

## Implicit Learning Out of the Lab: Language and Music

**Patrick Rebuschat (p.rebuschat@lancaster.ac.uk)**

Department of Linguistics and English Language  
Lancaster University, Lancaster, United Kingdom

**Morten H. Christiansen (christiansen@cornell.edu)**

Department of Psychology, Cornell University  
Ithaca, NY, USA

**Clément François (cfrancois@idibell.cat)**

**Daniele Schön (daniele.schon@incm.cnrs-mrs.fr)**

INSERM U 1106, Institut de Neurosciences des Systèmes  
Aix-Marseille Université, Marseille, France

**Shan Jiang (jiangs988@126.com)**

School of Social Administration, Shanghai University of  
Political Science and Law, Shanghai, China

**Jennifer B. Misyak (jennifer.misyak@wbs.ac.uk)**

Behavioural Science Group, Warwick Business School  
University of Warwick, Coventry, United Kingdom

**Martin Rohrmeier (mr1@mit.edu)**

Department of Linguistics and Philosophy, Massachusetts  
Institute of Technology, Cambridge, MA, USA

**Zoltan Dienes (dienes@sussex.ac.uk)**

School of Psychology, University of Sussex  
Brighton, United Kingdom

**Xiuyan Guo (xyguo@psy.ecnu.edu.cn)**

Shanghai Key Laboratory of Magnetic Resonance and  
School of Psychology and Cognitive Science, East China  
Normal University, Shanghai, China

**Feifei Li (lifeifei1206@163.com)**

School of Psychology and Cognitive Science, East China  
Normal University, Shanghai, China

**Richard Widdess (rw4@soas.ac.uk)**

Department of Music, School of Oriental and African  
Studies, University of London, United Kingdom

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### Goals and Scope

Implicit learning, essentially the ability to acquire unconscious (implicit) knowledge, is a fundamental aspect of human cognition. This symposium focuses on the acquisition of two cognitive systems that are widely regarded as prime examples of implicit learning “in the real world”, namely language and music (see e.g. Rebuschat et al., 2011; Rohrmeier & Rebuschat, 2012). This symposium brings together leading researchers from across the cognitive sciences (psychology, linguistics, cognitive neuroscience, computer science, and musicology) in order to discuss current trends in implicit learning research, to identify the progress made in recent years, and to outline future directions to take, both in terms of topics and novel methodologies.

The symposium will consist of five talks, followed by a brief general discussion. Each talk approaches the symposium topic from a highly innovative and interdisciplinary angle. Christiansen and Misyak focus on individual differences in implicit language learning, while Rebuschat concentrates on the role of implicit and explicit learning in second language (L2) acquisition. François and Schön’s work demonstrates the impressive effect of musical practice on the implicit learning of linguistic structure, while the last two talks, by Dienes and colleagues and by Rohrmeier and Widdess, focus on the implicit learning of Chinese tonal poetry and of syntactic features of North Indian music, respectively. These last two studies reflect a particularly important trend in implicit learning research

towards the use of more ecologically-valid stimuli. In addition to introducing novel and exciting subject areas, the research discussed in this symposium also reflects the strong tendency, within cognitive science, for methodological diversification. The talks will discuss data from behavioral and neurophysiological experiments as well as results of computational modeling.

### Morten H. Christiansen and Jennifer B. Misyak Individual differences in implicit statistical learning and language

Over the past decade, implicit learning under the guise of statistical learning has emerged as an important experimental paradigm with which to study mechanisms involved in language acquisition. Although few empirical studies have directly linked variation across statistical learning and language, it is generally assumed that greater sensitivity to statistical structure leads to better language performance. Here, we report the results of studies investigating the relationship of individual differences in statistical learning of adjacent and nonadjacent dependencies to variations in the processing of local and nonlocal dependencies in natural language. Together, the results indicate that individual differences in statistical learning are positively related to variations in language processing. However, the complexity of the pattern of interrelations suggests that future developmental and adult work on implicit statistical learning must incorporate careful attention to a diversity of natural dependency-structures to establish the proper relationship between adjacent and nonadjacent manifestations of statistical learning and the

extent to which they map onto similar structures in language.

