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INCIDENCE OF STYLISTIC KNOWLEDGE ON RHYTHM PERCEPTION

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ABSTRACT

From an ecological point of view, listening to music is a complex experience in which both bottom-up and top-down processes work together making possible an understanding of a musical piece. Listeners build their musical perceptions out of the individual parametric features of the musical work, but also by calling into play their prior musical experience, *i.e.*, their knowledge of a musical style. In this sense, it has been argued that all we know about a particular musical style influences what we perceive, that is, the way in which the mind organizes sensorial data presented to it. The aim of the present research was to investigate if listeners are influenced by their stylistic knowledge on the specific area of categorical rhythm perception. An experiment was run in which seventy-four participants were tested in their categorical perception and their stylistic knowledge asking them to perform an identification task and to complete a questionnaire about their stylistic knowledge, respectively. Nine rhythmic stimuli were used. Three of them were especially composed *expressive* versions where the inter-onset intervals didn't correspond to integer-ratio relations. They belonged to different stylistic musical contexts (*jazz* -swing-, *folcklore argentino* -carnavalito- and *medieval dance* -trotto-). Results showed that subjects who possessed specific stylistic knowledge about the musical contexts in which expressive patterns were presented tended to categorize them in a different way that subjects who did not possessed that specific knowledge. They also showed that those rhythmic patterns that had proportional inter-onset intervals were categorized in a different way according to the stylistic context in which they were presented.

1. BACKGROUND

Stylistic knowledge and cognition

Although a theoretical agreement exists on the idea that stylistic knowledge exerts a strong influence on music cognition (see for example, Meyer 1956, 1989 [1996]; Sloboda 1985; Narmour 1990, 1992; for a philosophical approach, see Stubley 1992), the way in which such influence effectively occurs still deserves investigation. In fact, according to Narmour (1992), "*although all experienced listeners share style knowledge to some extent, it is not tenable to posit that any one cultural segment of that shared knowledge represents a perceptual whole* […] *so there is no such cognitive thing as* ***a*** *style*" (p. 8). However, this does not mean that style does not stand as a substantial constituent of music cognition; instead, it evidences the current state of affairs concerning its research, where only recently we have begun to find theoretical and methodological tools to examine dynamic aspects of musical style (for example, Imberty 2003). Problematic though style may be, it nevertheless exists as an empirical fact; and, as Narmour (1992) has pointed out, "*Every theoretical model of music must come to terms with style* […]. *For, clearly, style exercises a profound influence on the cognition and perception of music*" (p. 8-9).

Music perception as an interaction between bottom-up and top-down processing

In spite of the difficulties found in the study of the influence of style in music cognition, a useful way to do it has consisted in adopting a distinction between bottom-up and top-down processes of music cognition. The type of processing referred to as 'bottom-up' is largely involuntary and operates on the parametric features of the perceptual data at the input or 'bottom' of the perceptual-cognitive system; its primary function is to partition our continuous auditory experience into manageable units for further processing, so it is known as '*data-driven processing*' -independent from the context to which it applies. On the other hand, in such further processing those units (melodic, rhythmic, harmonic, etc., groupings or patterns) are confronted with learned *schema-driven* information, that requires higher-level processing and interaction with long-term memory for their formation; so, this type of processing comes from the 'top' of the cognitive system -and so is referred to as '*conceptually* or *expectancy driven*' or more commonly 'top-down' processing, and is said to be dependent on the stylistic context. These schemata, in turn, have been defined as higher-level categories of experience, and represent a synthesis of the concepts and practices that appear to be related in different situations; these concepts and practices, finally, would form a context for the perception and understanding of music (Snyder, 2000).

Through this distinction, perception may be characterized as the result of both the cognition of the simplest parametric features of the stimulus, and the organization of such data around more detailed schemas. Thus, the bottom-up/top-down approach is a fruitful and ecological construct to account for the experience of music perception, since –according to it- perception results not only from general processes or laws of music cognition, but also from those contextually dependent processes that are sensitive to the influence of style. At the same time, musical style acquires a phenomenological status and can be conceived of as a *cognitive thing*, as long as it is defined as a complex organization of the sensory data extracted from the musical stimuli. It follows from this that the more complex the constituent structure is, more evident is the stylistic organization of music.

