

# The role of rhythm, syntax, and musical training in similarity judgements of series of words and letters



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**Introduction:** Recent findings suggest that musical training supports higher auditory language tasks. First, auditory language comprehension involves dynamic hemispheric interaction because prosodic information mainly processed in the right hemisphere influences syntactic and semantic processing in the left hemisphere (Friederici & Alter 2004, Hesling et al. 2005). Functional and structural brain differences between musicians and non-musicians might influence this interaction. For example, an enlarged corpus callosum probably increases interhemispheric transfer in musicians ( Schlaug 2003). Second, musical training enhances verbal memory (Ho et al. 2003, Schellenberg 2004), which might be useful for sentence processing: verbal and syntactic working memory could be supported by the same neural resources (Gordon et al. 2002). Last, musicians are better in extracting prosodic information from spoken utterances (Schön et al. 2004, Thompson et al. 2003).

**Aim:** We investigated the role of speech rhythm in the perception of syntactic structures at the lexical and sub-lexical level in musicians and non-musicians.

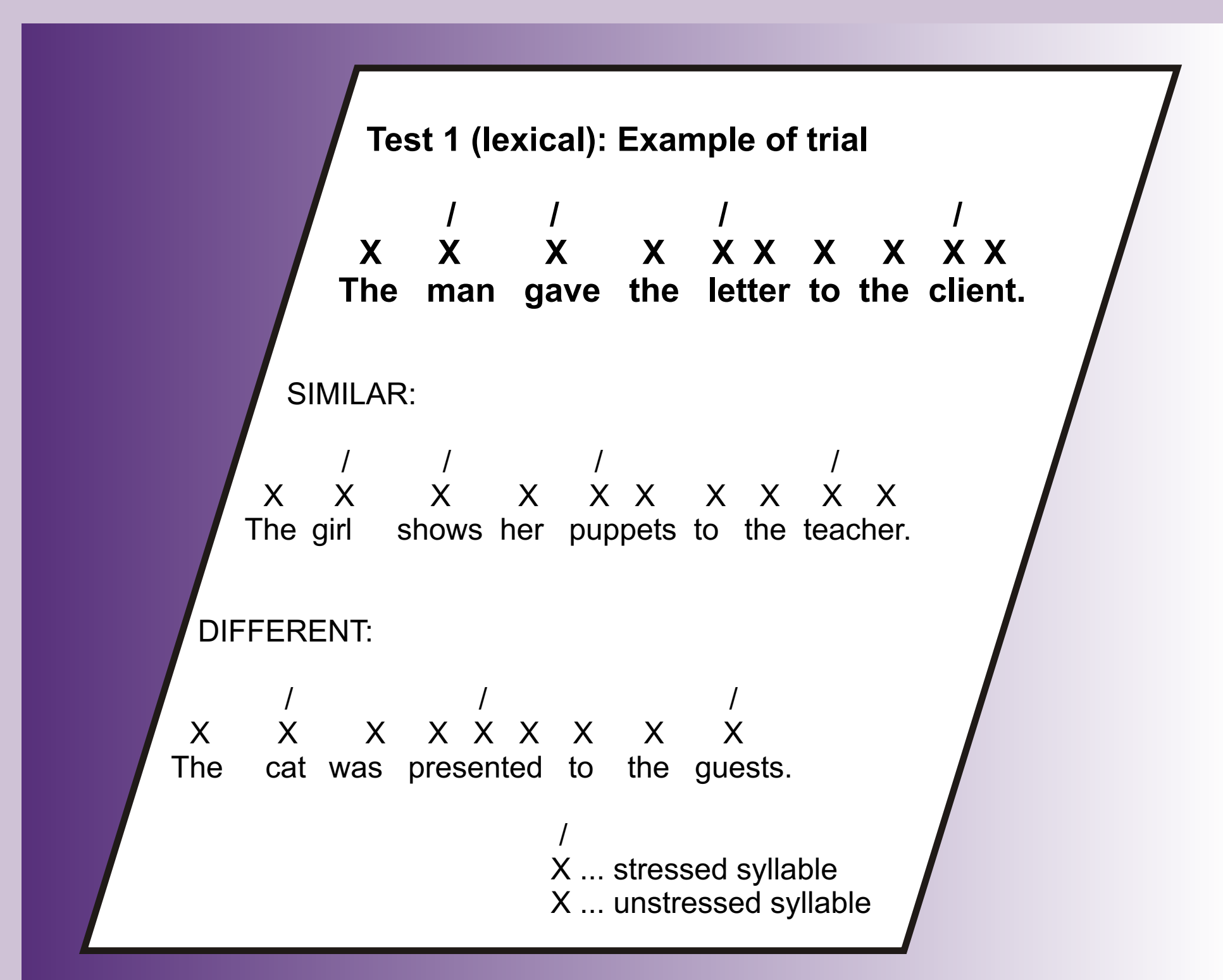


Figure 1 (above): Stimulus material of the test at the lexical level.

