THE EFFECT OF HARMONIC CONTEXT ON LEXICAL DECISION IN VOCAL MUSIC

Bénédicte Poulin, Emmanuel Bigand, Philippe Lalitte, Ronald Peereman, Arnaud Rey
Laboratoire d'étude de l'apprentissage et du développement, CNRS
Université de Bourgogne, Dijon, France

ABSTRACT

The main goal of this study was to investigate how harmonic structure can influence the processing of words in vocal music. Eight-chord sequences sung by four singers were presented to the participants. We manipulated the semantic relation between the last word and the previous linguistic context (t*he giraffe has a very long neck* versus *the giraffe has a very long foot)*. We also manipulated the harmonic function of the last sung chord in the musical context (*a related tonic chord* versus *a congruent but less related subdominant chord*). 42 participants performed a lexical decision task in which they had to decide quickly if the target (the last lyric of the sequence) was a word or a nonword. There was a main effect of the semantic relationship, the words semantically related to the linguistic context were processed faster than the words that were semantically unrelated. There was also an interaction between the semantic and the harmonic relationship. The related target words were processed faster when they were sung on a tonic chord rather than on a subdominant chord. This effect is not replicated for the unrelated target word. Our present study showed that manipulating the harmonic structure of a musical sequence influenced the processing of words even when the participants are not asked to pay attention to the music. This suggests that the processing of words and musical sounds is not independent, but interacts at some level of processing.

1. INTRODUCTION

In their seminal experiment, Meyer and Schvaneveldt (1971) have shown that two semantically related words (*bread-butter*) were processed faster and more accurately than two semantically unrelated words (*bread-doctor*). This semantic priming effect has been largely studied in single-word semantic priming paradigm (for a review see Neely, 1991) and also in long sentence contexts (Stanovich & West, 1979, 1981, 1983).

In the musical domain, priming effects were also observed in short and long musical contexts. Bharucha and Stoeckig (1986, 1987) have shown that a prime chord (C major) facilitated the processing of a harmonically related chord (G major) rather than of a harmonically unrelated chord (F# major). Bigand and Pineau (1997), by using long musical contexts, have shown that Western listeners are sensitive to the harmonic function of chords. A tonic chord (the most stable chord of a key) was better processed than a subdominant chord (a less stable but harmonically related chord) in eight-chord sequences. This result showed that listeners, even nomusicians, form expectancies on the upcoming events according to a sophisticated knowledge of the rules of the Western tonal harmony (for a review see Tillmann, Bharucha, & Bigand, 2000).

An important question raised in psychology concerns the specificity of the cognitive processes. Language and music are thought to be two systems that have similarities. Are the cognitive processes involved in language and music the same? Experiments crossing language and music and notably using songs could highlight this point. If language and music implied different cognitive processes, independence should be observed in the results. However, if language and music have common cognitive processes, an interaction should be observed. A recent electrophysiological research argues in favor of an independence between the processing of language and music (Bonnel, Faïta, Peretz, & Besson, 2001). In this experiment, the authors found that in operatic songs, lyrics and tones are processed in an independent way. However, other researches argue in favor of identical cognitive processes in music and language (Koelsch, Gunter, von Cramon, Zysset, Lohmann & Friederici, 2002; Patel, Gibson, Ratner, Besson & Holcomb, 1998). In a recent study, Bigand, Tillmann, Poulin, D'Adamo and Madurell (2001) have obtained an interaction at a behavioral level between language and music. They found that the harmonic structure of musical sequences influence the phoneme monitoring in vocal music. This finding supports the assumption according to which language and music interact at some level of processing.

The aim of the present study is to investigate how harmonic structure can influence the processing, no longer of phonemes but of words in vocal music. Sung chord sequences were used in which we manipulated both the harmonic function of the last chord and the semantic relationship of the last word. If the harmonic structure influences the processing of words then we could conclude that language and music interact at some level of processing.

1. EXPERIMENT

2.1. Method

Participants. 42 volunteer students participated in this experiment: 27 students from an introductory psychology course at the University of Burgundy with no formal training in music (referred to below as *nonmusicians*); and 25 candidates for the final diploma of musical conservatories (referred to below as *musicians*). All participants received course credits or were paid $7 for their participation.