In spite of the distinction discussed above, these types of processing are not independent from each another; its interaction seems a necessary condition to music cognition (Meyer 1989 [1996]; Narmour 1990, 1992; Snyder 2000). In fact, it has been argued that the interaction between them operate in such a way that in music cognition one or the other pervades or is prevalent, resulting in a cognitive processing biased by some of their constituent components. Snyder (2000), for example, points that inexperienced listeners that have not yet developed complex representations of musical experience, would tend to have a more 'bottom-up' perspective, that is, an approach more directly dependent on perceptually novel features in the music; similarly, Narmour (1990) suggests that "*if the input is ambiguous* [and thus harder to assimilate] *then bottom-up processing will dominate*" (p. 53). Contrary, Navon (1977) has suggested that if the stimulus is extremely familiar, global processes will "*inhibit the responses to the local level*" (p. 353; cited by Narmour 1990, p. 53). Watkins and Dyson (1985) highlighted that the processing of melodic sequences is facilitated if the input is brought into conformity with the schemata of familiar environmental events; even more, Snyder (2000) suggests that there would be a "*disadvantage of a generalized, schema-driven recognition system* [since] *because they are always undergoing the process of being slowly generalized, particular episodic memories of experiences that are similar and fit the same schemas tend to become confused* [a process that] *is referred to as an 'interference effect'*" (p. 99).
These statements are extremely suggestive and propound the question of how listeners not only build their musical perceptions out of the parametric features of music, but also call into play a whole amount of schematic information that corresponds to their prior musical experience, *i.e*., their knowledge of a musical style.

Metric inference, categorical rhythm perception and expressive timing

Rhythmic-metric perception of Western music is strongly based on inferential listening. The piece of music conveys information about recurrent durational patterns that the subject uses to organize the stream of events in time. The most salient pattern of durations is called *tactus* (Lerdahl y Jackendoff 1983, p. 21). The different beats group recursively above and below the *tactus*, therefore generating a hierarchical organization; the process called *metric inference* accounts for the way in which the listener configures the metrical structure of a piece of music (Lee 1991; Clarke 1999).

Two other processes are central in the rhythmic-metric perception: *rhythmic categorization* and *perception of timing*. As Clarke (1999) explains, when the subject listens to a musical performance, he assigns the continuously variable durations *of* and *between* events to a reduced number of *rhythmic categories* or discrete units -as usually symbolized using figures in musical notation. The pattern of these categories constitutes the *rhythmic structure* of the musical sequence, whilst the temporal deviation from these categories is understood as *expressive timing.* Accordingly, Desain and Honing (2003) state that categorization may be described as the mapping of the acoustic signal *from the space of the performance onto the space of the score*. They also say that, because timing expressivity would not be perceptible without categorization, such mapping implies not just the transformation of the signal from a continuous variable into a discrete one -with the consequent lost of information during the process- but also that both types of information are simultaneously available.

However, the notion of *rhythmic category* should not be understood as a rigid partition of the temporal *continuum*. Clarke (1987) informs that categorization would be sensitive to top-down processes of music cognition. Desain and Honing (2003), confirmed and enhanced such evidence by assessing the *way* in which a category (that is, its size and centroid value) is strongly dependent on the metrical context around which it is built. They inform that, for example, the participants in their study, when induced by a binary metrical context, tended to transcribe the pattern of inter-onset intervals (IOIs) (0.210, 0.474, 0.316) (in seconds) as 1-2-1, while when induced by a ternary context, tended to identify it as 1-3-2; therefore, *expressive or unstable* rhythmic patterns, i.e. those in which the IOI's do not correspond to an integer-ratio relationship (Desain y Honing 2002), tended to be categorized in a more parsimonious way in relation to the metrical context in which they were included, or, in cognitive terms, in relation to the *schema-driven groupings activated*.

Although the above discussed studies provide evidence about the existence of a schema-driven processing through which more coded information (metric configuration) influences the processing of simpler information (rhythmic categorization), such evidence has been obtained from 'context-free' stimuli. Both Clarke (1987) and Desain & Honing (2003) induced a given metrical context using brief patterns of simple sound stimuli that divided mechanically a *tactus* into two or three equal IOI; in fact, as Desain & Honing (2003) indicate, their stimuli are simple and mechanical given that otherwise it "*would be hard to construct* [them] *without creating, for example, a dependence of musical style*" (p. 359). It would be then enriching to examine if the complexity of music has a similar effect in the perception of rhythm.

