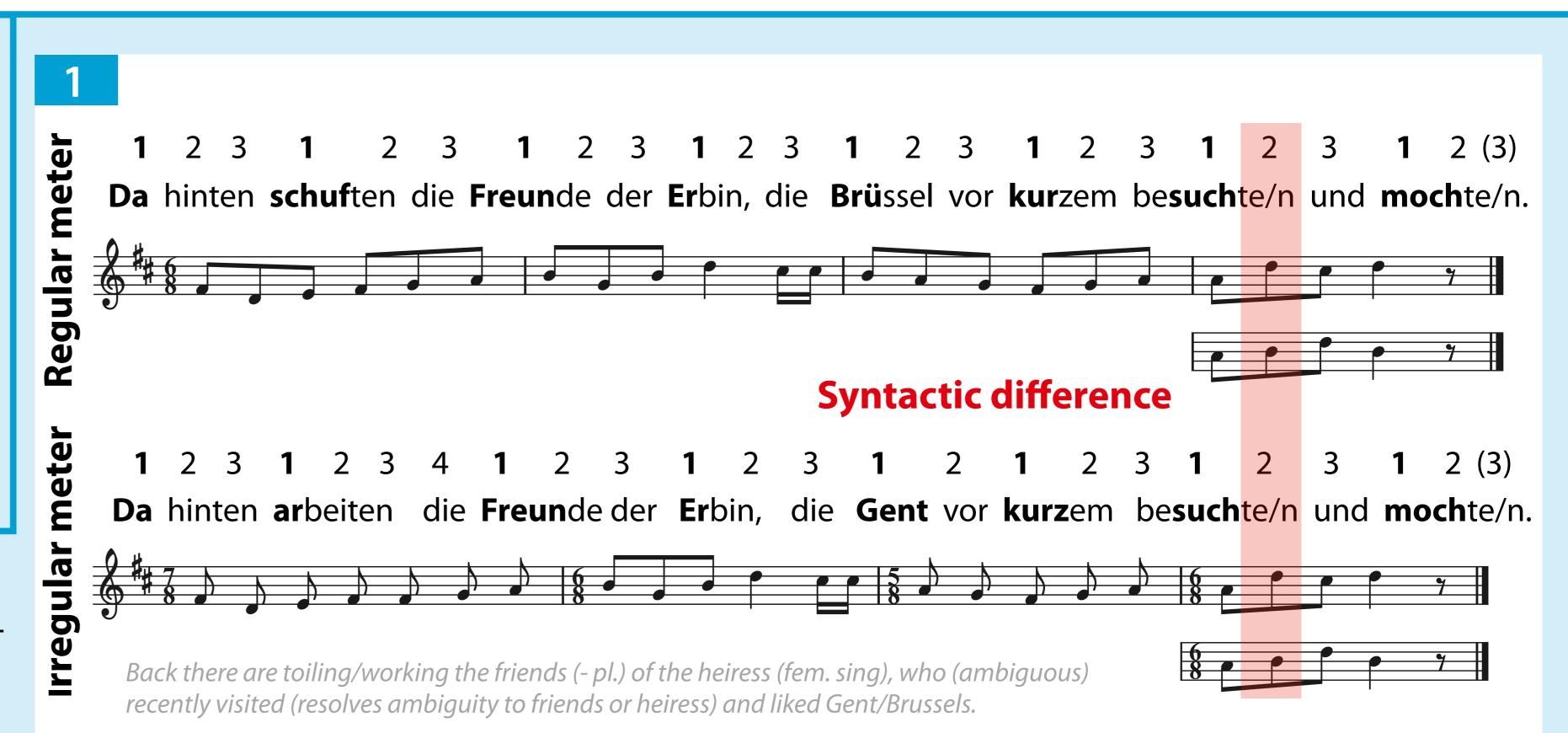


Figure 1: Stimuli. Sentences and melodies follow the same metrical structure. Syntactic difference: language, singular/plural verb conjugation; music, major/minor key in final measure.

Hypothesis:

- 1. Improved syntax-discrimination in regular- over irregular-meter items
 - Regular rhythm facilitates syntax processing [3]
- 2. Working memory and temporal discrimination thresholds correlate to performance
 - NOT just expertise [5,6]

Results

• Two subgroups emerged which performed better in either regular musicmeter (support hypothesis 1) or irregular music-meter (counter hypothesis), see Figure 2.