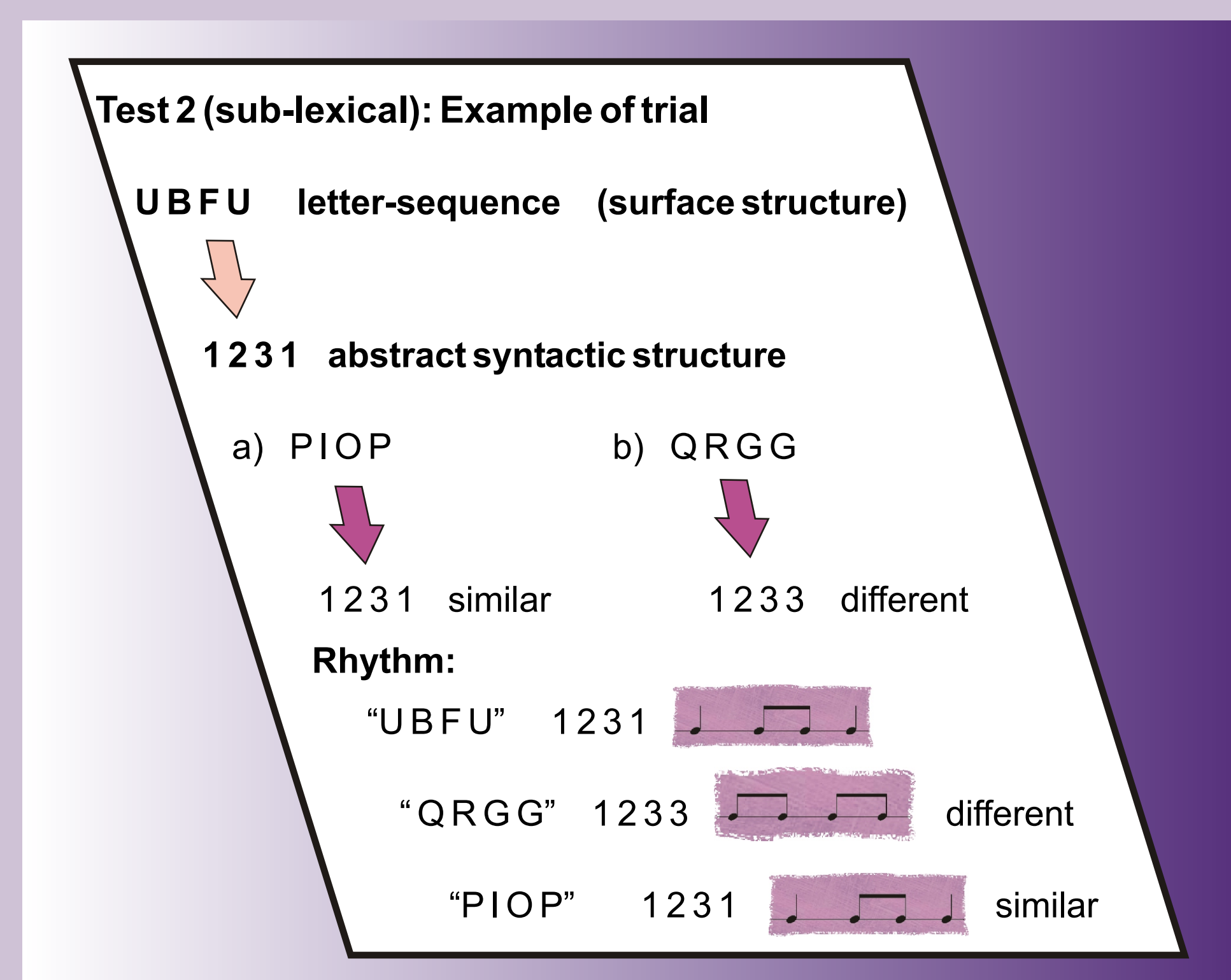


Figure 2 (above): Stimulus material of the test at the sub-lexical level.

## Materials & Method:

**Test 1 (lexical):** Participants heard 25 pairs of English sentences read with natural, constant intonation. They were either similar or dissimilar in both syntax and rhythm. Stimulus pairs varied in length and thus in syntactic complexity; "similar" sentences had the same number of syllables. Participants were asked to ignore the specific