

# **9<sup>th</sup> International Conference on Music Perception and Cognition**

**Alma Mater Studiorum University of Bologna, August 22-26 2006**

## **The effect of exposure and expertise on timing judgments in music: Preliminary results\***

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### **ABSTRACT**

*Previous studies have shown that experienced listeners can distinguish between an unaltered and a tempo-transformed audio recording by focusing on the expressive timing used by the performer. This was interpreted as evidence for the tempo-specific timing hypothesis (Honing, 2006a). This study tries to disentangle the various factors that might have contributed to this result, including familiarity with a musical genre, musical background and expertise. The preliminary results suggest that familiarity with a specific genre (listeners' exposure) has a significant effect on discriminating a real from a tempo-transformed performance, while formal musical training (listeners' expertise) does not have such an effect. These results are taken as further evidence for the sensitivity of listeners to timing deviations in music performance and that these are more likely enhanced by exposure through active listening than by formal musical training.*

### **Keywords**

Rhythm perception, timing, tempo, exposure, expertise

In: M. Baroni, A. R. Addressi, R. Caterina, M. Costa (2006) Proceedings of the 9th International Conference on Music Perception & Cognition (ICMPC9), Bologna/Italy, August 22-26 2006. ©2006 The Society for Music Perception & Cognition (SMPC) and European Society for the Cognitive Sciences of Music (ESCOM). Copyright of the content of an individual paper is held by the primary (first-named) author of that paper. All rights reserved. No paper from this proceedings may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information retrieval systems, without permission in writing from the paper's primary author. No other part of this proceedings may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information retrieval system, without permission in writing from SMPC and ESCOM.

### **INTRODUCTION**

Perceptual invariance has been studied and found in several domains of cognition (Shepard & Levitin, 2002). However, for certain aspects of music (e.g., melody) there is more agreement about perceptual invariance under transformation than for others, such as expressive timing under tempo transformation. Previous studies have shown that experienced listeners can distinguish between an unaltered and a tempo-transformed audio recording by focusing on the expressive timing used by the performer. This was interpreted as evidence for the tempo-specific timing hypothesis (Honing, 2006a) which suggests that expressive timing can function as a cue in discriminating between a 'real' performance<sup>1</sup> and a tempo-transformed performance. The results are counterevidence for the relationally invariant timing hypothesis (cf. Repp, 1994) which predicts both versions to sound equally 'natural' or musically convincing.

This study tries to disentangle the various factors that might have contributed to this result, including a listeners familiarity with a musical genre, previous exposure, and expertise as a result of formal musical training. It could be that the reported results are mainly due to expert knowledge on the musical genre (in the case of Honing [2006a], piano music from the classical repertoire), giving the results less generality. Alternatively, the results could have

<sup>1</sup> The label 'real' is used throughout to indicate an audio recording of a performance (e.g., as taken directly from a CD), containing expressive timing as intended by the performer, that is part of the specific style, or that is typical for that performer.

\* This research is in progress (May 2006). See Honing & Ladinig (in preparation) for a more elaborate discussion.

been a result of exposure, i.e. familiarity with the repertoire simply by listening to many examples. Therefore, in this study, we selected listeners from a variety of musical backgrounds, with different musical preferences and expertise levels, compared against stimuli from different musical idioms.

Comparing musically trained and untrained listeners, however, has its pitfalls. Bigand & Poulin-Charronnat (in press) advise—to avoid ‘misleading’ results—to use experimental tasks that do not rely on explicit naming (musically trained listeners would have an advantage) and they promote the use of ecological valid or ‘realistic’ stimuli (protomusical stimuli saying more about auditory capabilities of listeners than about their musical abilities). The design used in this, and preceding studies (e.g., Honing, 2006a; in press), accounts for both issues by using a comparison task that is compelling to both untrained and trained listeners, and by using fragments from commercially available CDs that are more realistic than, for example, MIDI renderings that are mostly used in music cognition research.

Since the use of expressive timing in music performance is so different between musical styles (Clarke, 1999), it seems worthwhile to study the possible effects in-between different musical genres. Therefore, in this study, we focus on the question: Are listeners more sensitive to timing deviations in musical styles with which they are highly familiar? And does expertise play a role in this? These two questions are investigated by using an Web-based experimental setup (cf. Honing, 2006a) that takes advantage of the widespread availability of Internet, high-quality audio, and state-of-the-art tempo-transformation techniques (minimizing the effect of signal processing artifacts).

