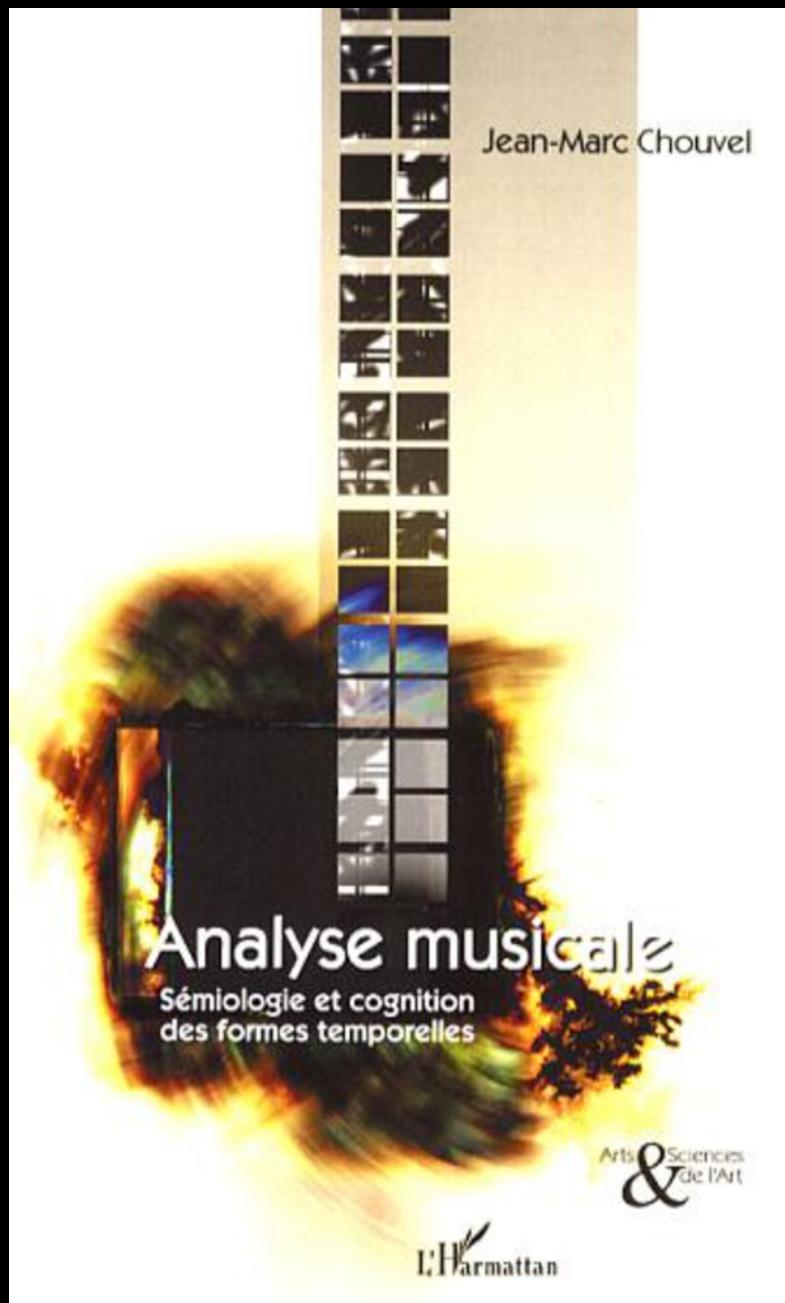


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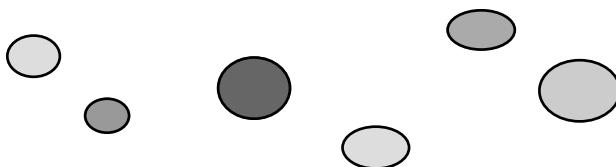
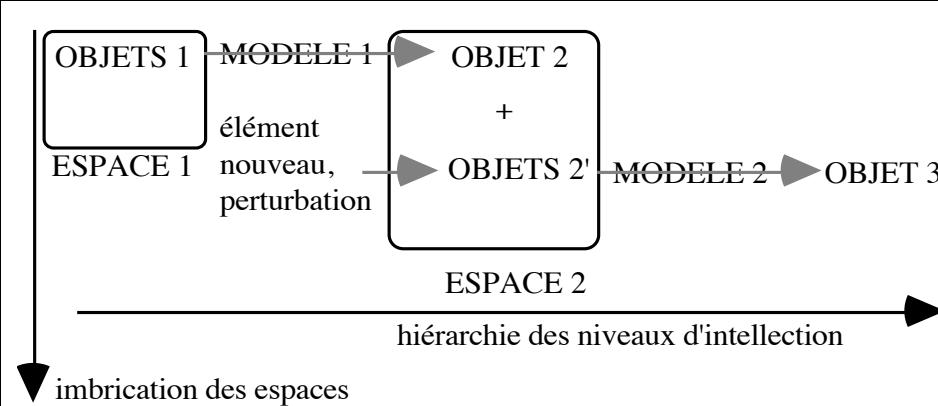
**Peut-on envisager une
représentation continue de la
structure musicale ?**

1. La notion de structure



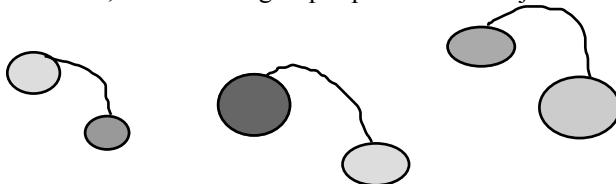
Jean-Marc Chouvel

Jean-Marc Chouvel
ANALYSE MUSICALE
Sémiologie et cognition des formes temporelles
L' Harmattan, Paris, 2006.
Arts et Sciences de l'art