**Patrick Rebuschat**

### **Implicit and explicit learning of L2 syntax**

First language acquisition is generally characterized as a process where most learning proceeds implicitly, i.e. incidentally and in absence of awareness of what was learned. At the same time, however, there is considerable debate as to whether implicit learning plays a similarly important role in the case of adult second language (L2) acquisition. In this talk, I will review a series of experiments that investigated the implicit and explicit learning of L2 syntax by means of an artificial language paradigm. This research addressed questions such as the following: Is there implicit learning in the case of L2 acquisition? If so, how is implicit knowledge of language represented in the mind (rules, patterns, chunks...)? How do task instructions affect the acquisition of implicit and explicit knowledge? Is there an implicit-explicit interface? And what is the role of individual differences (e.g. working memory capacity), in the implicit and explicit learning of languages?

**Zoltan Dienes, Xiuyan Guo, Shan Jiang,  
and Feifei Li**

### **Implicit learning of symmetries in tonal language**

Implicit learning research has identified a number of structures that people can unconsciously learn, including chunks and fixed patterns of repetition. Language and music appear to involve structures more complex, indeed higher than finite state, for example symmetry structures that are simply generated by recursive rules (e.g. centre embedded, cross-serial dependency structures). The implicit learning of such structures presents an interesting challenge to existing models of implicit learning, such as the Simple Recurrent Network (SRN). We build on our earlier work in music and movement, by looking at symmetries in the tonal structure of Chinese poetry. We show that people can acquire unconscious knowledge of both cross-serial dependencies and centre embeddings in tonal poetry, with the former being easier than the latter. We also show that people can generalise their unconscious knowledge from being trained on strings of a certain length to test strings of a different length, indicating apparent learning of the symmetry itself rather than chunks or fixed length associations. We also show the SRN can model many of the details of this learning, exploring whether the SRN is more than a graded finite state machine.

**Clément François and Daniele Schön**  
**Implicit learning of linguistic structures and  
the effect of musical practice**

Both speech and music involve sequences of sounds ordered in time according to complex rules. The acquisition of both

language and music require learners to engage several cognitive functions and notably the ability to sequence sound patterns. There is increasing evidence showing that the statistical regularities found in the input can play a important role in the implicit acquisition of several linguistic and musical structures. We previously showed that combining music and language into song can facilitate speech segmentation in implicit learning paradigms (Schön et al., 2008). Moreover, we recently conducted a set of experiments with adults and children showing that musical practice directly affects sensitivity to statistical regularities in speech both at the neural and behavioral levels (François & Schön, 2011; François et al., 2012). Interestingly, our results seem to show that musical training and expertise have effects on brain plasticity that may go beyond primary auditory regions. These results also confirm that neurophysiological measures are more robust and sensitive than behavior to study implicit statistical learning processes.

**Martin Rohrmeier and Richard Widdess**  
**Implicit learning of musical grammar:  
The acquisition of North Indian music**

Recent years have witnessed an increasing interest in the implicit and statistical learning of music (see Rohrmeier & Rebuschat, 2012, for a review). Despite this interest, only few studies employed stimuli that resemble actual musical systems more closely, and only little research has been carried out on the acquisition of non-Western music. In this paper, we present the findings of a study that addressed this gap. The study focused on the implicit learning of modal melodic features in traditional North Indian music by Western learners who were unfamiliar with this musical system. Participants were trained on the ālāp (introduction) section of either the rāga Toṛī and Multānī and tested on novel excerpts from (later) jor sections of both rāgas featuring five distinct melodic features. Three of the five features were melodically distinctive of either rāga, whereas two were only distinctive based on other than mere pitch sequence features (for instance, emphasis). Findings indicated that Western participants unfamiliar with Indian music learned to distinguish features of either rāga without intending to and after a very short exposure period. These results confirm that implicit learning constitutes a powerful mechanism that plays a fundamental role in the acquisition of highly complex, ecologically-valid musical stimuli.

**Moderators:**  
**Patrick Rebuschat and Martin Rohrmeier**

### **References**

- Rebuschat, P., Rohrmeier, M., Hawkins, J. H., & Cross, I. (2011). *Language and music as cognitive systems*. Oxford: Oxford University Press.
- Rohrmeier, M. & Rebuschat, P. (2012). Implicit learning and acquisition of music. *Topics in Cognitive Science (TopiCS)*, 4(4), 525–553.