meaning of the sentences as the rated stimulus pairs as "similar" or "different". After the test, participants completed a questionnaire about the criteria underlying their similarity judgments.

**Test 2 (sub-lexical):** Identical except letters replaced words and abstract syntactic structures (e.g. 1231, realised e.g. as UBFU) replaced word syntax.

The order of the tests was varied within the groups of musicians and non-musicians, which had no significant effects on the results of the tests.

## Participants:

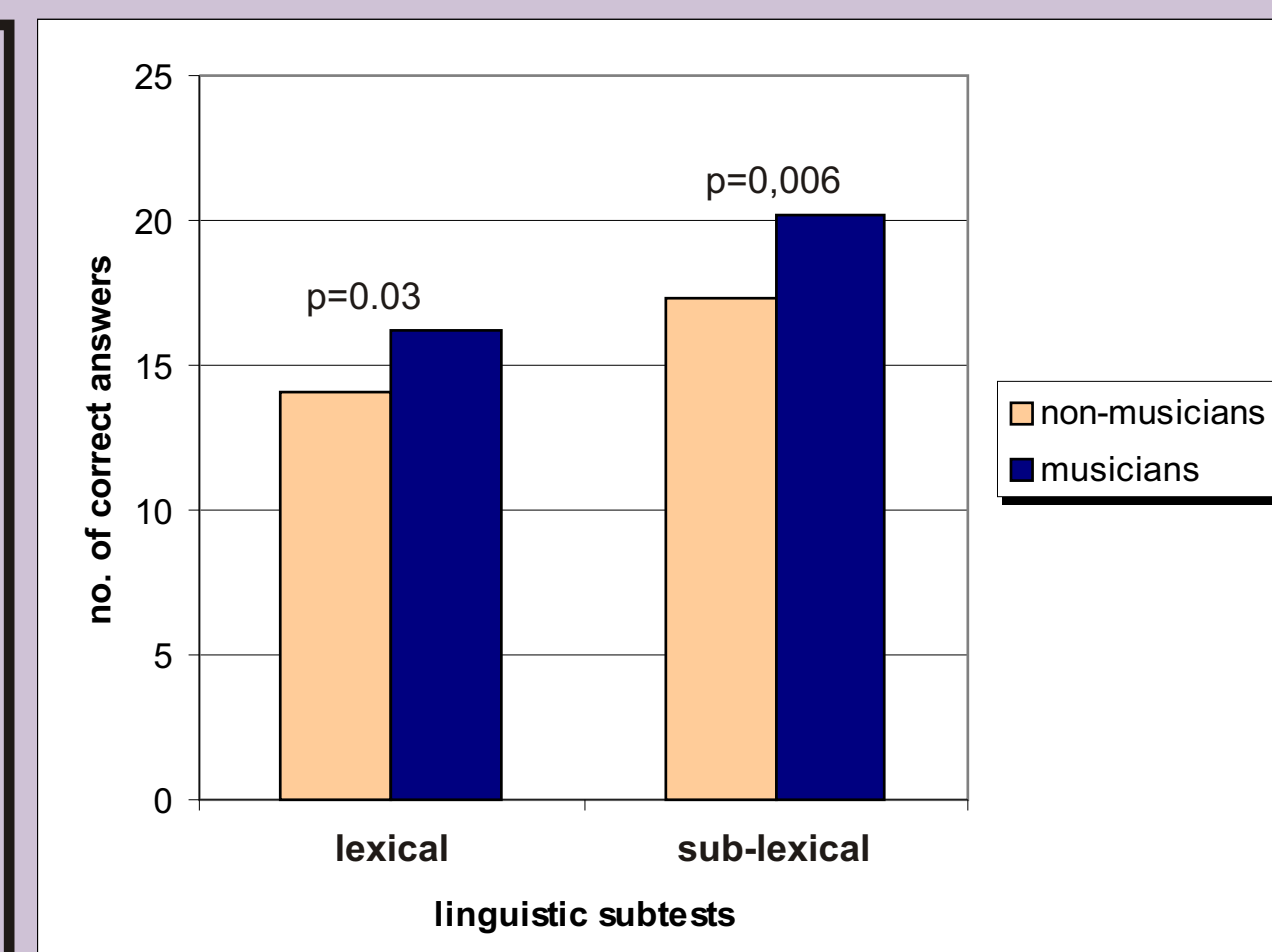
- 63 German speaking adolescents
- 32 males, 31 females
- students of four Austrian Gymnasien (~academic high schools)
- mean age 15,4 years
- learning English for 7-8 years
- 33 musicians (regular music lessons outside school, for mean duration of 6 years)
- 30 non-musicians (never played an instrument)
- wide range of parental education and English grades, nearly equal distributions for musicians and non-musicians