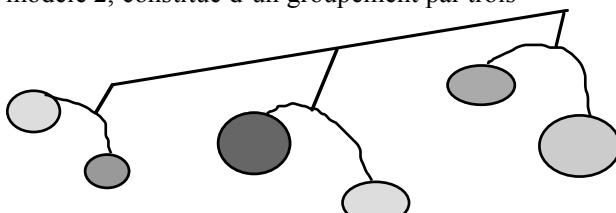


objets1, objets arrondis

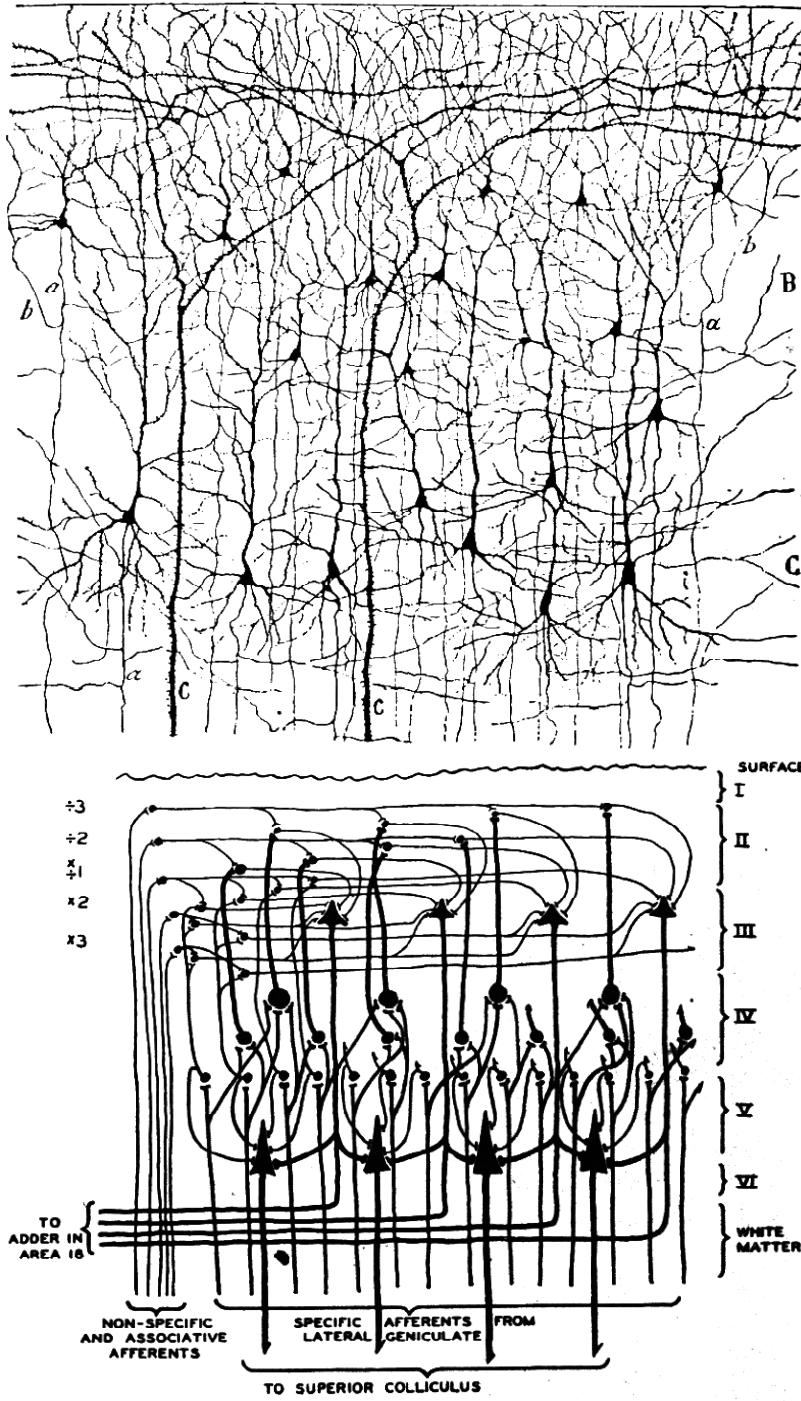
espace1, constitué d'objets arrondis
 modèle 1, consistant à grouper par deux les objets



objets 2, paires d'objets 1 reliés
 espace 2, constitué de ces paires
 modèle 2, constitué d'un groupement par trois



objet 3, trio de paires d'objets arrondi ...



- a) dessin de Jamon y Cajal (1900) issu de préparations de Golgi (section du cortex) ;
 b) schéma des réseaux neuronaux impliqués dans la perception (ici visuelle)

Pitts & McCulloch, pp. 134 & 135.