## EXPERIMENT

### Aim and task

The aim of this study is to systematically study the effect of exposure and expertise on the identification of a real performance in three musical genres: “Jazz”, “Rock” and “Classical”. The participants ( $N = 151$ ) were asked to listen to fifteen pairs of audio fragments (i.e., five pairs in each genre) from commercially available recordings of different performances of the same piece. One stimulus of the pair was a real recording (taken from a CD), the other a manipulated, tempo-transformed alternative recording. The latter was originally performed at a different tempo but had been time stretched (or time compressed) to become close in tempo to the other performance of the pair.<sup>2</sup> The task was to judge which of the two performances was a real (i.e., not tempo-transformed) recording while focusing on

<sup>2</sup> An earlier study (Experiment 2 in Honing, 2006a) showed that artifacts of the time-scale method had only a marginal effect, not influencing the overall results. In this study this is even less of an issue since we are interested in the differences between listeners.

the use of expressive timing in the performance (see Figure 1).

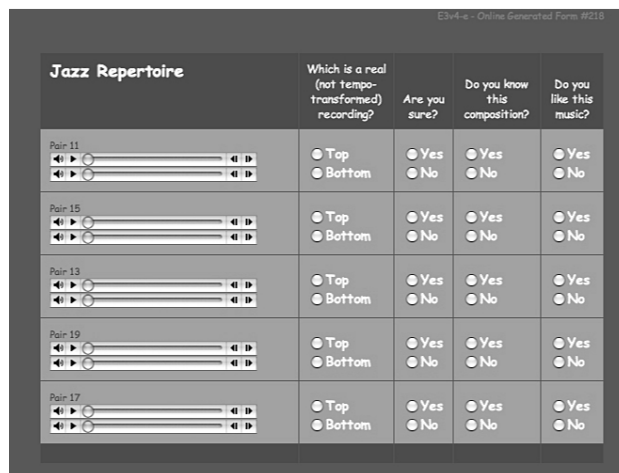


Figure 1: Fragment of the online interface.

## Hypotheses

First of all we expect to replicate the results from the previous experiment with regard to the Classical genre; Five (out of seven) stimuli pairs were reused in this study to allow for comparison between the studies.

Furthermore, we expect to find similar recognition rates for the jazz and rock repertoire, as was suggested in a pilot study (Honing, in press), with a slightly stronger effect in jazz as compared to the other genres, because of the apparent and prominent role of expressive timing in the jazz repertoire (e.g., groove, swing).

Finally, and most importantly, in this experiment we concentrate on the possible influence of musical competence on the results. At least two views on musical competence exist. The first states that musical competence is mostly determined by intensive musical training and remains rather rough in untrained listeners (e.g., Wolpert, 2000). The opposite approach argues that musical competence is a common and generally shared skill that is fundamental to our cognition (e.g., Bigand & Poulin-Charronnat, in press; Mithen, 2005), resulting in a view that attributes similar musical competence to listeners without extensive musical training (cf. Honing, 2006b). Based on the latter position, we expect a much larger effect of exposure than for expertise.

## METHOD

### Participants

Invitations were sent to various mailing lists, online-forums and universities, to reach a wide variety of respondents ( $N = 151$ ). Five gift certificates were raffled among those who responded. The respondents were between 15 and 63 years old ( $Mean = 34$ ,  $SD = 11.3$ ;  $Mode = 26$ ) and had various musical backgrounds. 18% did not receive any

formal musical training, 16% can be considered musical experts (*i.e.*, more than ten years of formal musical training and starting at a young age; Ericsson, Krampe & Tesch-Romer, 1993). Roughly 32% mentioned classical music as their main exposure category, 31% jazz, and 37% rock music.

### Equipment

We processed the responses in an online Internet version of the experiment using standard Web browser technologies (see Honing [2006a] for details). The stimuli were excerpts of commercially available recordings and were converted to the MPEG4 file format to guarantee optimal sound quality on different computer platforms and to minimize the download-time.<sup>3</sup> The experimental setup was generated using POCO (Honing, 1990).

### Materials and stimulus preparation

The experiment used 30 original and 30 tempo-transformed recordings. The two stimulus pairs derived from each performance pair (A/B) were presented to two different groups of listeners. Group 1 ( $n = 75$ ) was presented with fifteen A/B' pairs (prime indicating a transformed recording), whereas Group 2 ( $n = 76$ ) was presented with fifteen A'/B pairs. This was done to prevent the respondents from remembering characteristics of the stimuli in one pair and using them to make a response to the other pair.

The tempo-transformed versions were made using state-of-the-art time-scale modification software (Bonada, 2000). For each recording, the tempo of the first four bars was measured with a metronome and checked perceptually by synchronizing it with the music. The resulting tempo estimate was used to calculate the tempo-scaling factor to make the stimulus pairs similar in tempo. All sound excerpts were taken from the beginning of a recording. The presentation of the stimuli was randomized within and between pairs for each participant, as was assignment of participants to either Group 1 or Group 2. Participants could choose between a Dutch or English version of the online experiment.

