Consciousness and Cognition 20 (2011) 214–222

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Incidental and online learning of melodic structure

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ARTICLE INFO

Article history:
Received 5 February 2010
Available online 15 September 2010

Keywords:
Incidental learning
Implicit learning
Artificial grammar learning
Online-learning effect
Unsupervised learning
Melody
Music perception

ABSTRACT

The cognition of music, like that of language, is partly rooted in enculturative processes of implicit and incidental learning. Musicians and nonmusicians alike are commonly found to possess detailed implicit knowledge of musical structure which is acquired incidentally through interaction with large samples of music. This paper reports an experiment combining the methodology of artificial grammar learning with musical acquisition of melodic structure. Participants acquired knowledge of grammatical melodic structures under incidental learning conditions in both experimental and untrained control conditions. Subsequent analysis indicates a large effect of unsupervised online learning in the experimental and control group throughout the course of the testing phase suggesting an effective ongoing learning process. Musicians did not outperform nonmusicians, indicating that musical expertise is not advantageous for the learning of a new, unfamiliar melodic system. Confidence ratings suggest that participants became aware of the knowledge guiding their classification performance despite the incidental learning conditions.

1. Introduction

In order to make sense of music, humans need to apply a considerable amount of knowledge about musical structure. Most members of Western societies are competent music listeners, despite having had little or no formal musical training. Considerable experimental evidence indicates that nonmusicians as well as musicians possess detailed knowledge of musical structure (Bigand, 2003; Deliège, Mélen, Stammers, & Cross, 1996). Musical knowledge, like native language knowledge, is assumed to be *implicit*, i.e., mentally represented without awareness of the entirety of the complex structure and governing principles, being acquired incidentally through attending and interacting with a larger number of samples during the process of musical enculturation (Deliège & Sloboda, 1996) in analogy with linguistic enculturation (Berry & Dienes, 1993; Rebuschat, 2008; Williams, 2009; Winter & Reber, 1994).

This study is directed towards exploring the acquisition of basic melodic structures which employ sequential and schematic patterns. Such melodic patterns are frequently found in musical styles all over the world, such as Japanese *gagaku,* North Indian *ragas*, Iranian *gusheh*, Brazilian samba or Middle Eastern *maqam* (Reck, 1997), and play an important role for schematic tonal structure (such a clausulas, cadences or motifs, riffs, phrase beginnings or endings), prototypical voice-leading schemata (Gjerdingen, 1988; Gjerdingen, 2007) and cross-cultural melodic expectancy (Eerola, 2003; Narmour, 1990; Narmour, 1992; Pearce & Wiggins, 2006). Sequential melodic patterns are here modelled using the artificial grammar learning paradigm (Reber, 1967; see Pothos (2007), for an overview) in order to embed this study within this well-explored area of research.

Numerous studies use artificial finite-state grammars (Chomsky, 1956) in abstract contexts (e.g. Dienes, Altmann, Kwan, & Goode, 1995; Matthews et al., 1989; Perruchet & Pacteau, 1990; Reber, 1967) or in respect of human language acquisition

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doi:10.1016/j.concog.2010.07.004

(Braine, 1963; Moeser & Bregman, 1972; Morgan & Newport, 1981). At present, however, there is little work with respect to musical or melodic structure. A number of studies have explored implicit factors in music perception using the priming paradigm (Tillmann, 2005), yet few studies have investigated how humans acquire knowledge of musical structure incidentally by mere exposure to, and interaction with, music.