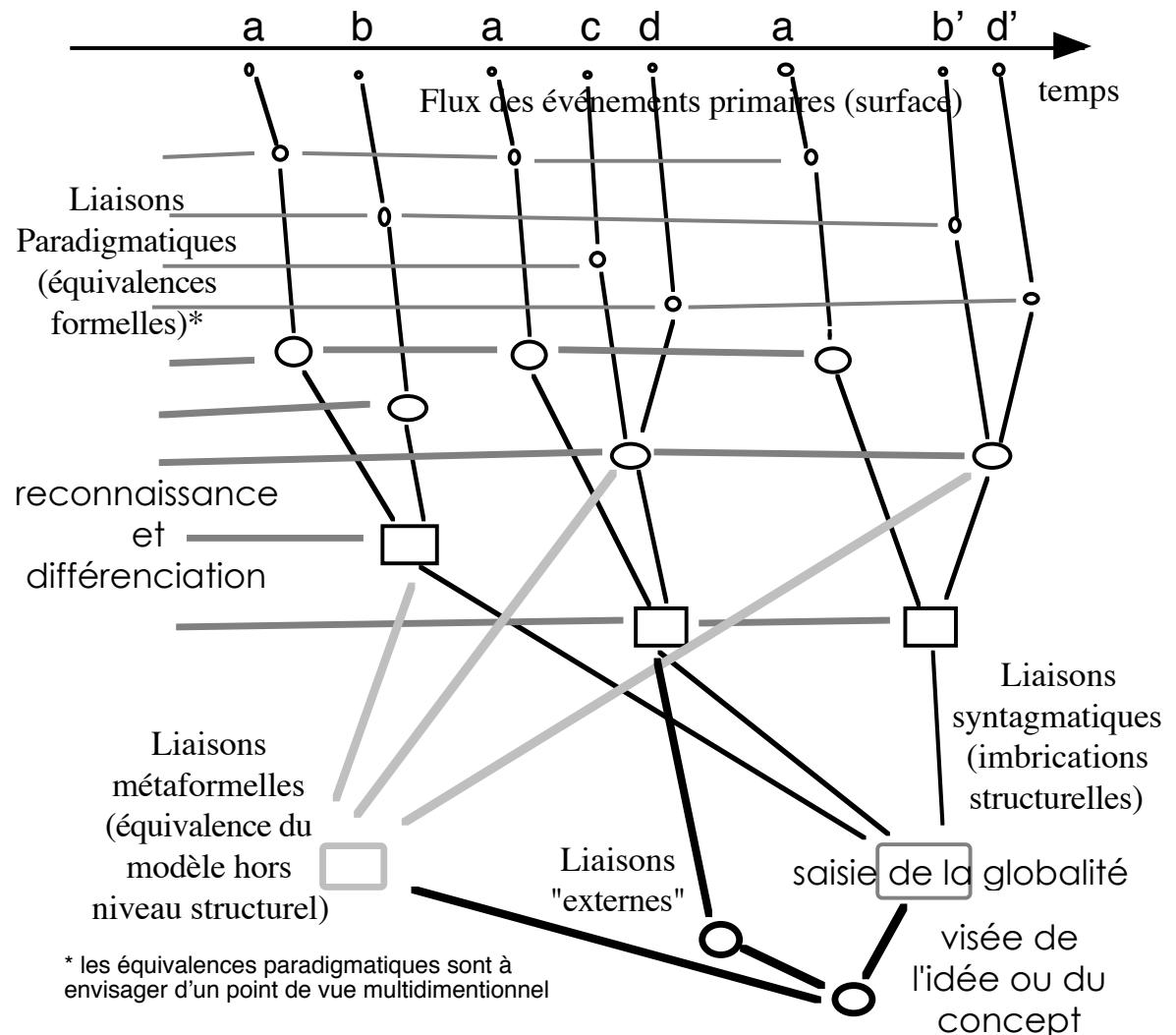
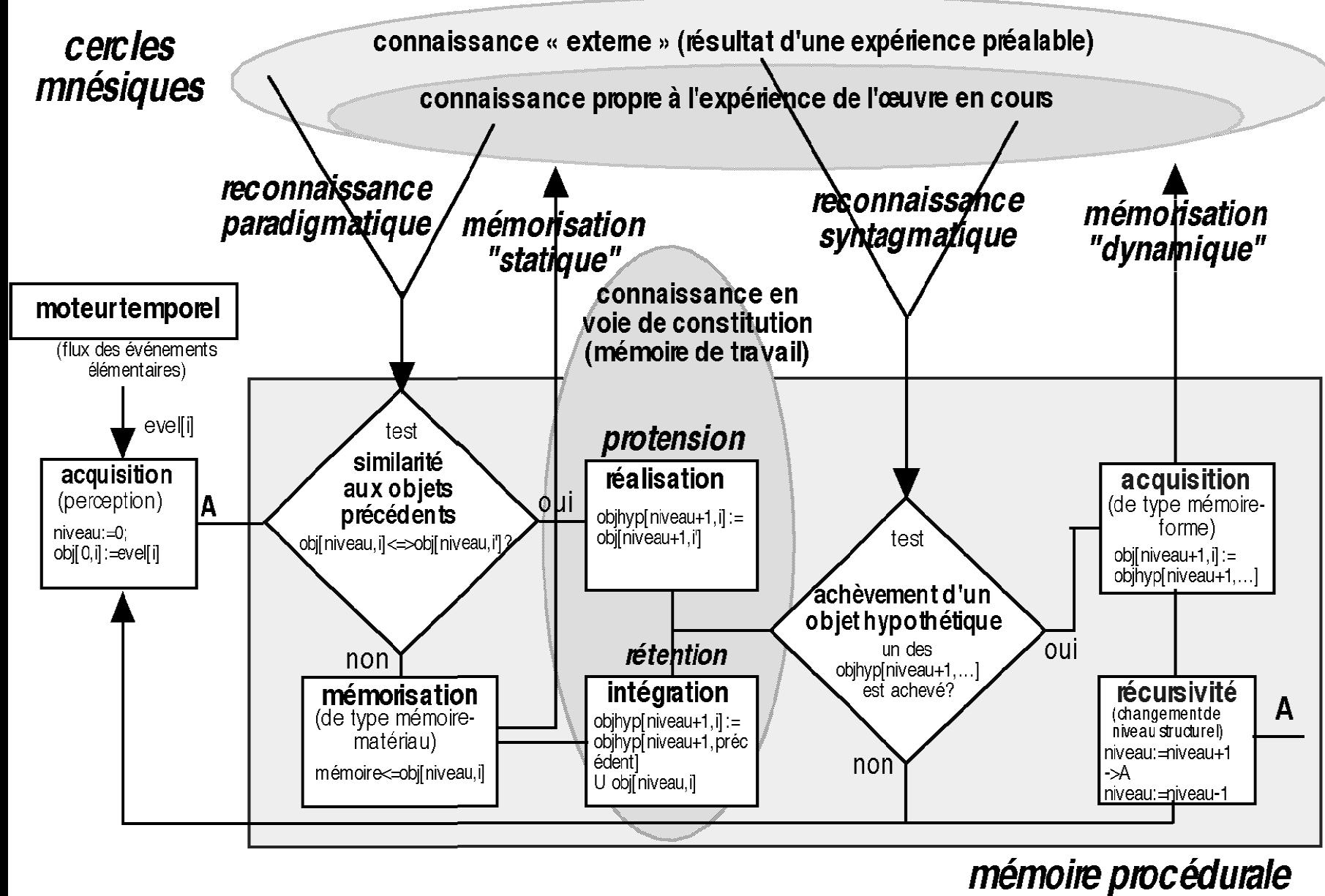


Schéma de réalisation d' une analyse qui rendrait compte des différents types de liens entre événements.