### Procedure

Participants were asked to visit a Web page of the online experiment.<sup>4</sup> First, they were asked to test their computer and audio system with a short sound excerpt and to adjust the volume to a comfortable level. Second, the respondents were asked to fill in a questionnaire to obtain information on, for example, their musical background, exposure and experience. Finally, they were referred to a Web page containing the actual experiment (see Figure 1). The total experiment took, on average, 39 minutes to complete.

### Analyses

The response forms were automatically sent by e-mail to the authors and converted into a tabulated file for further

analysis with POCO (Honing, 1990) for symbolic and numerical analyses, and SPSS (Version 11) for statistical analyses. To filter out the occasional non-serious responses, only entirely completed response-forms, and those responses that took more than ten minutes for the listening part of the experiment, were included. Dropout (percentage of visitors that didn't finalize the experiment) was 32% of all respondents.

The information as collected in the questionnaire was used to assign expertise and exposure levels to each participant. With regard to expertise, participants were classified into three categories: 1) *non-musicians*, which received no training at all, 2) *expert musicians*, with formal musical training longer than nine years starting before the age of eight, and 3) *semi-musicians*, participants that fall between these two extremes. We will refer to these categories as *expertise*.

With regard to exposure, participants were also classified into three categories: *classical*, *jazz*, and *rock listener*. These categories were assigned based on information provided by the respondents by assigning percentages of their listening time to the different genres. We will refer to these categories as *exposure*.

### RESULTS

Overall the participants correctly identified the real performance 59.9% of the time ( $SD = 9.9%$ ). In the classical genre this was 65.9% ( $SD = 19.9%$ ),<sup>5</sup> for jazz 55.6% ( $SD = 18.1%$ ), and for the rock genre 58.2% ( $SD = 20.3%$ ). In general, participants did better for the classical stimuli than for the other two genres.

To test our hypothesis about the influence of exposure and expertise on the judgments of timing we conducted a 2-way ANOVA with the overall amount of correct judgments as dependent variable and participants exposure and expertise as factors. There was, however, no significant main effect for exposure or for expertise, nor for their interaction.

Since we had collected participants confidence for every judgment, we decided to clean the response data from guessed responses, and only analyze the data for which subjects were sure about their judgments. Within these data, exposure had a significant effect on the ability to correctly and confidently identify real recordings [ $F(2, 81) = 3.12, p = .05$ ], while there was no effect for expertise [ $F(2, 81) = 1.97, p = \text{n.s.}$ ], nor a significant interaction [ $F(4, 81) = .418, p = \text{n.s.}$ ]. These results are support for our hypothesis that exposure would be the main effect.

Contrasts revealed that the significant effect of genre exposure was based on jazz listeners giving significantly more correct answers than rock listeners ( $p < .05$ ), with the classical listeners being in the middle and showing no significant differences in either direction.

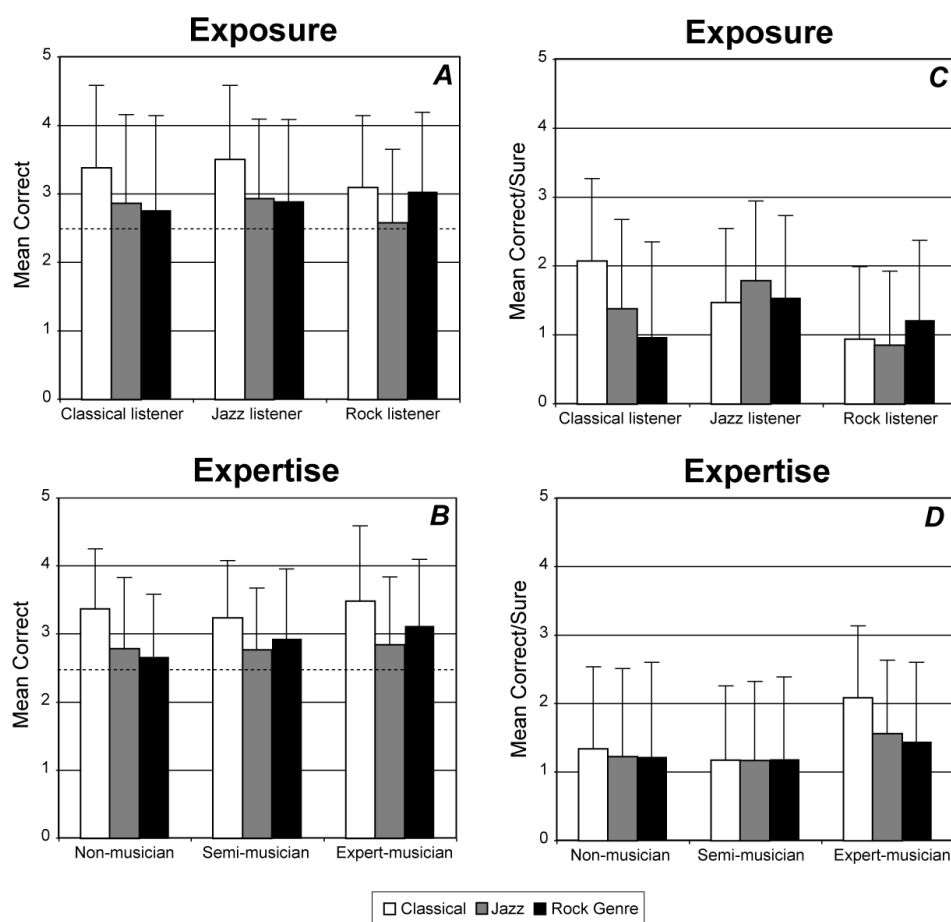
<sup>3</sup> <http://www.apple.com/quicktime/technologies/aac/>

