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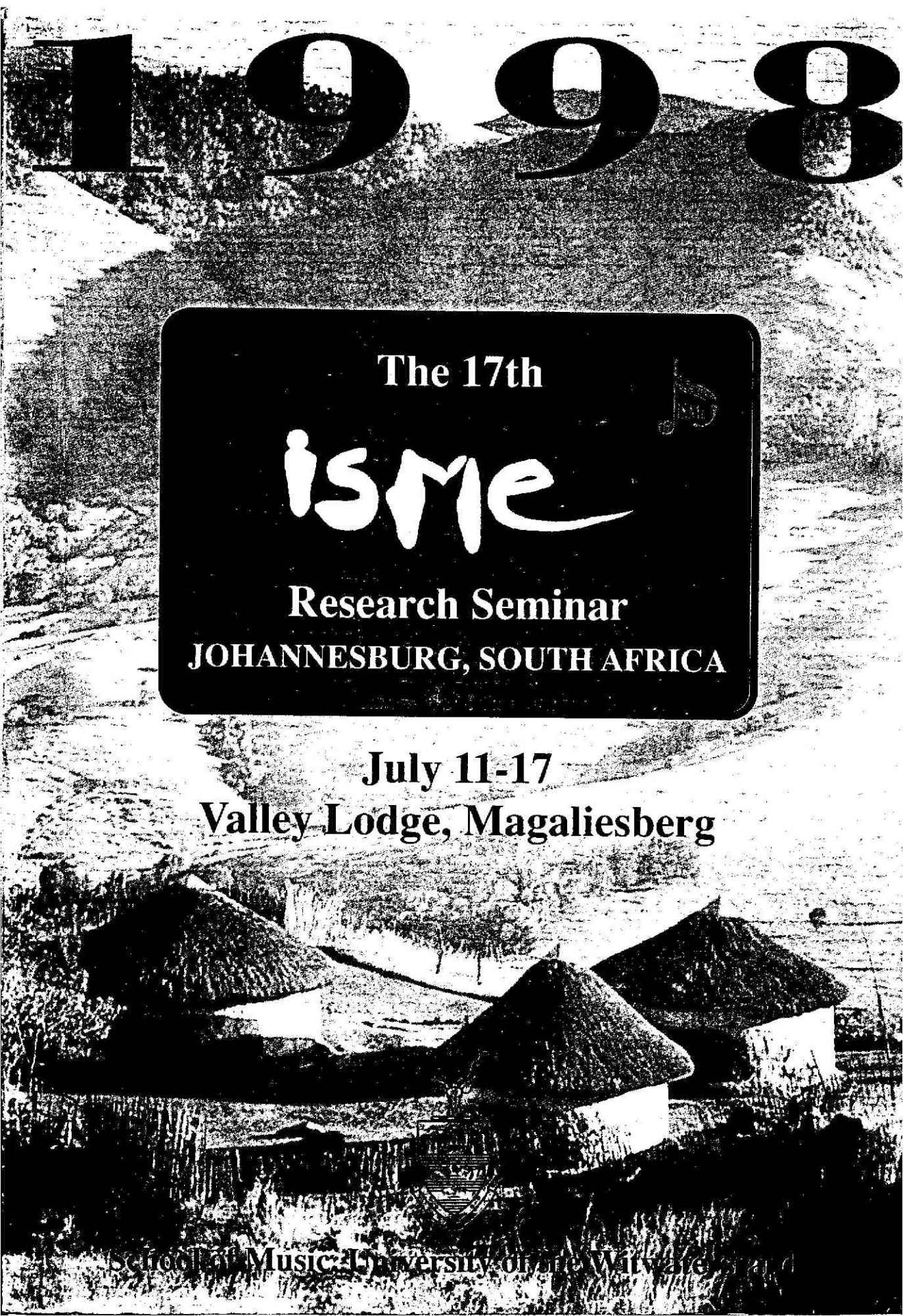
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This paper is submitted for consideration for BOTH the XVII International Research Seminar, Johannesburg, and the poster session at the XXIII ISME International Conference in Pretoria. South Africa, July 1998"