cercles mnésiques



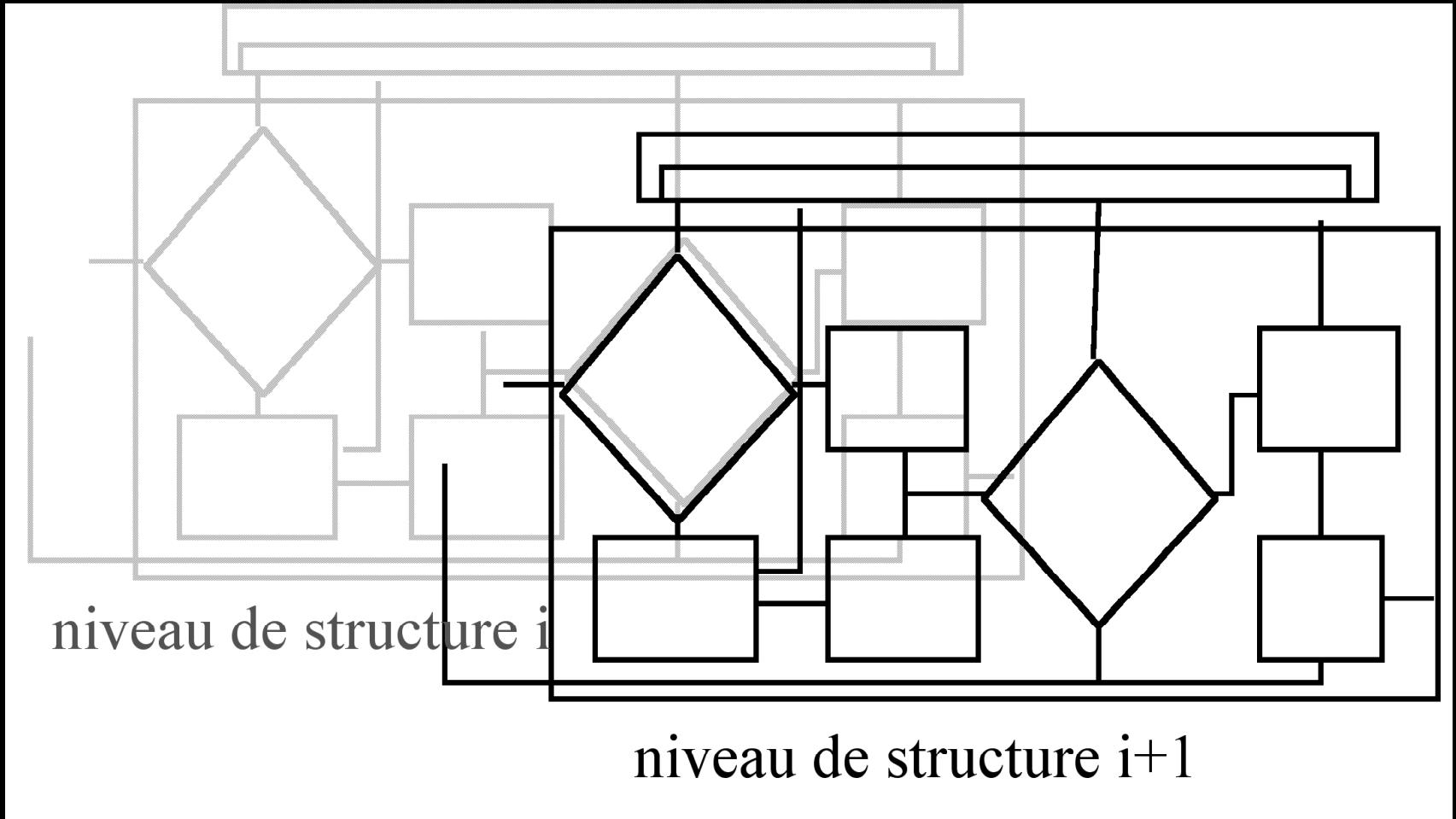
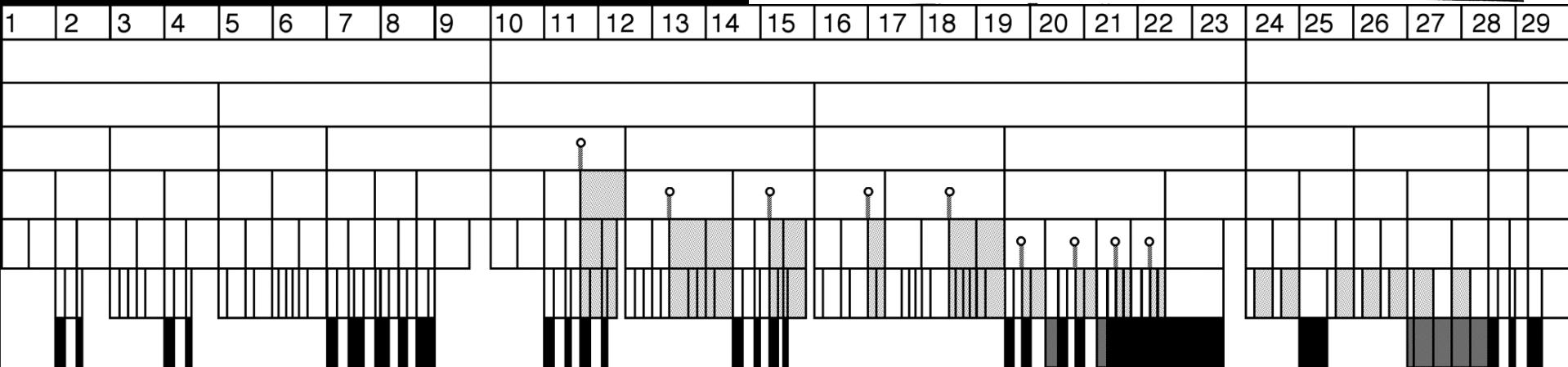
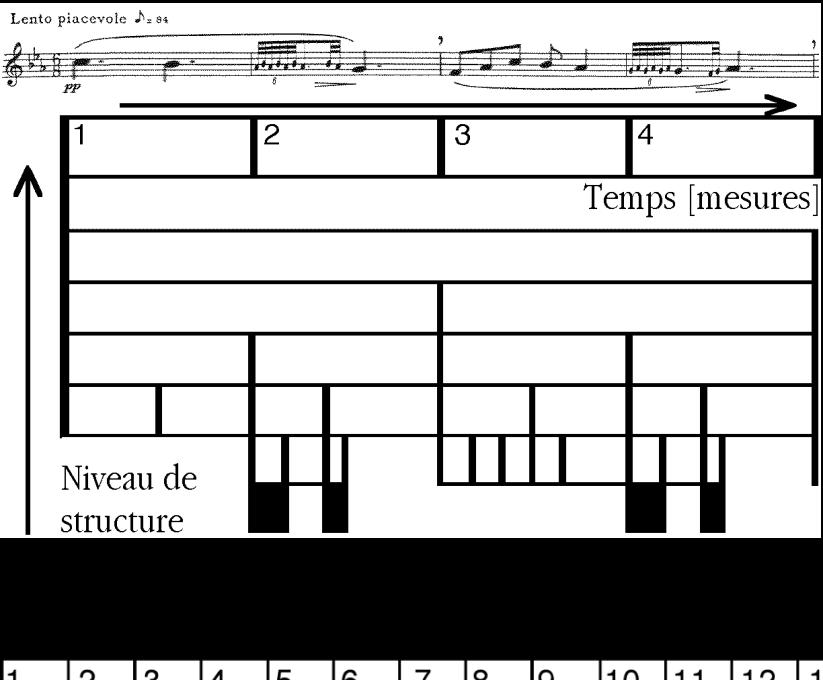


Schéma général de la superposition possible des opérateurs cognitifs de deux niveaux successifs mettant en évidence les parallélismes possibles entre la validation au niveau inférieur et la reconnaissance au niveau supérieur.