2. AIMS

The present work aims to asses if knowledge of musical style influences the way we perceive a piece of music; more specifically, if the availability of stylistic knowledge influences the way in which the mind configures the metric organization, in order to categorize expressive and unstable rhythmic patterns in terms of their stylistic constraints. This being true, availability of a stylistic knowledge in which the stream of events is organized schematically in a binary way, will induce a categorization of *expressive* rhythmic patterns in a binary form;

similar results will be expected with styles that are understood in ternary terms. While in the absence of stylistic knowledge it is expected that categorization tends to be regulated basically by data-driven processing and, so, by the attributes of the musical percept. The experiment that follows assesses the validity of such hypotheses.

3. METHOD

Subjects. 74 students of music at the Faculty of Fine Arts (UNLP) took part in the experiment. 50 students were recruited from the course Audioperceptiva I, while the remaining 24 from the course Audioperceptiva II; these are compulsory courses that develop ear training and sight reading skills in the first year of the undergraduate music courses. Competences required to solve the experimental tasks had been acquired in previous courses by the participants. Students received credits for their participation.

Apparatus. Stimuli were generated using an SB Live! (B800) synthesizer and General MIDI sounds and the sequences were produced using Cakewalk Pro Audio 9.0. They were presented in digital format through an AIWA NSX-990 reproducer, at a room were students are usually given the courses.

Materials. 9 musical fragments (average duration: 32.89 sec, SD ± 8 sec) belonging to different musical styles were used: *Jazz* (2), *Argentine Folk music* (2), *Romantic music* (2), *Renascence music* (1) and *Medieval dance* (1). Six were original versions taken from commercial recordings; the remaining three were synthesized versions in which the rhythmic attributes were manipulated according to the hypothesis of the experiment. They belonged to *Jazz (Swing)*, *Argentine folk (Carnavalito)* and *Medieval dance (Trotto)* and were selected because their rhythmic-metric configuration presented a strong schematization in terms of whether a binary structure (*Jazz*; *Carnavalito)* or a ternary one (*Trotto*).

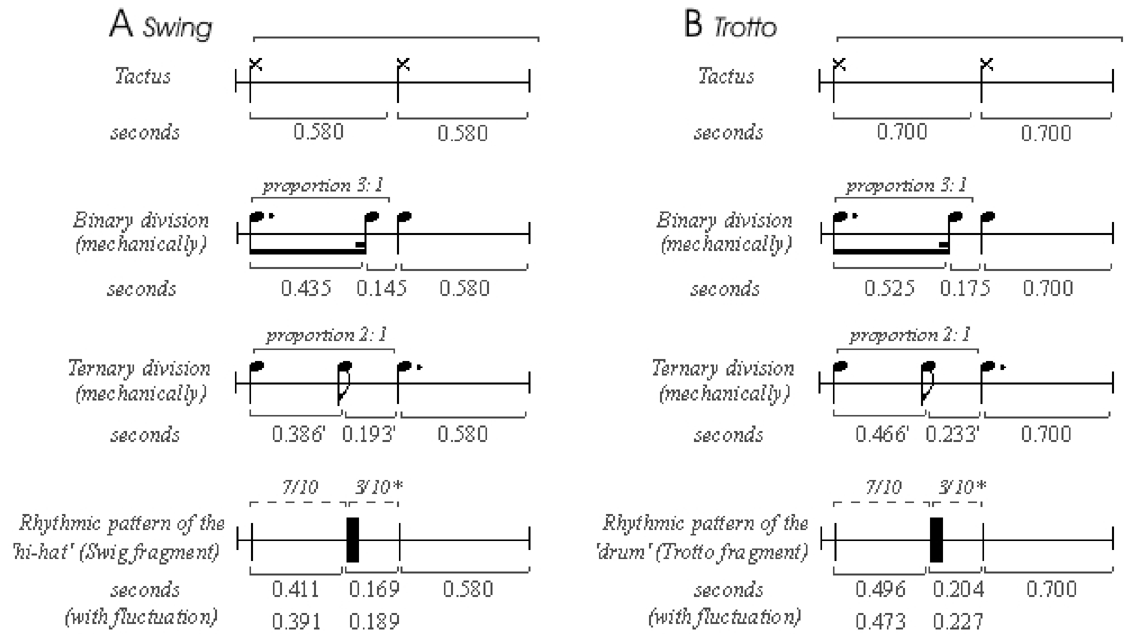

Figure 1: Durational features of the *Swing* (A) and the *Trotto* (B) patterns used for the transcription task. From top to bottom: i) the duration of tactus, ii) the correspondent mechanically binary division, iii) the correspondent mechanically ternary division, and iv) the patterns of IOI used for the transcription task (gross line representing variability of the IOIs). * Proportions are rounded for readability.