The two post-hoc subgroups differed in the pattern of cognitive factors that correlated to performance, irrespective of expertise (support hypothesis 2), see Table 1.

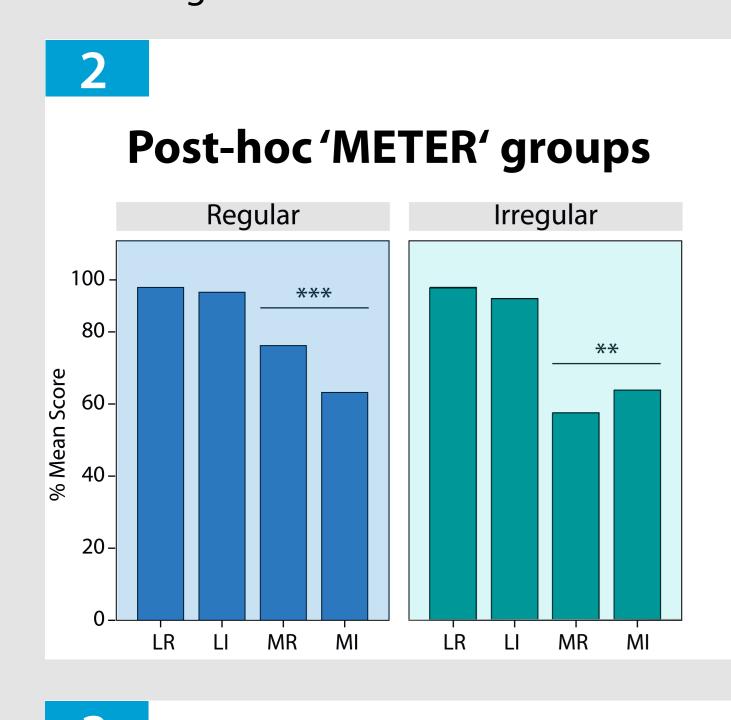
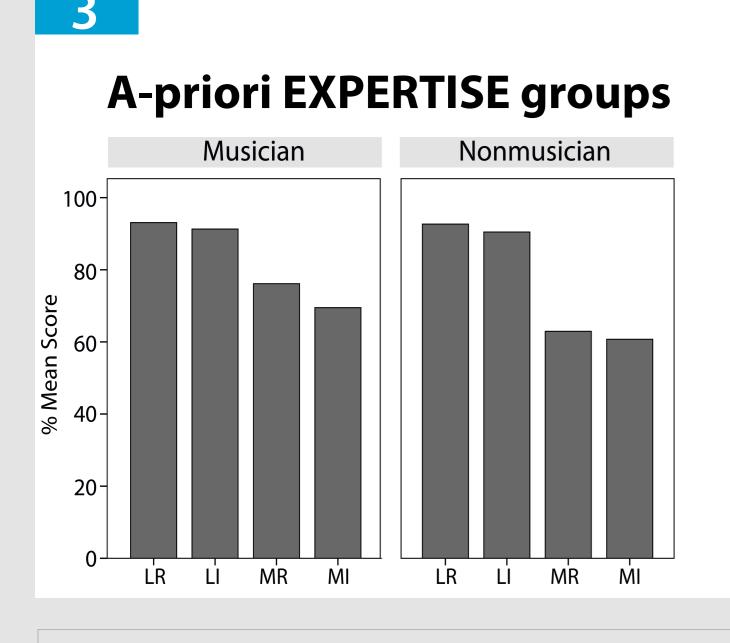


Figure 2: Two subgroups had opposite directions for musicmeter performance. The 'regular' group had a higher score in the regular (MR) condition, the 'irregular' group a higher score in the irregular (MI). t-test, one-tailed, p < .01**, *p*<.001***.



participants meter (regular vs. irregular) did not influence syntax discrimination.