**Figure 3 (right):** Enhanced performance of musicians in both tests.

- Test 1 (lexical):  $t_{(61)} = -2.17, p = 0.03$ , mean diff. = 2.2
- Test 2 (sub-lexical):  $t_{(61)} = -2.85, p = 0.006$ , mean diff. = 2.9

In both tests there was a main effect of musical training but not of sex:

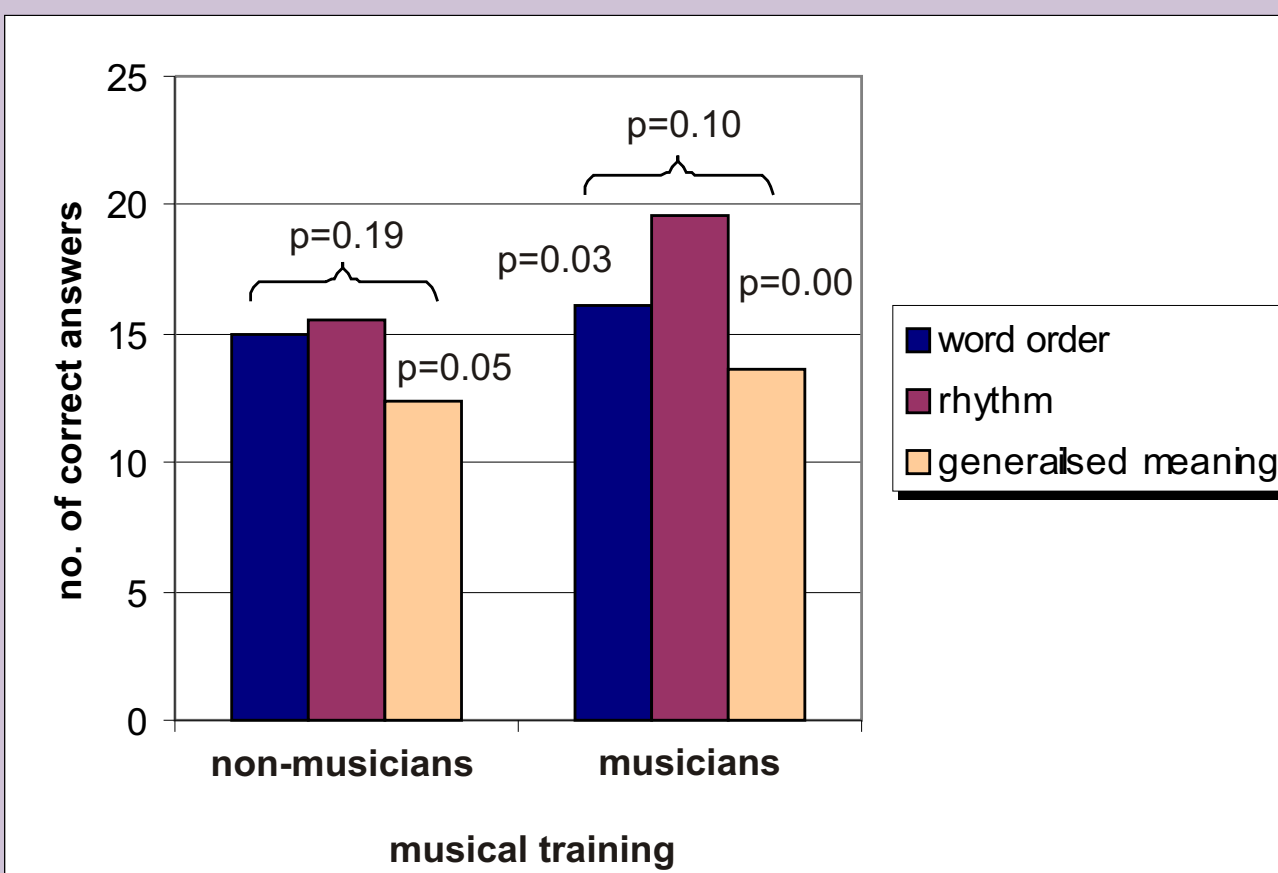
- Test 1 (lexical):  $F_{(1)} = 4.24, p = 0.044$
- Test 2 (sub-lexical):  $F_{(1)} = 8.62, p = 0.005$