2. La représentation de la structure

Narcissus, extrait des 6 Métamorphoses d'après Ovide de Benjamin Britten



Lento piacevole $\text{♩} = 84$

Narcissus, extrait des 6 *Métamorphoses d'après Ovide* de Benjamin Britten



Nicholas Daniel

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

Lento piacevole $\text{♩} = 84$

pp 6 , 6

5 *più f* 4 *p cresc.* 10 *mf espress.*

* *pp* *mf* *pp* *mf*

15 *pp* *f* *p* *pp* 4

mf *b* *b* *mf*

20 *b* *b* *b* *b*

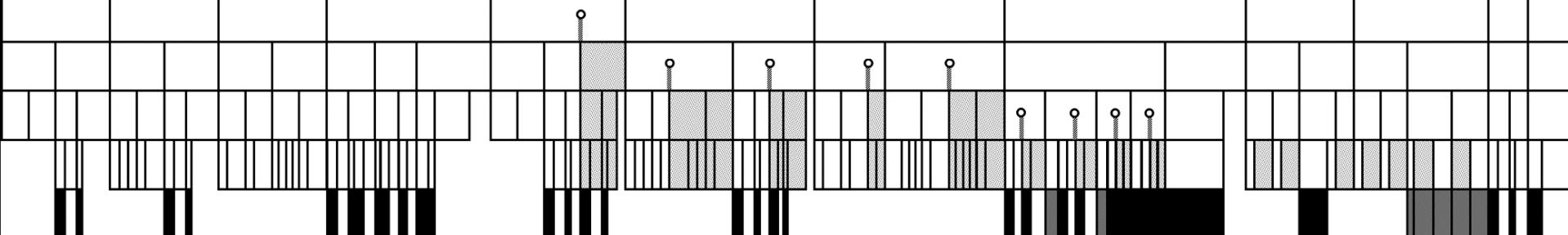
25 *b* *b* *b* *b*

26 *b* *b* *b* *b*

27 *b* *b* *b* *b*

28 *b* *b* *b* *b*

29 *b* *b* *b* *b*



140

150

160

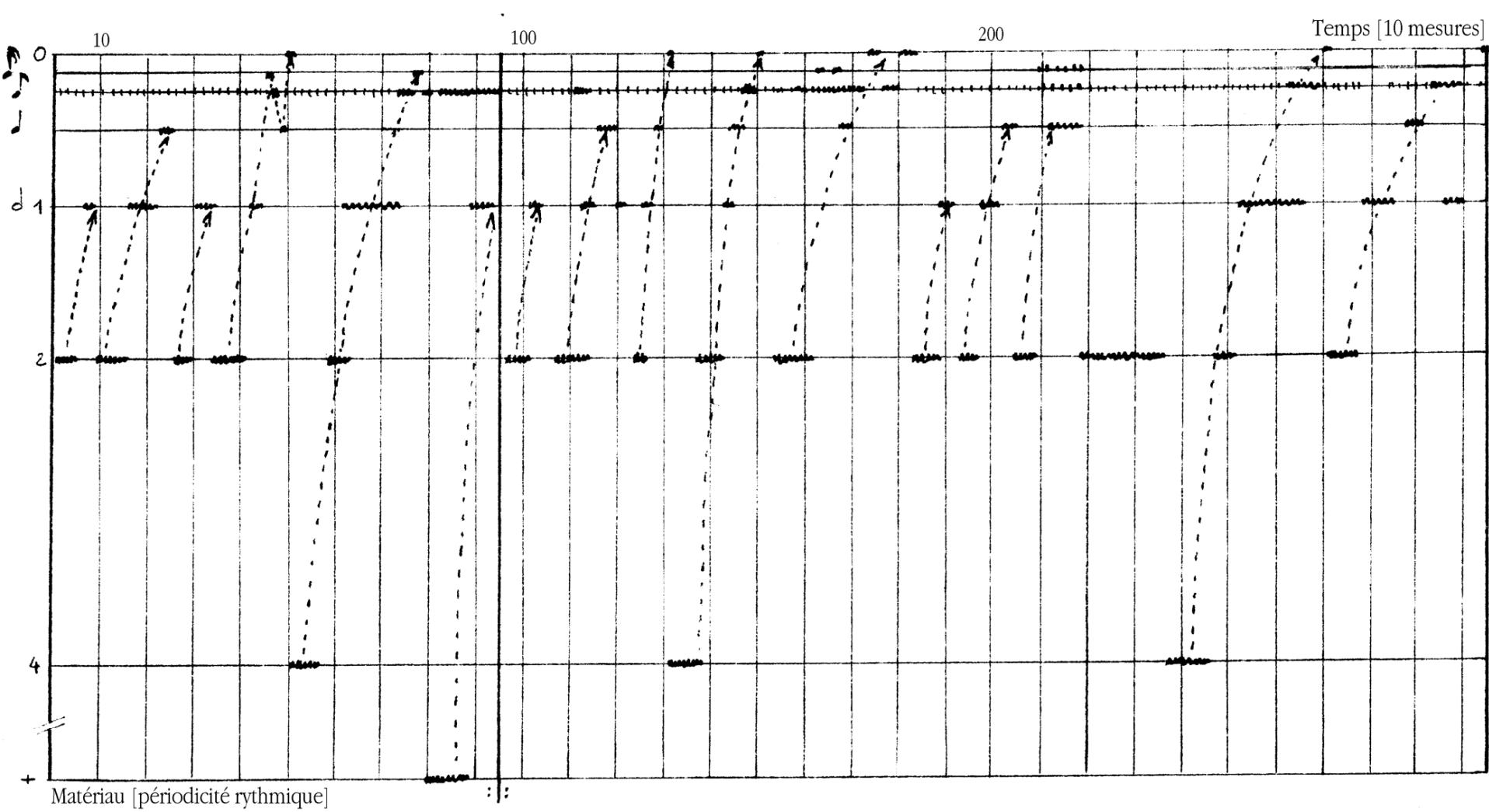
170

180 2

Premier mouvement du quatuor opus 33 n^e5 de Joseph Haydn, mesures 140 à 183



(Kontras Quartet)



Profil de périodicité des événements pour le premier mouvement du *Quatuor opus 33 n° 5* de Joseph Haydn

2. Der Frühling

J. B. Rousseau

Singstimme

Pianoforte

Con moto

mf con espressione

p dolce ed espressivo

1. Es lockt und säu - selt um den Baum: wach
 2. Es zieht ein We - hen sanft und lau, ge -
 3. Es weht der Wind den Blü - ten - staub von

sost.

dim.

p dolce

temps

- mesures à 6/8
- cellules rythmiques (phrasé supérieur)
- notes ligne supérieure
- pédale pivot intermédiaire
- notes ligne basse
- phrasé (basse)
- Zones harmoniques
- etc.