Apparatus. The sentences were sung by four professional French singers. The recording took place in a recording studio, with a couple of mikes and four individual mikes for the singers. In order to increase the stability of tempo and accuracy, the four singers heard, in their headphones, the musical sequences played by a

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piano. The sung sentences were recorded by Protools software, version 5.1. The sound stimuli were captured by SoundEditPro software at CD quality (16 bits and 44Khz). The experiment was run with Psyscope software (Cohen, MacWhinney, Flatt, & Provost, 1993).

Stimuli. 48 eight-chord sequences drawn from Bigand, Poulin, Tillmann, Madurell, & D'Adamo (2003) were used. The first six chords of the sequences were held constant. The harmonic function of the target chord was manipulated by changing the last two chords. The last chord functioned either as a stable tonic chord (I) or as a less stable subdominant chord (IV). In order to neutralize local harmonic priming effects, the last two chords were always one step apart on the circle of the fifth, creating a local authentic cadence (V-I). 24 sentences were created that constituted the lyrics of the eight-chord sequences. All these sequences have eight syllables and the last word (target word) was always a monosyllabic word. 12 of these sentences ended by a word that was either semantically related or semantically unrelated to the previous context (t*he giraffe has a very long neck* versus *the giraffe has a very long foot).* The other half ended by a nonword that could be considered either semantically related or semantically unrelated to the previous context.

Procedure. All the sequences were presented and the participants performed a lexical decision task in which they were asked to quickly decide whether the last sung word was a word or a nonword. They were alerted by a feed-back signal if they gave an incorrect response.

Design. Crossing the Semantic relationship (related *versus* unelated), the Harmonic function (tonic *versus* subdominant) and the Lexicality (word *versus* nonword) resulted in 96 sung sentences. Each participant heard these 96 sung sentences in a random order. The musical expertise (musicians *versus* nonmusicians) defined the within-subject variable.

2.2 Results

Percentages of correct responses are displayed in Table 1 and were analyzed with a 2 (Musical Expertise) × 2 (Harmonic Function) × 2 (Semantic Relationship) ANOVA. Correct responses were more numerous for semantically related word rather than for semantically unrelated words, $F(1,50) = 58.91$, $p < .001$, $MSE = 123.42$. There were no other significant effects.

Correct response times are displayed in Table 2. Correct response times were faster for semantically related word rather than for semantically unrelated words, $F(1,50) = 195.90$, $MSE = 3395.97$. The semantically related word sung on a tonic chord was processed faster than the same word sung on a subdominant chord, this effect was not observed for the semantically unrelated word as shown by a significant Harmonic Function × Semantic Relationship interaction, $F(1,50) = 6.83$, $p < .05$, $MSE = 3418.11$. There were not other significant effects.

	Semantically related		Semantically unrelated	
	Tonic	Subdominant	Tonic	Subdominant
Non-musicians	94.14 (1.32)	90.74 (1.68)	77.16 (2.38)	82.72 (2.55)
Musicians	93.33 (1.36)	92.33 (1.44)	81.67 (3.15)	81.67 (2.50)

Table 1: Percentages of correct responses for semantically related and unrelated targets, for tonic and subdominant chords and for musicians and nonmusicians. Standard errors are indicated between brackets.

	Semantically related		Semantically unrelated	
	Tonic	Subdominant	Tonic	Subdominant
Non-musicians	609.52 (22.60)	640.28 (30.50)	767.47 (26.99)	755.23 (29.14)
Musicians	663.93 (27.32)	697.75 (35.70)	774.77 (35.94)	766.79 (35.95)

Table 2: Correct response times for semantically related and unrelated targets, for tonic and subdominant chords and for musicians and nonmusicians. Standard errors are indicated between brackets.

3. DISCUSSION

The present study shows that the harmonic structure underlying sung sentences influences the processing of words. Semantically related words sung on a tonic chord were processed faster and more accurately than the same words sung on a subdominant chord. This effect was very strong both because listeners did not pay attention to the manipulated factors, contrary to other studies (Bonnel et al., 2001; Patel et al., 1998) and because this effect is observed for both musicians and nonmusicians.

This finding supports a dependence hypothesis between language and music at a behavioral level of treatment. This result is in accordance with some electrophysiological studies assuming that the neural networks of language and music are the same or at least have common parts (Koelsch et al., 2002).

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