**Figure 4 (below):**

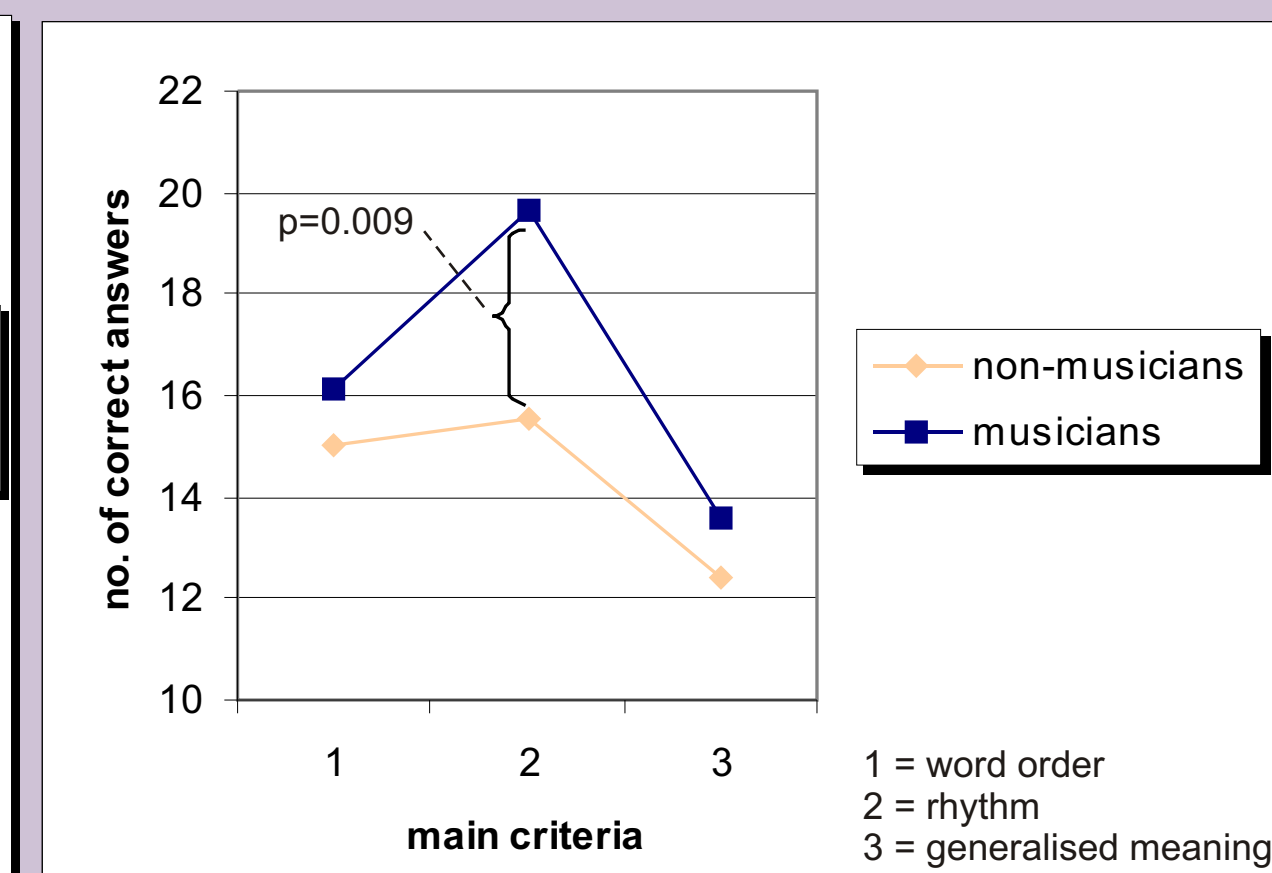
The influence of the main criterion of similarity (participants' self-report) on performance in Test 1 (lexical).

- main effect of musical training  $F_{(1)} = 5.50, p = 0.023$
  - main effect of main criterion  $F_{(1)} = 11.1, p = 0.000$
  - no interaction
- In both groups, participants who gave 'rhythm' as their main criterion achieved the highest mean score. Those giving 'generalised meaning' (e.g. "somebody does something") as their main criterion performed worst.



**Figure 5 (below):**

Test 1 (lexical): Musicians giving 'rhythm' as their main criterion performed significantly better than non-musicians:  $t_{(18)} = 2.93, p = 0.009$ . The differences between those giving 'word order' or 'generalised meaning' were not significant.



**Results: Quantitative results:** In both tests, musicians scored better than non-musicians, i.e. their results corresponded more closely to predetermined syntactic and rhythmic similarity.