Commercial samples: five presented a binary structure and the last one presented a ternary structure[1].

Synthesized materials: The *tactus* was close to the spontaneous or preferred level of the metre (cf. Fraisse 1982, Lee 1991, Clarke 1999) in order to prime both the salience of such beat and also its configuration as the reference beat. The fragment of *Jazz -Swing* (*tactus*: IOI=580ms), was selected from the first improvisation of "Blue rondo a la turk" by D. Brubeck (1965), adapting it to the recorded version of 1959 by Brubeck himself as performer. The melody was synthesized using the sound "Acoustic Grand Piano"; the bass line used the sound "Contrabass"; the rhythmic line used a hi-hat like sound from the percussion patch "Standard Kit". The fragment *Medieval dance* (*tactus*: IOI=700ms), consisted of the melody of a *refrain* from a Trotto of XIV century (as codified by Graetzer (1963)); a two parts rhythmic accompaniment was composed and added to the melody, using the typical patterns of the style (cf. Graetzer 1963); the melody was synthesized using the sound "Acoustic

[1] The assignment of ternary and/or binary division was performed aurally by the authors, assessing the well-formedness of the different materials; for further validation of this, see the Results section.

Guitar (steel)" and the rhythmic lines used a 'drum-like' and 'sleigh bells' sound respectively. The fragment of *Folk style* (*tactus*: IOI=750ms) consisted of the melody of the *Carnavalito* "El Quebradeño" (as codified by Aguilar (1991)); a harmonic accompaniment was composed and added according to the stylistic features of the *Carnavalito* (cf. Aguilar 1991; Aretz 1952); the melody was performed using the sound "Pan Flute", whilst the accompaniment was performed with the sound "Acoustic Guitar (steel)". Both the 'hi-hat' line in the *Swing* and the 'drum' line in the *Trotto* were composed around an equivalent rhythmic pattern that was recurrent in the whole fragment. This pattern corresponded basically to the ratios 7/10, 3/10 and 10/10 from their respective *tactus*[2]. According to this, the IOI of the "hi-hat" rhythm fluctuated between (0.411, 0.169, 0.580) sec. and (0.391, 0.189, 0.580) sec., while the IOI of the "drum" rhythm fluctuated between (0.496, 0.204, 0.700) sec. and (0.473, 0.227, 0.700) sec. (see Figure 1). As we notice, the durations of the first two IOI are closer to a mechanically ternary division of the *tactus* than to a binary one, without matching exactly with neither of them. The relative instability in the arrangement of the IOI and their fluctuation between the above mentioned durations fulfilled the following goals: 1) to increase the cognitive conflict promoted by the IOIs, under the assumption that they would activate a data-driven processing in those subjects not familiarized with the particular style, and a stylistic schema-driven processing in those subjects familiarized with it; and 2) to enrich the samples with rhythmic expressivity or *timing*. Figure 1 shows the sample features above described and contrasts them with the proportions that would result from a mechanical ternary and binary division of the tactus.

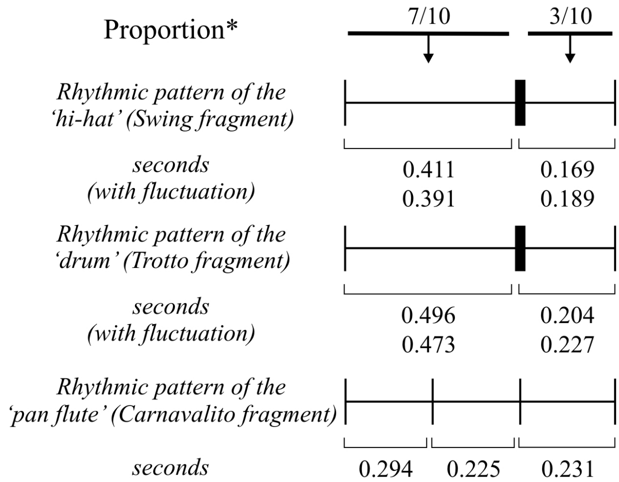

Figure 2: Relationships between the IOI patterns of the *Swing*, the *Trotto* and the *Carnavalito* used for the transcription task. As can be observed, the two first IOI from the pattern of the *Carnavalito* conform to 7/10 of the tactus whilst the third IOI the remaining 3/10. * Proportions are rounded for readability.