ON LINE AURAL IDENTIFICATION of HARMONIC SEQUENCES . The role of repetition

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ABSTRACT

The aim of the present research is to provide further explanation concerning the role of stimulus repetition during the on line process of aural identification of harmonic sequences. This process involves i) to build a mental representation; ii) to relate it with the knowledge base available in the long-term memory system; iii)to select the correct label iv) to write the label without interrupting the continuous listening. The time span between chords is decisive in this mechanism.
Nine sequences containing eight harmonic functions of I, IV and V degrees were presented 3 times each. Subjects (N=72 undergraduates students) should listen to each presentation and write the label of each chord down with roman numbers while listening.
Findings show that the first presentation is a powerful *image* that influences the following identifications. Repetition favours the identification of those chords which had been omitted in the previous listening.
Once the image has been shape as a percept it will be difficult to change it. When the response is wrong repetition would operate in a paradoxical way fixing the error. Many of the common practices in the context of the music class are based on repetition. Findings show that repetition does not provide *per se* a base for the improving of the results.

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INTRODUCTION

The development of abilities to identify by listening on line and to label harmonic functions is part of the ear training of courses for professional musicians. This development requires the use of cognitive strategies of variable complexity. The mechanism involves i) to process the input and to build a mental representation; ii) to relate this representation with the knowledge base available in the long-term memory system; iii)to select the correct label iv) to write the label without interrupting the continuous listening of the musical stream of information. When the time span between chords is less than one second the *time* for solving this chain of operations is decisive. Teachers are used to managing the students' difficulties presenting the same stimulus several times.

According to Povel & Egmond (1993) musical listening is an on line process that has two stages: i) a dynamic circuit between the input and the knowledge base is activated; ii) as a consequence, a mental representation is built.

In the tonal music the knowledge base is built according to the rules of the tonal system. Some explicative approaches are derived: i)psychological models that conceive the tonal space as a virtual space that operates as a powerful cognitive map of the multiple relationships between tones (Brown, Butler & Jones, 1994) and ii) theoretical models which can be explaned in terms of the triads of I, IV and V degrees of the scale which sounds components complete the mayor scale (Schenker,1954; Platt & Racine,1994). Both approaches share a) *the hierarchical nature of the tonal system,* with relationships between elements at different levels and b) *the assignment of a relative position of their elements* related to the tonic.

How are harmonic aspects activated while listening to music? Some studies (Bharucha, 1984; Deutsch, 1984; Butler, 1992) report that some components such as the order of occurrence of the chords, the characteristic sounds, and the metrical organisation may take part in the building of the mental representation of the harmonic image.
Listening to a harmonic sequence would involve to process of each chord which is understood both as a local goal and as a member of the chain. The diachronic nature of this process may create

expectations about the following incoming chord information. Expectations are supposed to be based in the internal building of the sequence in which the order of occurrence of chords, the vocal leading and the metrical stress are the main indicators. These features are variables in the process of identifying and labeling each chord.

The particular relationships between chords into a given sequence generates the perceptual configuration of a tonal centre. This concept has been named *tonal clarity* (Croonen y Kop, 1989). There are strong and weak sequences in terms of tonal clarity. A paradigmatic strong sequence would be IV, V, and I. Strong sequences would be easier to memorise than weak sequences.

The speed of the succession is another variable into consideration. At first, the listener shapes a previous idea of the tonal centre, as a hypothesis. This will then be contrasted with the real tonic as on line listening progresses. The perceived relationships of tension and distension of the following events are confronted with the tonic (Brown, Butler y Jones, 1994). The time span available to process the income information gives better oportunities of assigning meaning to it. Studies on melodic cognition show that it is possible -in short-term tasks- to use the interval information in very short periods of time such as one second (Croonen y Kop, 1989; Croonen, 1995). The interval information may be involved in the process of identification of harmonic functions allowing the comparison between the roots of the successive chords and the tonic.