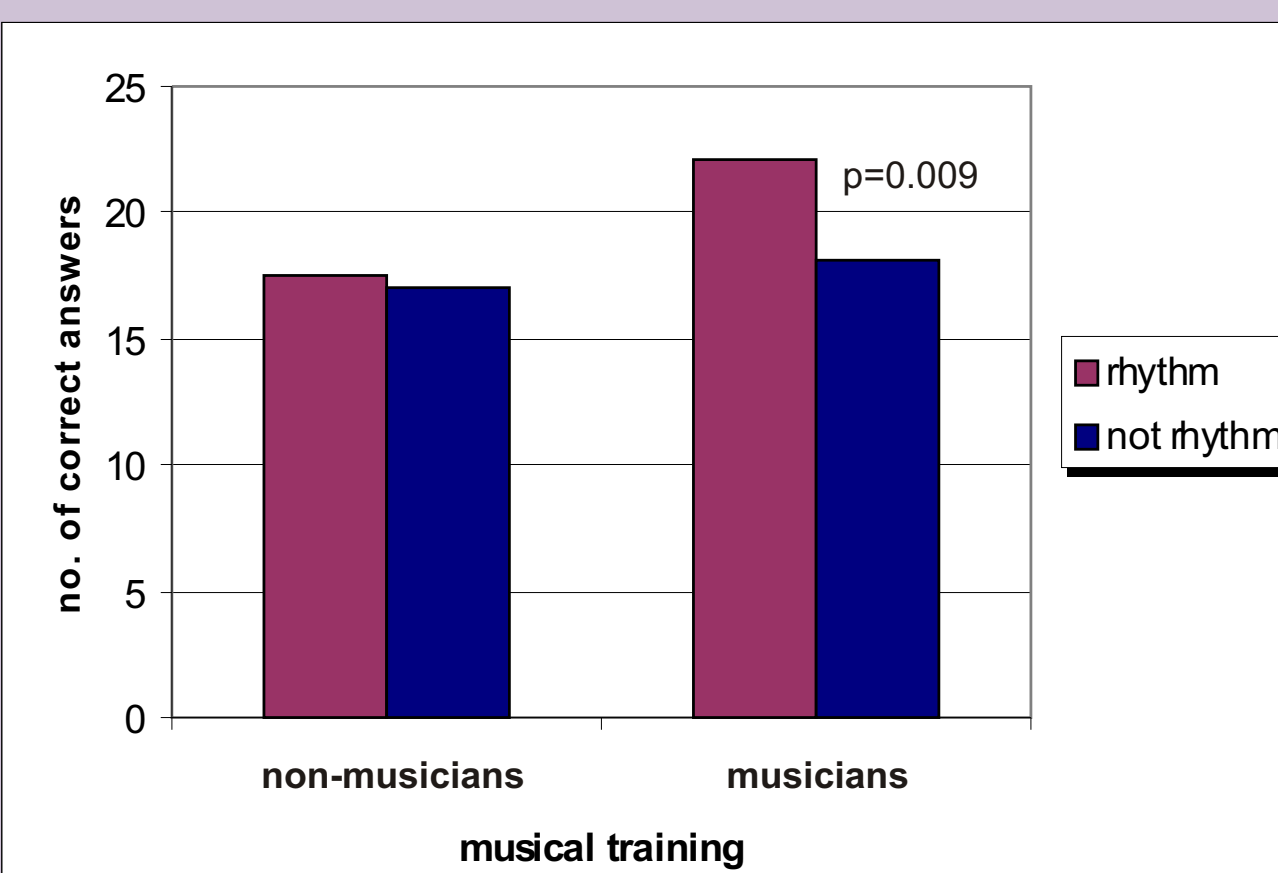
**Qualitative results:** Participants who gave rhythm as their main criterion scored better in both tests. The probability of scoring well was enhanced by being a musician and by saying that rhythm was the main criterion, so that the combination of both produced the best performance (see figures 3-7). The participants' social background and English competences had no significant influence on the performances in the tests (examined by means of t-tests and one-way ANOVAs). Musicians with a longer duration of musical training (more than 5 years) performed better in Test 2 (sub-lexical) only  $t_{(31)} = -2.090, p = 0.045$ . We did not find any significant differences between males and females.

**Discussion:** Our findings are consistent with the idea that musical training enhances cognitive abilities in the auditory language domain - an example of a positive transfer effect of musical training outside the domain of music. Specifically, musicians were more sensitive to speech rhythm and/or syntactic structure than non-musicians. We found no support for the claim that musicians are more likely to attend to rhythm in these kinds of language tasks. Our results are consistent with Schön et al. (2004) and Thompson (2003) who found that musicians have an enhanced ability to perceive prosody in speech. In contrast to their studies, we did not focus on intonation but on rhythm in the context of a second language.