The arrangement of the temporal relations of the remaining textural lines was accomplished according to similar criteria for the treatment of the IOI. The arrangement of the fragment of *Folk style* assigned the same rhythmic sequence of the 'hi-hat' in the *Swing* and of the 'drum' in the *Trotto* to the line of the "acoustic guitar"; however, in order to match the rhythmic stylistic characteristics of the accompaniment, which are based in a tactus internal pattern of 2:1:1 (see, for example, Aguilar 1991; Aretz 1952), it was necessary to arrange an IOI pattern containing three attacks. This was resolved dividing the first IOI of the pattern by 2, in such a way that the obtained proportions were neither binary nor ternary mechanical divisions of the tactus. The IOI from the first tactus were repeated in the second one; thus, each tactus contained three IOI that fluctuated between (0.312, 0.219, 0.219) sec. and (0.281, 0.225, 0.244) sec., corresponding to the same hypothesis and compositional criteria that were used in the elaboration of the other materials. Finally, the temporal arrangement of the melody of *Carnavalito* was done following the same criteria described so far, and resulted in a melodic motive conforming to the pattern (0.294, 0.225, 0.231) sec. Figure 2 illustrates the characteristics of this melodic motive and compares it with the percussion lines of the other fragments. Summarizing, in all the fragments, the rhythmic patterns of a metrical level lower than the tactus were composed in order to avoid any mechanically binary or ternary division of it, i.e., all the IOI sub-tactus were *unstable or expressive*.

Procedure. The experiment had two stages. In stage I, participants were required to identify rhythmic patterns present in the fragments and to transcribe them using conventional music notation, and finally to recognize the musical style of all the fragments. Participants registered their answers in a form provided by the experimenters. For control materials subjects were required to transcribe different rhythmic patterns containing the tactus and its division; for target materials the following transcriptions were required: the 'hi-hat' pattern in the *Jazz*, the 'drum' pattern in the *Trotto*, and a brief rhythmic motive from the melody in the *Carnavalito* above described.

[2] The proportions presented here are rounded for readability, but the stimuli were precisely controlled in a way that is described above.

Each fragment was presented twice. The test was taken in groups. Stage I lasted 40-45 minutes approximately. In stage II participants were required to answer a questionnaire devoted to collect information about the stylistic knowledge of the participants. This stage lasted for about 20-25 minutes.

4. RESULTS

Concerning the task performing in stage I –transcription task- given that participants provided different notation to account for the same temporal pattern, the binary or ternary category of each response was determined following these criteria: i) the proportions between the musical figures that were used to code each pattern; ii) the way in which participants used beams in order to group the corresponding rhythmic figures and iii) the use of irregular values to encode the rhythmic patterns. Concerning the task performed in stage II, it was considered that those participants who reported familiarity with the styles present in the experiment (i.e. usually played or listened to 'folk music') or who precisely assigned the style to a particular fragment (for example, "Carnavalito"), possessed knowledge of that style.

A first analysis was conducted to assess the degree of agreement between the metric structure (tactus and binary and/or ternary division) assigned to each control fragment by the participants in both groups; there was Spearman correlation of 0.84 ($p < .01$) between them, and therefore data from all participants were collapsed into a single group for subsequent analyses. Given that participants' responses to the control fragments tended to be the same as the metric assignments inferred by the authors, the correlation also indicated that the metric organization estimated by the latter described appropriately the way in which events were organized in time; as a consequence, the participants' responses were classified in correct and incorrect according to their correspondence to the validated metric analysis. As subjects performed efficiently in most of the control fragments, bringing a number of correct responses higher than the answers expected by chance, their responses were considered valid to the analysis of results.

The analysis of responses showed an association between knowledge of musical style, identification of binary/ternary division and categorization in the three target fragments (Chi square: *Jazz*, $p < .05$; *Carnavalito*, $p < .05$; and *Trotto*, $p < .01$). Therefore, for example, those who had knowledge about *Swing* style tended to configure meter around a binary *tactus* and tended to categorize the pattern (0.411, 0.169, 0.580) sec. as 3-1-4, whilst those who did not possess that stylistic knowledge tended to configure it around a ternary *tactus* and to categorize the same rhythmic patterns as 2-1-3; similarly, subjects with knowledge of *Carnavalito* style tended to configure its meter around a binary *tactus* and to categorize the pattern (0.312, 0.219, 0.219) sec. as 2-1-1, while those without knowledge of that style tended to configure it around a ternary *tactus* and to categorize the same patterns as 1-1-1.