Some studies explore *learning* in domains related to music. In the context of segmentation, Saffran et al. (1999) found statistical learning of "tone words" within a continuous monophonic melodic stream in adults and infants. However, they did not test for awareness in their learning experiment so as to distinguish incidental unaware (implicit) from aware learning. Bigand, Perruchet, and Boyer (1998) used musical timbres (such as violin, trumpet or gong) as terminals of a finite-state grammar. Dienes and Longuet-Higgins (2004) found that only specialist participants could learn 12-tone serialist transformations. Kuhn and Dienes (2006) used a set of self-similar diatonic melodies and found some evidence of implicit learning (knowledge of chunks). Loui et al. (2006), Loui and Wessel (2008) investigated the acquisition of regularities in an artificial western-like structured musical system employing non-western tuning (Bohlen-Pierce scale; Walker, 2001). The stimuli employed two types of monophonic melodies that followed two different underlying chord progressions; subjects could consistently recognise melodies they had previously heard, and there was some tendency towards generalisation to unheard melodies as well as sensitivity to the underlying tonal distribution. Altmann, Dienes, and Goode (1995) found learning of sound sequences with Reber's (1967) original finite-state grammar using a set of randomly-assigned sine tones for each terminal symbol.

While several of the studies above yielded important findings regarding the cognition of complex, non-local structures, some employ material that is unrepresentative of musical structures central in music perception (Deutsch, 1999), as the great majority of typical musical melodies do not conform to strictly formal, or "mathematical" characteristics (Piston, 1948, chap. 7; Aldwell & Schachter, 1989).

The present study focuses on the learning of sequential melodic patterns generated by a finite-state grammar under incidental learning conditions. Learning of artificial finite-state grammars was explored in various domains by Reber (1967), Altmann et al. (1995), or Bigand et al. (1998) for instance. The present study uses tone sequences that are intended to conform to general principles of melodic organisation identified in a wide range of theoretical and empirical studies of musical perception (e.g., Bregman, 1990; Deutsch, 1999; Huron, 2001; Narmour, 1990; Narmour, 1992; Schellenberg, 1996), but that do not incorporate structures that would be assimilated to the over-learned configurations of Western tonal music, already familiar to the experimental participants. This experiment thus links to established methodologies used by Saffran et al. (1999), Dienes and Longuet-Higgins (2004), Kuhn and Dienes (2005), Kuhn and Dienes (2006), and Altmann et al. (1995), but moves beyond these studies by explicitly controlling its stimuli in respect of some general principles of melodic organisation demonstrated to be relevant in music perception. Based on this methodology this study aims to explore incidental learning of melodic pitch structures in a way that models some core processes involved in the acquisition and development of musical competence.

2. Method

2.1. Participants

Fifty-nine western adults participated in either an experimental (8 women, 14 men, mean age 29.0 years) or a control condition (18 women, 19 men, mean age 30.1 years). The experimental/control group had 11/18 musicians and 11/19 nonmusicians respectively. Musician participants all played their instrument(s) actively, had an average of 10.3 years of music lessons and practised/performed 6.8 h per week on average. Nonmusician participants did all not play music actively (0 h per week), had practised an instrument for 2.4 years on average and had stopped practising (if they had played) for 9.5 years on average.

2.2. Grammar

Fig. 1 displays the finite-state grammar (FSG) that was selected for the experiment and the musical lexicon. Tone pairs were employed as terminals in order to obtain melodies of realistic lengths while keeping the grammar reasonably small. The tones stemmed from the diatonic scale in order to employ familiar and categoriseable pitches (Deutsch, 1999). The selected terminals allowed generation of melodies that featured predominant small interval steps, as typical in Western melodies (Narmour, 1990) but conveyed as few prototypical tonal patterns (e.g. beginning or ending with the same tone, formulaic or cadential patterns; see Huron, 2001; Krumhansl, 1990; Narmour, 1990; Schellenberg, 1996) as possible.

2.3. Stimulus material

2.3.1. Grammatical stimuli

Applying a constraint that all circular paths may only be traversed up to three times, the FSG generates 33 different melodies between 8 and 30 tones. To investigate whether stimulus learning would derive from mere sequence memorisation or induction of some underlying structure, 17 tone sequences were selected and employed for both, learning and testing phase ('old-grammatical'), and 16 remaining grammatical sequences were only used for the testing phase ('new-grammatical').