It is probable that the access to interval information depends on the availability of repetitive listening of the musical sequence. According to Croonen (1995) repetitive listening helps to gather the interval information of tonal strong series but do not help in the case of tonally weak series. Repetition acts in two ways: i)allowing the *familiarity* with the stimulus and ii) increasing the available time to accomplish the processing of the chord information. However familiarity with the stimulus is not clearly the only reason to recognis a given sequence better than another one (Croonen, 1995).

The idea of *familiarity* has been applied to the study of basic procedures to identify conceptual categories (Pollard-Gott, 1983). To do so the listeners need to be exposed to the stimulus for several opportunities. In this process, repetitive listening turns into learning, because it implies the acquisition of concepts in an increasing way. It would be interesting to know if, once the category has been attributed, the new opportunities to listen modify the previous identification.

The aim of the present research is to provide further explanation concerning the role of stimulus repetition during the on line process of aural identification of harmonic sequences.

METHOD

Subjects

72 undergraduates students belonging to the Introductory Music Course - Facultad de Bellas Artes, Universidad Nacional de La Plata (mean = 20 years) -.

Subjects were selected according to an aural skills test involving: 1)diatonic melodies by steps and intervals from tonic to dominant notes. 2) tonic and dominant harmonic functions in root position and inversions 3) sight reading of tonal melodies by steps.4) series of diatonic intervals 5) binary and ternary rhythms of melodies.

Apparatus

Cake Walk 2.0 Sequencer ; MIDI connection with Proteus FX and Marantz S.D. 1000 audio-cassette recorder.

Stimuli

Nine sequences of eight harmonic functions (I, IV and V degrees) were composed.
Timbre used= Grand Piano. Tempo q = 70 .
Each stimulus was presented 3 times.
The first presentation was preceded by a tonal cadence (IV-V-I).
The sequence began after 2,88 sec. The time span between each presentation was 15 sec.

Procedures

Subjects had to listened to the 9 secuences, in 3 successive presentations, and to write down the label of each chord using roman numbers. The order of the series was randomly arranged.
They had to write when they were sure of the response; in other ways they should leave the spaces in blank until the next presentation comes.
Seconds between presentations could be used to complete the responses.

RESULTS

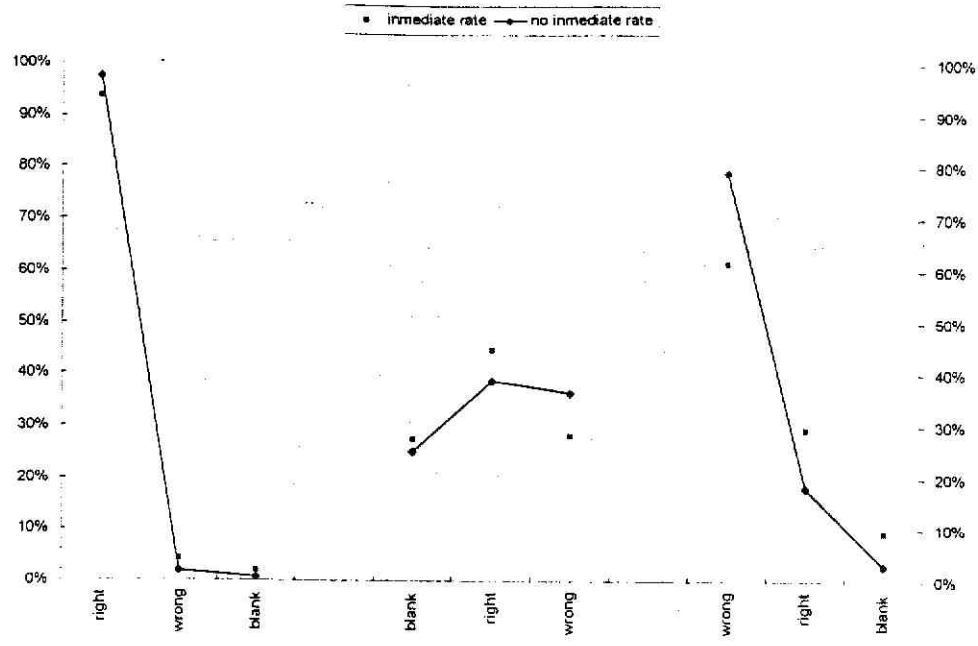
The responses were classified in right, wrong and blank.
The obtained data belonging to each presentation was compared.
The variability of the responses to each category (right, wrong and blank)were measured according to:
Rate of immediate growth between the first and the second presentation.
Rate of non immediate growth between the first and the third presentation. (Table 1).