**Figure 6 (below):**

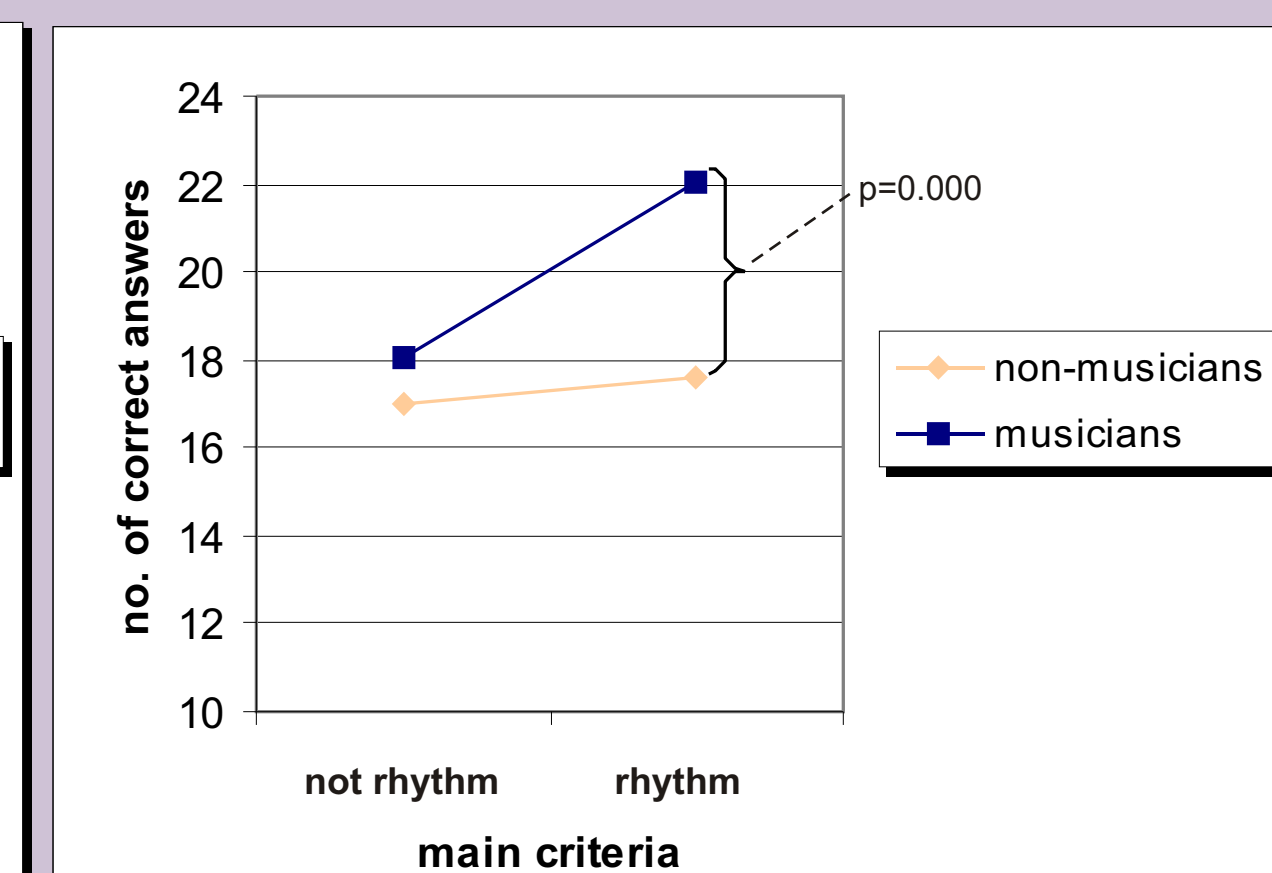
In Test 2 (sub-lexical) the chosen main criterion also predicted good or bad performance. Here we compared participants who named 'rhythm' as the main criterion with all other participants.

- main effects of musical training:  $F_{(1)} = 6.53, p = 0.013$
- main effect of criterion:  $F_{(1)} = 4.35, p = 0.042$
- no interaction



**Figure 7 (below):**

Musicians giving 'rhythm' as the main criterion for similarity in Test 2 (sub-lexical) performed best:  $t_{(38)} = 4.12, p = 0.000$ , mean diff. = 4.49.



## References:

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