Multilayer integration and metacognition: an exploratory study

Ester Pineda, Hervé Platel, François Madurell

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Ester Pineda[1,3], Hervé Platel[2] & François Madurell[1]

[1] Institut de Recherche en Musicologie (IReMus UMR 8223), Sorbonne Université, Paris, France
[2] UMRS 1077 NIMH, INSERM-EPHE-UNICAEN, Caen, France
[3] Conservatoire Jean-Philippe Rameau, Paris, France

INTRODUCTION

An increasing body of research has explored the importance of deliberate practice and effective learning strategies to build instrumental performance by heart [1-3]. Few studies, however, have addressed the way that music itself (style, structure) and the cognitive profile of the musician determine performance and retrieval cues. Eminently **multimodal at the cognitive level** (visual, motor, auditory, perceptive, emotions, etc.) **mental representations** constitute the different components or layers of inner audition. Performers gradually build a **multilayered** representation of the work that will take shape upon transmission in a dynamic process involving the musician's body as a whole. We assume that perception and action are strongly intertwined and can mutually exert influence on each other to build inner representation of music [4]. We also consider that **inner audition** results from the **psychological individuality** of the performer and the particular features of the **repertoire**.

AIMS

As a first approach, we aimed at investigating the associative nature of inner mental representations of different types of music, while collecting some elements of the musician's cognitive profile. We studied the memorisation strategies and retrieval structures adopted by expert pianists according to a sample of music works involving different hierarchies types of cognitive skills.

METHODS

PARTICIPANTS

- Six professional pianists with post-graduate degrees in music performance. Range of 5 to 40 years of experience (concerts and teaching)

MATERIALS AND PROCEDURE

Music : Bach *Toccata in E minor*
Rachmaninoff, *Prelude op 23 n° 5*
Debussy, *Prelude* n°3 (Vol. 1), *La Puerta del Vino*
Takemitsu, *Lytany*

Performance data collection:

- Video and audio recording

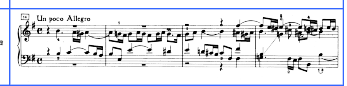
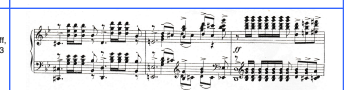
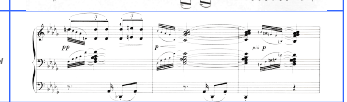
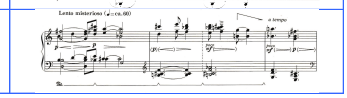
Post-performance data collection:

- Interpretation phenomenological semi-structured interview
- Pianists completed an episodic buffer assessment test (Quinette et al., 2013)

WORKS INVOLVING DIFFERENT TYPES OF COGNITIVE SKILLS

- Cognitive load (polyphonic piece in counterpoint, i.e. *fugue* or *toccata* with several voices
- Expressive (melodic-harmonic writing)
- Motor (virtuosity)
- Mental imagery (other type of temporality, far from tonal syntactic writing)

PIECES ILLUSTRATING COMMON PIANISTIC SITUATIONS

MAIN COGNITIVE TRAIT IN TASK	MUSIC: TITLE	MUSIC: SCORE EXCERPT
structure analysis	Bach *Toccata in E minor*	
motor	Rachmanionoff, *prelude* op. 23 n°5	
mental imagery, visualisation	Debussy, *Prelude* n°5 (Vol. 1), *La Puerta del Vino*	
mental imagery, visualisation	Takemitsu, *Lytany*	

PARTICIPANTS:

Professional pianists show high level of metacognition in relation to their preparations for performance involving technical matters, interpretation, and issues relating to learning itself, e.g. concentration, planning, monitoring and evaluation [2].

SEMI-STRUCTURED INTERVIEW:

The interviews aim to highlight working strategies in the elaboration of an interpretation (work with or without score, separate hands, overall or partial vision, analysis, etc.), memorisation strategies (storage, restitution, coupling), but also to explore thoughts and associated perceptions (mental imagery) with the awareness that subjects might have of these processes (metacognition).