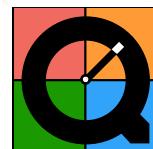
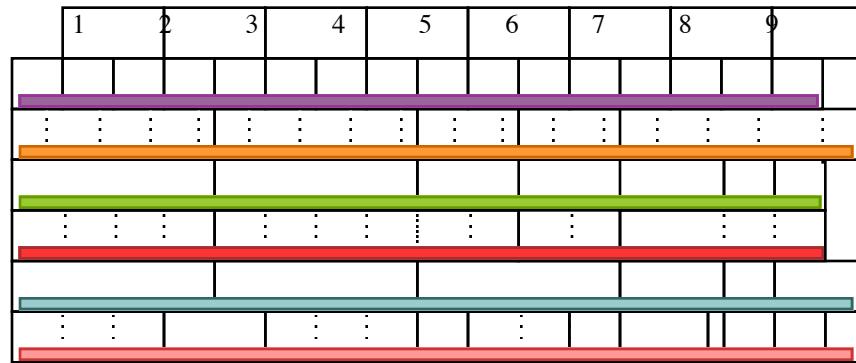


Fig. 2 : Quelques propositions de segmentations possibles pour les huit premières mesures de l'introduction au piano du lied *Der Frühling*, Op. 6 n°2 de Johannes Brahms.

zu 2

Sop. El.

Hb.

Klar. A.

Vcl. in E

Viol. in E

Ftr.

Pas. zu 3

Tbs.

Pk.

Vl. I

Vl. II

Br.

Vc.

Eb.

l'ouverture de Tannhäuser de Richard Wagner, M. 39 et suivantes.

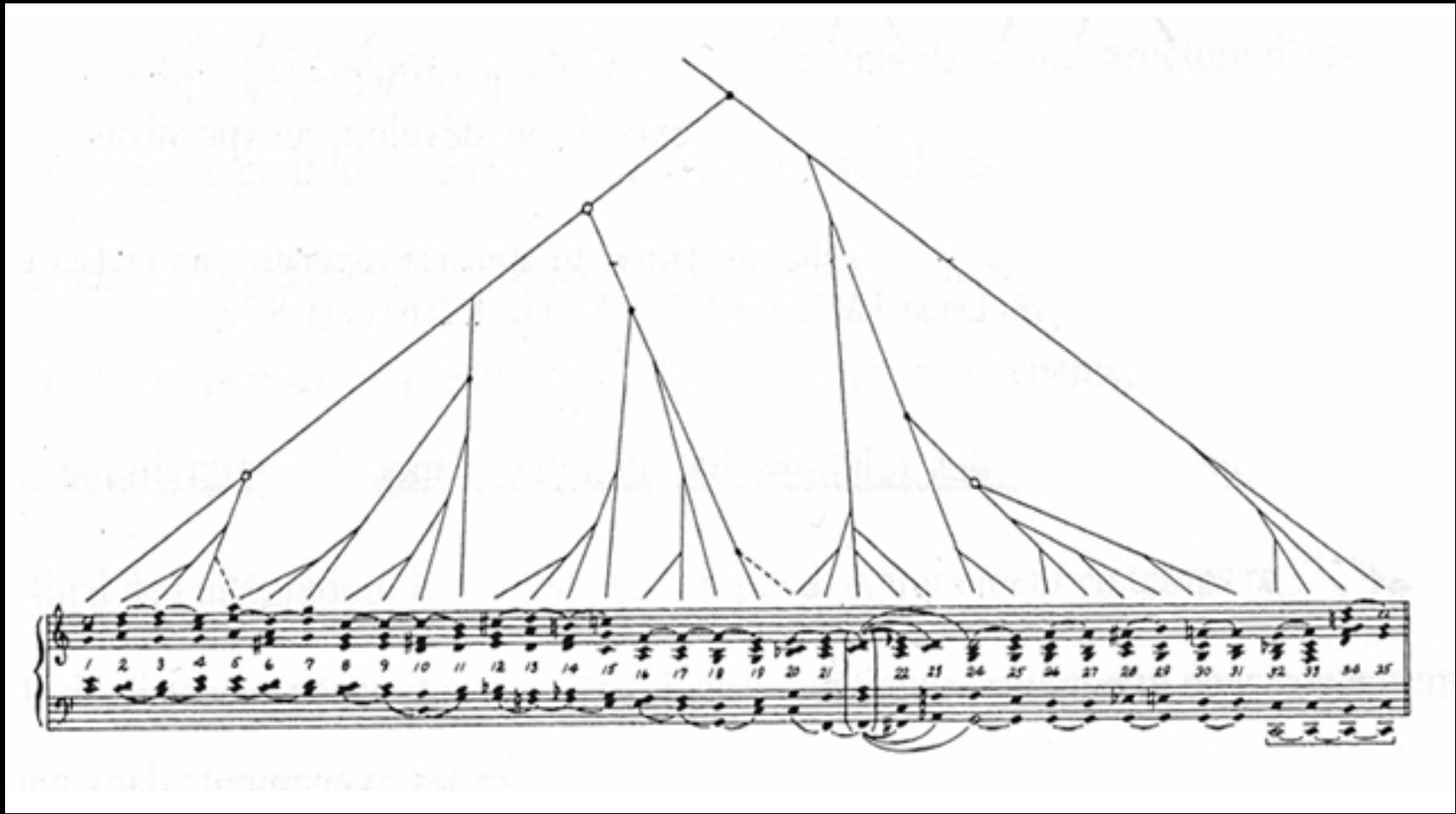


A musical score page from Richard Wagner's *Tannhäuser*. The score is written in 2/4 time and includes parts for Flute (Fl.), Oboe (Ob.), Clarinet A (Klar. A), Bassoon (Bass. in E), Trombone (Trom. in E), French Horn (Fr.), Bassoon (Bass. zu 8), Trombone (Tbs.), Piccolo (Pkk.), Violin I (Vl. I), Violin II (Vl. II), Cello (Vc.), and Double Bass (Cb.). The score shows various musical staves with notes and rests. Several measures are highlighted with colored ovals and boxes: a green oval highlights the first measure of the Violin I part; a purple double-lined box highlights measures 2 and 3 of the Flute, Ob., and Klar. A blue double-lined box highlights measures 4 through 7 of the same three instruments. A red double-lined box highlights measures 8 through 11 of the Flute, Ob., and Klar. Measures 12 through 15 are also enclosed in a red box.

