

The influence of temporal regularities on the implicit learning of pitch structures

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ABSTRACT

Background

Implicit learning (IL) is the acquisition of complex information without the intention to learn. According to the Dynamic Attending Theory (Jones, 1976), external regularities can entrain internal oscillators that guide attention over time, helping listeners develop temporal expectations that influence perception of future events.

Aims

Our study aimed to investigate the influence of temporal regularities on the IL of an artificial grammar of tones. If participants acquire knowledge about the artificial pitch grammar during the exposure phase despite the temporal variability, then pitch expectations for upcoming tones should lead to faster processing of grammatical (expected) target tones, compared to ungrammatical (unexpected) tones in both regular and irregular timing patterns. However, if temporal expectations facilitate grammar learning, then a benefit for IL should be observed for temporally regular relative to irregular presentations.

Method

For an initial exposure phase, regular and irregular temporal patterns were created. Regular patterns were constructed to allow the abstraction of a clear metrical structure. Irregular patterns were constructed by reorganizing the same temporal intervals to disrupt this metrical structure. All regular patterns were characterized as highly metrical, and all irregular patterns were characterized as non-metrical based on algorithms of Povel and Essens (1985). A behavioral pre-test using six other participants confirmed that metrical patterns were judged more regular (3.46 ± 0.66) than the irregular patterns (4.62 ± 0.58) on a subjective scale (from 1 (strongly regular) to 7 (strongly irregular), $p = 0.047$).

The artificial tone system was composed of five tones differing in pitch applied to a finite state grammar. In the exposure phase, artificial grammar melodies of 10 and 12 tones were presented with regular patterns or irregular time patterns, respectively, to two participant groups. In a subsequent test phase both groups heard the same 5- and 6-tone melodies, all presented in an isochronous rhythm. The task was to judge as quickly and accurately as possible whether target tones (i.e., one tone within the melodies) were in-tune or out-of-tune. This target tone was either the grammatical tone or replaced by an ungrammatical tone.

Results

Correct response times (RTs) were analyzed and compared with a previous study where the exposure phase used an isochronous presentation of the artificial pitch material (Tillmann & Poulin-Charronnat, 2010). For the group with the regular exposure phase, RTs were faster for grammatical target tones than for ungrammatical target tones for both 5- and 6-tone sequences (RT difference of 46 ms and 27 ms, respectively). For the group with the irregular exposure phase, a significant processing advantage for grammatical tones was observed only for 6-tone sequences (33 ms) but not for 5-tone sequences (0 ms). RT differences for the group with regular presentation were equivalent to RT differences previously observed with the isochronous presentation.

Conclusions

The findings suggest that regular temporal patterns, which allow perceivers to develop expectations about future events, facilitate learning of an artificial pitch grammar. A second experiment that combines electrophysiological and behavioral methods (currently under progress) aimed to investigate which type of temporal patterns, i.e. regular metrical or isochronous, leads to better IL of tone structures, and whether a metrical framework might provide an additional benefit for learning. Preliminary results of this second study will also be presented.

Keywords

Artificial grammar, auditory expectations, temporal structures, tone sequences

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