<sup>4</sup> <http://www.hum.uva.nl/mmm/exp/>

<sup>5</sup> Hence a replication of the results for the classical repertoire as reported in Honing (2006a).

To analyze how different listener types (“classical listener”, “jazz listener” and “rock listener”) perform in different musical genres, a repeated measure ANOVA was performed, with the three different genres as dependent variables. Considering all data (no matter if participants were confident about their judgment or not) the analysis revealed no significant results for both independent variables (see Figure 2A and Figure 2B). However, when considering only the judgments where participants were confident, one can again see a significant effect for genre exposure [ $F(2, 81) = 3.9, p < .01$ ] (see Figure 2C), while there is no effect for expertise [ $F(2, 81) = 1.12, p = \text{n.s.}$ ] (see Figure 2D), nor an interaction of these two factors [ $F(4, 81) = .827, p = \text{n.s.}$ ].

Since the effect of exposure had a significant effect on the number of correct judgments for the different repertoires, this data was viewed in further detail. For the classical repertoire, classical listeners did best, and they did significantly better than rock listeners ( $p < .05$ ), with jazz listeners located between them. For the jazz repertoire there was no significant difference between listeners categories, only the tendency ( $p = .053$ ) for jazz listeners to do better than rock listeners, with classical listeners located in the middle. For the rock repertoire the jazz listeners did best, and they did significantly better than classical listeners ( $p < .05$ ), with the rock listeners located in the middle. Finally, each listener group did best in its own genre (see Figure 2C).



**Figure 2:** Effect of exposure and expertise on correct judgments. Panel A and B show the overall results, Panels C and D show only the judgments that listeners were certain of. The dotted line in Panel A and B indicates chance level (50% correct).

## CONCLUSION

The experiment reported here was concerned with the question of whether exposure and/or expertise have an effect on making timing judgments in music. The preliminary results suggest that familiarity with a particular genre (listeners' exposure) has a significant effect on discriminating a real from a tempo-transformed performance, and that formal musical training (listeners' expertise) has only a marginal effect. These results are taken as further evidence for listeners' sensitivity to timing deviations in music performance (the tempo-specific timing hypothesis; Honing, 2006a), while these can be modulated by exposure, but not so much by expertise.

Recently, similar results have been found in the pitch domain (Bigand & Poulin-Charronnat, in press). The latter study showed that pitch expectancies are more likely acquired through exposure to music than through the help of explicit formal training. The current study can be seen as

additional evidence for this in the time domain. It provides further support for the idea that musical competence in listening is more likely enhanced by active listening (exposure) than by formal musical training (expertise).

## ACKNOWLEDGMENTS

Thanks to Jordi Bonada (Music Technology Group, University Pompeu Fabra) for time-scaling of the audio fragments; Tom ter Bogt (University of Utrecht) and Glenn Schellenberg (University of Toronto) for their advice; Bas de Haas, Niels Molenaar, Maria Beatriz Ramos and Leigh M. Smith for their help in selecting and preparing the audio fragments used; All beta-testers (University of Amsterdam and University of Utrecht) are thanked for their time and their suggestions as to how to improve the Internet version of the experiment. This research was realized in the context of the EmCAP (Emergent Cognition through Active Perception) project funded by the European Commission

(FP6-IST, contract 013123) and a grant of the Dutch Science Foundation (NWO) to the first author.

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