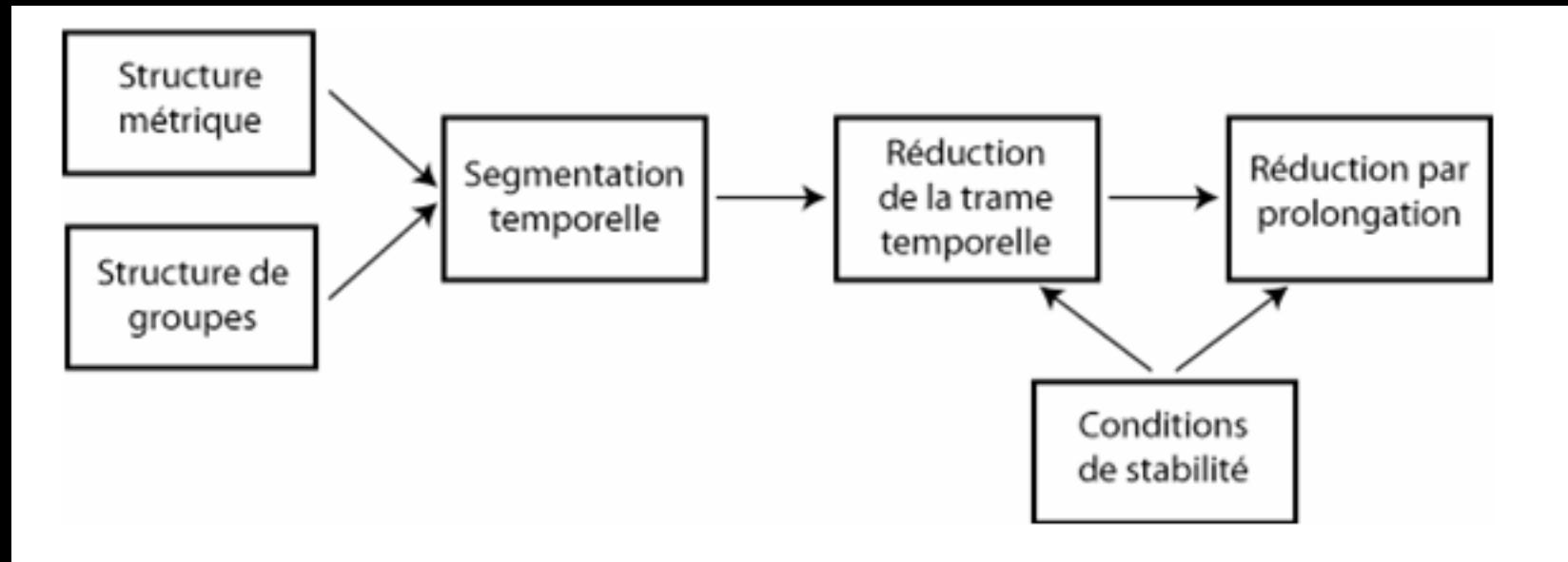
L'ouverture de *Tannhäuser* de Richard Wagner, M. 39 et suivantes.



Structuration hiérarchique de la musique: la TGMT



Représentation d' une hiérarchie d' événements obtenue par prolongation. D' après Lerdahl et Jackendoff, 1983 (Fig. 10.11). Les branchements sans cercles indiquent une progression entre deux événements différents. Les branchements avec un cercle noir indiquent une prolongation faible créée par la répétition d' un événement sous une autre forme (e.g., une inversion d' accords). Les branchements avec un cercle blanc indiquent une prolongation forte créée par la répétition d' un événement à l' identique. Les mouvements de tensions et détentes créés sont les plus forts pour les progressions, puis pour les prolongations faibles, puis pour les prolongations fortes.



Représentation schématique de la TGMT. D'après Bigand, 1994.

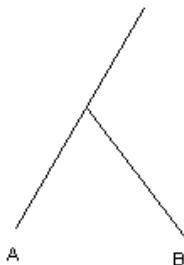
Branching Symbols



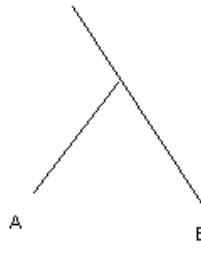
right branch
continuation
“branching back”



left branch
anticipation
“branching forward”



A stronger than B



B stronger than A

3. Structure et temporalité

RONDO.
Allegretto.

W. A. Mozart, Rondo (Allegretto) de la sonate K. 545. (début)

The musical score consists of eight staves of piano music. The first staff begins with a forte dynamic (f) and a tempo marking of **Allegretto**. The second staff starts with a piano dynamic (p). The third staff begins with a forte dynamic (f). The fourth staff starts with a piano dynamic (p). The fifth staff begins with a forte dynamic (f). The sixth staff starts with a piano dynamic (p). The seventh staff begins with a forte dynamic (f). The eighth staff begins with a piano dynamic (p).

Measure 1 (a): Treble clef, 2/4 time. Dynamics: f, p, f.

Measure 2 (b): Treble clef, 2/4 time. Dynamics: p.

Measure 3 (c): Treble clef, 2/4 time. Dynamics: f.

Measure 4 (d): Treble clef, 2/4 time. Dynamics: mf.