Finally, and given that *Trotto style* was the least known out of the three different styles presented to the subjects, responses given by those participants who manifested knowledge of the other two styles (*Swing* and *Carnavalito)* were compared to the answers given by the same subjects to the *Trotto*; it was observed that those who categorize the rhythmic patterns as binary in the *Swing* and *Carnavalito* styles tended to categorize the pattern of the *Trotto* as ternary ($p < .05$ y $p < .001$, respectively).

5. CONCLUSION

The purpose of the present study was to estimate if stylistic knowledge –understood as a higher-level schematic processing that activates long-term memory information of previous musical experience-, influences the way we perceive and understand music. More specifically, the aim was to test if such knowledge influences the representation of metrical structure and the categorization of expressive rhythmic patterns that are immersed in a familiar musical context, i.e., within a specific and well known musical style. Therefore, complex musical stimuli were composed (containing melody, harmony, timbre, and so forth) and their IOI carefully treated.

Results provided evidence of the influence of style in categorical rhythm perception: participants who reported knowledge of *Swing* and *Carnavalito* styles tended to categorize its unstable temporal patterns in a binary organization, while those who did not tended to categorize them as a ternary organization; accordingly, almost all participants did not claim knowledge of the *Trotto* style and categorized its rhythmic unstable pattern as a ternary structure. Further evidence of the association between stylistic knowledge and categorical rhythm perception was obtained evaluating how those who knew the *Swing* and *Carnavalito* styles answered at the *Trotto* style; these subjects tended to assign a binary structure to the former two but a ternary structure to the latter, suggesting that different stylistic contexts and different levels of stylistic knowledge activated the use of different categories to similar patterns. However, differences in *tempi* between fragments may account for the obtained answers; since *tempo* influences the inference of the *tactus* (Fraisse 1982; Lee 1991) it is probable that affected the categorization process of shorter temporal patterns (i.e. at the subtactus level).

Although results highlight the presence of a '*data-driven processing'* in the stimuli categorization, they also suggest the influence of a '*schema-driven processing'* in a very specific inter-opus way. This derives from two issues: i) stimuli never made explicit a strictly binary or ternary subtactus organization; and ii) the temporal patterns that resulted from the division of the *tactus* were closer to a ternary organization than to a binary one. It suggests that it was the amount of previous experience, or schematic patterns of stylistic knowledge, what accounted for the differences observed at the identification task. It was found that, in expert performances and listening preferences of Jazz music, the *expressiveness* of the ‘eighth note pattern’ emerges from a swing ratio of around 3:1 for slower tempi -*ca*. 110 bpm- (Friberg & Sundström 1999); therefore, in our study it is probable that those who knew the style of the *Jazz* had internalized such *expressiveness* as a schematic behavioral pattern, and applied it in a schema-driven processing to categorize the unstable temporal patterns of the musical fragment. Moreover, it is probable that the participants noticed the ambiguity of the temporal patterns and, instead of modifying such schema in order to configure a ternary metrical organization they preferred an interpretation of such ambiguity as expressive timing (Desain and Honing 2003; Clarke 1999). From a more radical perspective, and given that imagination may be a component of rhythm perception (cf. Desain 2004a, 2004b), the same results might suggest the overlapping of learned rhythmic schemas (for example, binary schema in *Jazz* style) to the incoming stimuli, a phenomenon referred to as *interference effect* (Snyder 2000; see p.99-100).

Finally, our results concur with previous findings which point out that the shape of a given rhythmic category is open to top-down cognitive influences (Desain and Honing 2003; Clarke 1987). But at the same time, they strongly suggest that the experience of musical rhythm involves a complexity that goes beyond the merely durational component, and is also shaped by the interaction of melodic, timbric, harmonic, and other factors (cf. Cooper and Meyer 1960; Fraisse 1982; Lee 1991) belonging to musical style. Moreover, the study brings information supporting the idea that music cognition involves a network of relationships that is specific to the piece, and at the same time extends beyond it, in order to include other pieces that share stylistic features (Clarke 1989; Narmour 1990, 1992). In this sense, music cognition implies not only a bottom-up processing but also a top-down or stylistic one; this two-way cognitive mode of music processing highlights the need to consider musical style as the context from which we perceive and understand music.

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