Figure 3: Grouping conventionally into musicians and nonmusicians, type of

Table 1

Correlations between performance scores and diagnostic scores

Diagnostic tests		Regular Group				Irregular Group			
	LR	LI	MR	MI	LR	LI	MR	MI	
Forward digit span		.357†					.459*	.473*	
Backward digit span							. 409†	.590*	
Modified listening span		.344†			.502*			.370+	
Modified reading span			.379†	.301†	.572*	.533*			
Non-word repetition	.536**	.289†	.362*	.410*	. 408†			.473*	
Musical Ear Test: melody	.348*		.429*	.306†			.558*	.515*	
Musical Ear Test: rhythm		.317†	.274†	.432*	341 †	347 †	.412*	.364†	
Duration detection°							434*		
Anisochrony detection: tones°			302 †	 302†			548*	506*	
S Anisochrony detection: music°			404*	290					
Phase increase°			.408*	.350+					
Phase decrease°			.697**	.492*					
Period increase°	.405*		.355†				.626**	.344†	
Period decrease °	.325+		.424*	.328†					
%change 600ms intervals°	.413*		.505**	.306†					
Total %phase change°			.550**	.350+					
Total %period change°	.438*		.504**	.287†	 394†				
Beat alignment test: total score°	.281 _†		.576**						

Table 1: The supporting-hypothesis group 'regular-better' had timing ability diagnostic scores correlated with performance scores across domains; counter-hypothesis group 'irregular-better' had working-memory diagnostic scores correlated with performance scores across domains. Kendall's tau correlations, one-tailed, $p<.05^*$, $p<.01^{**}$, $p<.1^{\dagger}$. Battery for the Assessment of Auditory Sensorimotor and Timing Abilities°[12].

Discussion

Inter-individual differences in the use of metric cues might influence syntax processing – across domains – more strongly than previously believed.

L = language, M = music, R = regular meter, I = irregular meter

- Global cognitive factors such as timing abilities or working memory capacity might drive the use or nonuse of metric regularity, respectively.
- Inter-individual cognitive differences account better for affinity to metrical structures than does musical expertise.

References:

- [1] Koelsch, S., Gunter, T.C., Wittfoth, M., & Sammler, D.(2005). Interaction between syntax processing in language and in music: an ERP Study. Journal of Cognitive Neuroscience, *17*(10), 1565-77.
- [2] Vuust, P., Roepstorff, A., Wallentin, M., Mouridsen, K., & Ostergaard, L. (2006). It don't mean a thing... Keeping the rhythm during polyrhythmic tension, activates language areas (BA47). Neuroimage, 31(2), 832-41.
- [3] Schmidt-Kassow, M., & Kotz, S.A. (2008). Entrainment of syntactic processing? ERPresponses to predictable time intervals during syntactic reanalysis. Brain Research,
- 1226, 144-55. [4] Pakulak, E., & Neville, H.J. (2010). Proficiency differences in syntactic processing of monolingual native speakers indexed by event-related potentials. Journal of Cognitive
- Neuroscience, 22(12), 2728-44. [5] Bigand, E., & Poulin-Charronat, B.(2006). Are we "experienced listeners"? A review of the musical capacities that do not depend on formal musical training. Cognition, *100*(1), 100-30.
- [6] Koelsch, S., Gunter, T., & Friederici, A.D. (2000). Brain indices of music processing: "nonmusicians" are musical. *Journal of Cognitive Neuroscience, 12*(3), 520-41.
- [7] Wechsler, D. (2006). Wechsler Intelligenztest für Erwachsene WIE. Frankfurt/M.: Harcourt Test Services.
- [8] Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and
- reading. Journal of Verbal Learning and Verbal Behavior, 19(4), 450-466. [9] Oberauer et al (2000). Working memory capacity – facets of a cognitive ability
- construct. Personality and Individual Differences, 29, 1017-1045.
- [10] Mottier, G. (1951). Über Untersuchungen der Sprache lesegestörter Kinder. Folia *Phoniatrica et Logopaedica 3*(3), 170-177. [11] Wallentin, M., Nielsen, A.H., Friis-Olivarius, M., Vuust, C., Vuust, P. (2010). The Musican
- Ear Test, a new reliable test for measuring musical competence. *Learning and Individual Differences, 20*(3), 188-196.
- [12] Farrugia, N., Benoit, CE., Harding, E., Kotz, S.A., Dalla Bella, S. (July, 2012). BAASTA: Battery for the Assessment of Auditory Sensorimotor and Timing Abilities. In Proceedings of the 12th International Conference of Music Perception and Cognition (ICMPC '12). Thessaloniki, Greece.