"If you don't know what you're doing, you can't do what you want", *Moshe Feldenkrais*

METACOGNITION: Quirk [5] defines metacognition as "the ability to think about one's thinking and feelings and to predict what others are thinking". Musicians have been trained during formal studies to develop metacognition that allows them to be flexible thinkers and agile learners so they can adeptly deal with new knowledge, complexity, and uncertainty. Through the metacognitive approach participants revealed the understanding they have on their patterns of cognition and emotions as well as the complex interplay between cognition and emotion in piano performance.

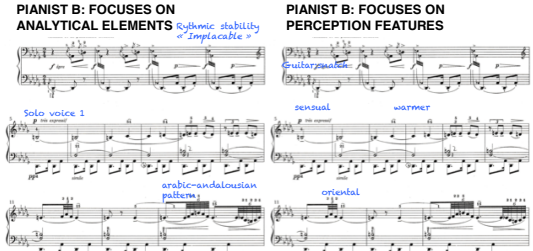
RESULTS

Comparing pieces involving different types of hurdles (motor, expressive, cognitive load, mental imagery), we found that polyphonic pieces were particularly difficult to memorise. Collected data suggested that difficulties were related to high cognitive load (monitor several voices at the same time) as well as to motor integration entangled by homogenous writing. Although there were similarities in the strategies adopted, particularly on memory, there was considerable variation on individual approaches. Retrieval of impressionist and contemporary music was more highly associated with musical imagery and emotions. Our results also shed light on individual diversity on combining aural, kinesthesic and mental imagery.

COGNITIVE PROFILE MODULATED APPROACHES

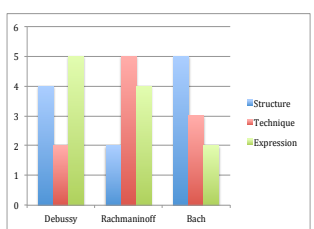
PIANIST B: FOCUSES ON ANALYTICAL ELEMENTS

PIANIST B: FOCUSES ON PERCEPTION FEATURES



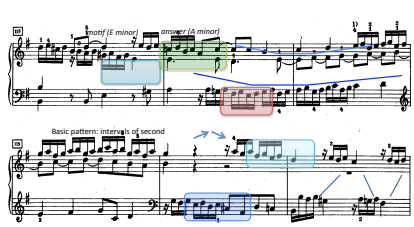
Examples 1 and 2: Debussy, *Prelude* n°3 (Vol. 1), *La Puerta del Vino*, bars 1 to 16

MONITORING A PIECE: PERFORMANCE CUES ON SCORE



Score annotations dependence on music writing

POLYPHONIC WRITING: COUNTERPOINT AND COGNITIVE LOAD



J.S. Bach, *Toccata* in E minor, bars 115 to 120

EPISODIC BUFFER ASSESSMENT TEST [6] We observe that 4 out of 6 musicians perform significantly better than the general population in the integration test ($p < .01$) assessing associative short-term memory, while two others showed a standard performance. This suggests that we have a population with a particularly efficient associative memory, in agreement with what is usually observed when comparing cognitive performances of young and old musicians versus non-musicians [7].

CONCLUSIONS

- Cognitive strategies adopted by the pianist to memorise depended on the musical writing
- Performance cues were determined by the musical writing but also by the cognitive profile of the musician
- Polyphonic pieces were particularly difficult to memorise due to cognitive load although the musician's presented excellent associative memory performances

This preliminary work supports the interest of approaching cognitive psychology from a musicology perspective and suggests further directions. In particular, to complete the assessment of cognitive profiles, we plan to measure visual perceptual treatment modes with Navon's Global / Local test (1977), personality traits from a scale measuring introversion and extraversion, as well as empathy with the Baron-Cohen & Wheelwright (2004) EQ test.

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