Musicality influences the processing of accentuation in sentences with *only* by L2 English learners

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Research on the relationship between music and language has revealed advantages of musicality in the perception of acoustic variation in prosodic parameters in a foreign or second language (L2), e.g. pitch [1] and duration [2]. In this study, we investigate whether these benefits in speech perception extend to higher order processing in L2 prosody such as the processing of the prosodic cues to information structure. Specifically, we address the following question: **Does musicality facilitate the processing of accentuation in English sentences with *only* by Dutch learners of English?** Sentences containing the focus particle *only* need accentuation to determine the locus of contrast (e.g. I have only CARRIED the bag vs. I have only carried the BAG), and thus require the processing of the accentuation-to-contrast mapping. These sentences may pose a challenge for Dutch learners of English, because the Dutch equivalent of *only* ('alleen') typically directly precedes the word in contrastive focus [3], whereas in English, *only* usually precedes the verb, regardless of which word is focal [4]. Dutch listeners have been shown to expect an accent on the word directly following *alleen* [5]. They may also expect the accent to fall on the verb following *only* in English. Given that musicality is related to heightened sensitivity to acoustic variation in L2 prosody, we hypothesised that learners with higher musicality are more efficient in higher order prosodic processing in L2 and demonstrate less influence of L1 processing patterns.

Method: Thirty-three advanced Dutch learners of English participated in this study. In a 64-channel event-related potentials (ERP) experiment, the participants were instructed to listen to short trials recorded by a native speaker of British English. Each trial contained a sentence with *only* in which either the verb or the object was accented; the sentence with *only* was preceded by a context in half of the trials, creating four conditions (Table 1). ERPs were recorded from the word onset to 1000ms after the word onset during the word *only*, the verb, and the object noun. Following the ERP experiment, the participants completed a short version of the Profile of Music Perception Skills (PROMS) test [6]. The PROMS scores were used as a measure of musicality, which refers to one's musical perceptual ability.

Analysis: ERPs in three time windows were analysed using Mixed Effect Modelling (lme4 in R): 100-200ms (analysed for *only*, verbs, and objects), 200-390ms (analysed for verbs and objects), and 500-900ms (analysed for objects). The average ERPs per condition per area were used. CONTEXT (present vs. absent), ACCENT (verb vs. object), LATERALISATION (right, middle, or left) and ANTERIORITY (front, central, or back) and MUSICALITY were included as fixed factors and STIMULUS-LIST and PARTICIPANT as random intercepts.

Results: We found a significant three-way interaction of CONTEXT x ACCENT x MUSICALITY for *only* in the time window 100-200ms ($p < .001$). Subsequent analyses showed that in the accented-object condition with context, lower PROMS scores led to more negativity than higher PROMS scores (Figure 1A), suggesting more processing effort in the participants with lower musicality. Acoustic analysis of our stimuli revealed that the words before *only* had a significantly higher pitch and *only* had a longer duration in the accented-object condition than in the accented-verb condition. Our participants might thus have anticipated the locus of accentuation upon hearing *only* [7]. The presence of context appears to enhance the L1-based expectancy of accentuation in the verb, making the anticipated lack of accentuation in the verb more effortful to process for the participants with lower musicality. The higher processing effort in participants with lower musicality thus suggests that they are less flexible in adjusting their expectations when listening to L2 prosody than listeners with higher musicality.

The modelling on the ERPs in the verb did not yield a main effect of MUSICALITY or a significant interaction involving MUSICALITY, despite the fact that the average ERPs suggested a difference

between the participants with lower musicality and those with higher musicality. Our sample size was probably too small to observe a relationship between variation in musicality scores and ERPs in the verb region. In subsequent modelling, we re-coded MUSICALITY as a categorical variable by dividing the participants into two groups on the basis of the median value of the PROMS scores (i.e. 40), low musicality (lower than 40, *N*=16) and high musicality (40 or higher, *N*=17). We found a significant interaction of CONTEXT x ACCENT for the verb in the time-window 200-390ms ($p < .001$) for the high-musicality group, but not for the low-musicality group. Further analyses showed that in the accented-object condition without context, the high-musicality group exhibited less negativity than the low-musicality group (Figure 1B). The negativity found in the low-musicality group suggests a continued expectancy of accentuation on the verb. Here, the effect of CONTEXT is different than in *only*; the absence of context makes the lack of accentuation in the verb difficult to process for the low-musicality group, possibly because it is strange to use *only* in an isolated sentence and even stranger to then deaccent the verb. These differences in expectancies provide further evidence that listeners with high musicality are more flexible when processing L2 prosody.

Conclusion: Our study has provided the first evidence for an influence of musical abilities on high order prosodic processing in L2, i.e. the processing of the prosodic cues to information structure. Higher musicality is related to better online adjustment of expectations for accent placement while listening to sentences with *only*. The heightened sensitivity to acoustic variation in pitch and duration that has been related to higher musicality may play a role in the more efficient higher order prosodic processing in L2.

Table 1. Examples of experimental stimuli. Pitch accents are represented by capitals.

Context sentences	**Target sentences**	
The dinosaur has a pumpkin and a bucket. He was going to throw them and carry them. Then he changed his mind.	(A) The dinosaur is only THROWING the bucket.	(B) The dinosaur is only throwing the BUCKET.
-	(C) The dinosaur is only THROWING the bucket.	(D) The dinosaur is only throwing the BUCKET.

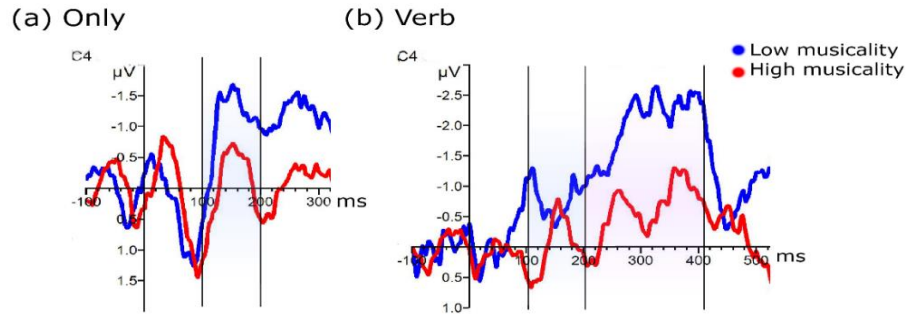

Fig. 1 Grand-average ERPs for the low- and high-musicality group from the word onset (t = 0) for *only* (A) in the condition accented objects with context, and for verbs (B) in the condition accented objects without context.

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