Responses	Presentation 1	Rate of immediate growth	Rate of non immediate growth	Presentation 3
Right	3254	14	19	3994
Wrong	852	11	16	1012
Blank	1078	-59	-83	178

Table 1. Rates of growth (immediate /non immediate)of responses

Tendency to stability or change in the responses along the successive presentations was analysed according to:
Rate of immediate permanence: proportion of the identical responses between first and second presentation.
Rate of non immediate permanence: proportion of responses that being identical between the first and the second presentation remain identical in the third one. (Graphic 1)

Graphic 1 . Permanence Rates of Responses



Right $X^2 = 52$ $p < .001$

Blank $X^2 = 7.16$ $p < .05$

Wrong $X^2 = 33.14$ $p < .001$

Note : This graphic shows the total amount of responses. The tendency for each sequence shows similar profiles.

DISCUSSION

The present research enhances the knowledge available concerning the role of repetition during on line aural identification of harmonic sequences. It also provides explanation about the relative incidence of repetition in omitted and incorrect answers.

Most of the answers were shaped during the first presentation. According to Butler (1990) the tonic is the first tonal feature that the listener configures when he listens to a tonal sequence. In the present study the tonic identification was favoured for the tonal cadence before the harmonic sequence begins. The time span between the tonal cadence and the the harmonic sequence was of almost three seconds. During this lapse the subject could even internally rehears the tonic previously configured (Croonen & Kop, 1989). The high level of correct answers to the first presentation would be explained by this test's feature.

Tonal clarity would be guaranteed since the sequences used only the I, IV and V degrees. For this reason the series may be considered tonally strong. However, is equally clear any sequence that contains these degrees? Characteristics of the series such as the voice leading, the texture and the order of appearance of the different degrees among others may be valuable indicators to estimate the degree of tonal clarity of a given harmonic sequence.

As it can be observed (Table 1) 20 percent of the responses could not be configured in the first listening and required a new presentation. The data shows that this new presentation provided to the

listener another opportunity to shape the answers that had been omitted in the first listening. Although most these new answers were right, the second presentation did not guarantee, the total correct solution of the task, since wrong and blank responses remained. The number of right and wrong responses to the third presentation was similar.

Results show that THE FIRST PRESENTATION is a powerful *image* that influences the following identifications. Repetition favours the identification of omitted chords in the previous listening. It would be possible to think that i) subjects omit the answer because they were not able to shape a clear image of the object and ii) repetition gives both a new opportunity to *familiarise* with the stimulus and spare time to process the available information.

When responses to the first presentation are wrong things are different. Once the image has been shape as a percept it will be difficult to change it. In this case, repetition would operate in a paradoxical way fixing the wrong answer. This statement has very strong implications in the field of Music Education because many of the common practices in the context of the music classroom are based on repetition. Findings allow us to say that in this kind of task repetition does not give *per se* a base for the improving of the results.

Turning the wrong *image* into a correct one would be the result of strategies that allow the subject to re-process the incoming information in an immediate way. During this process the monitoring of the teacher and the immediate feedback would prevent from the fixation of the error.

Another implication for music education would be the development of an ear training based in the immediate response. In this case, it would be helpful to develop cognitive strategies that allow to monitor -while teaching- the reaction time to process the stimulus.

Futures endeavours should be focused in the study of a immediate reaction in the accomplishment of practical musicians who usually play harmonic accompaniments for singers.

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