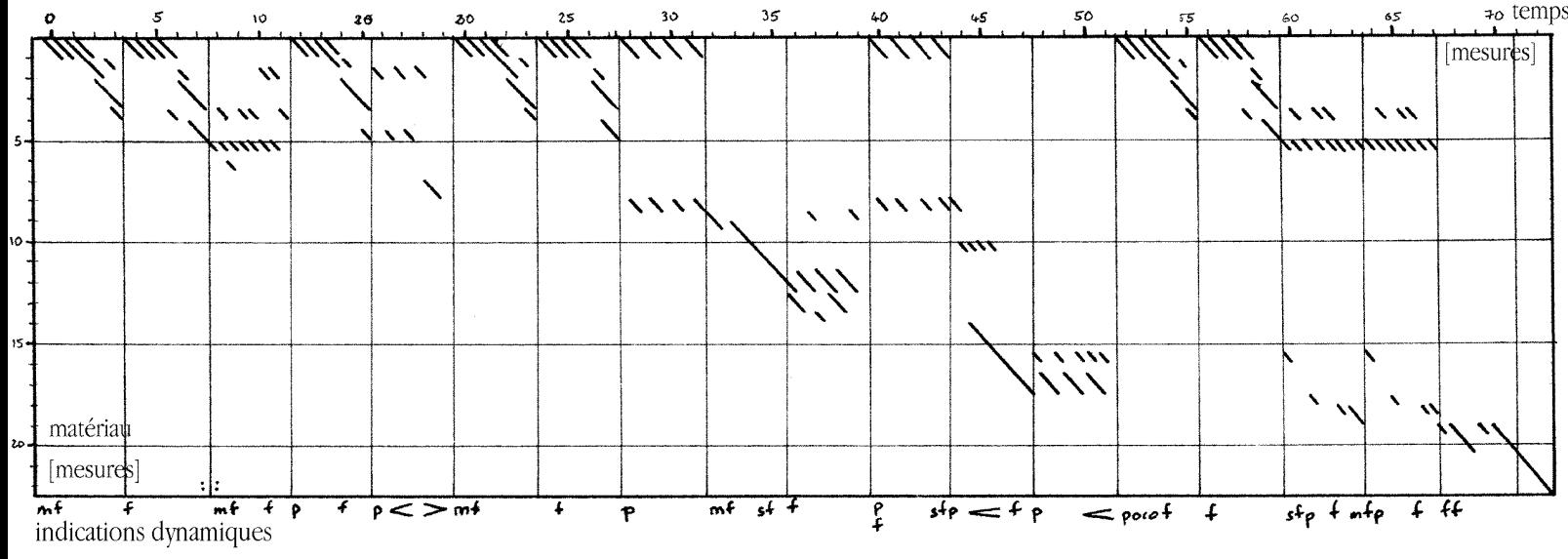
Measure 5 (e): Treble clef, 2/4 time. Dynamics: f.

Measure 6 (a''): Treble clef, 2/4 time. Dynamics: p. Articulation: *legato*.

Measure 7 (b'): Treble clef, 2/4 time.

Measure 8 (f): Treble clef, 2/4 time.

Measure 9 (g): Treble clef, 2/4 time.



RONDO.

a Allegretto.



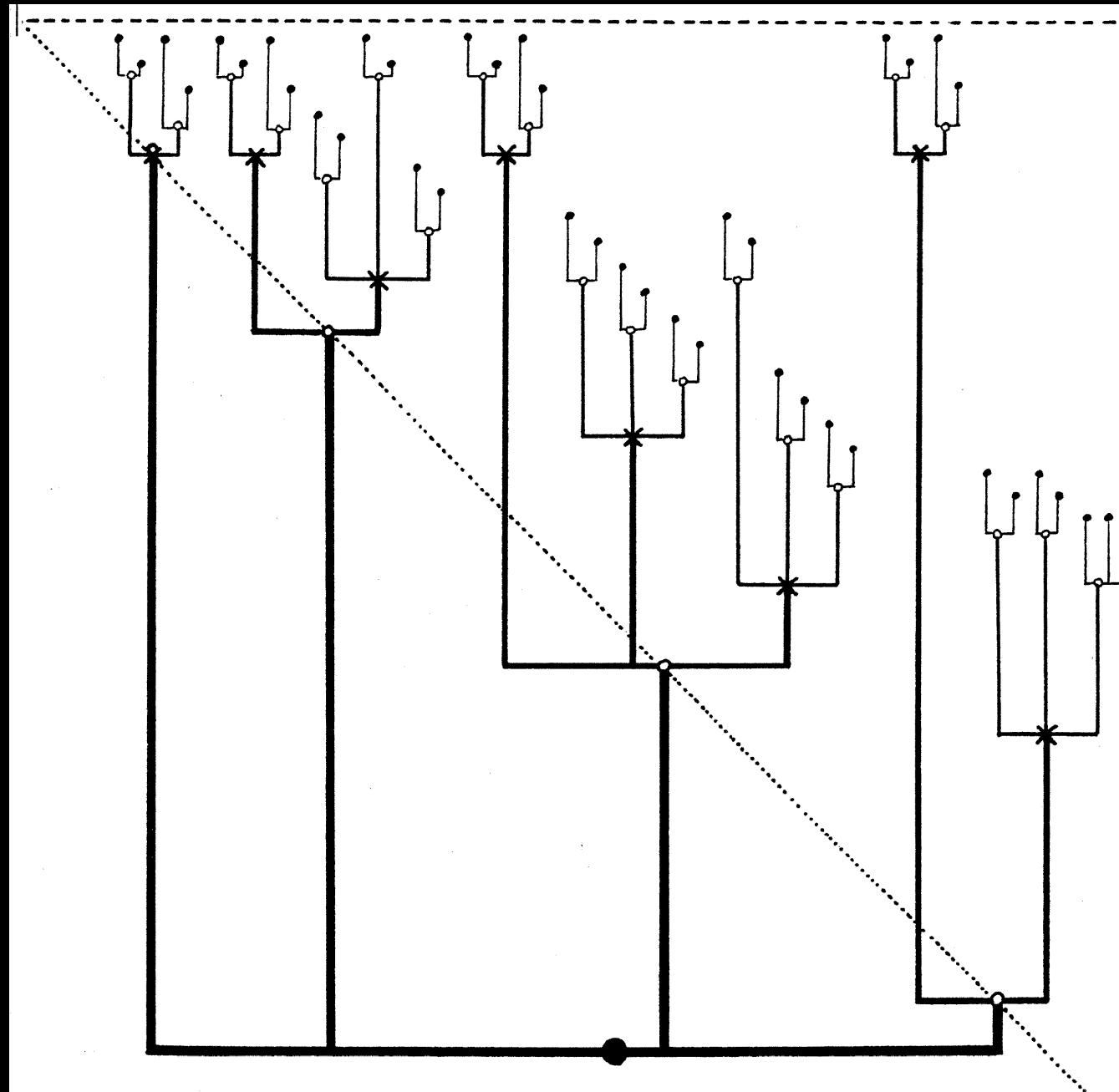
b

a'

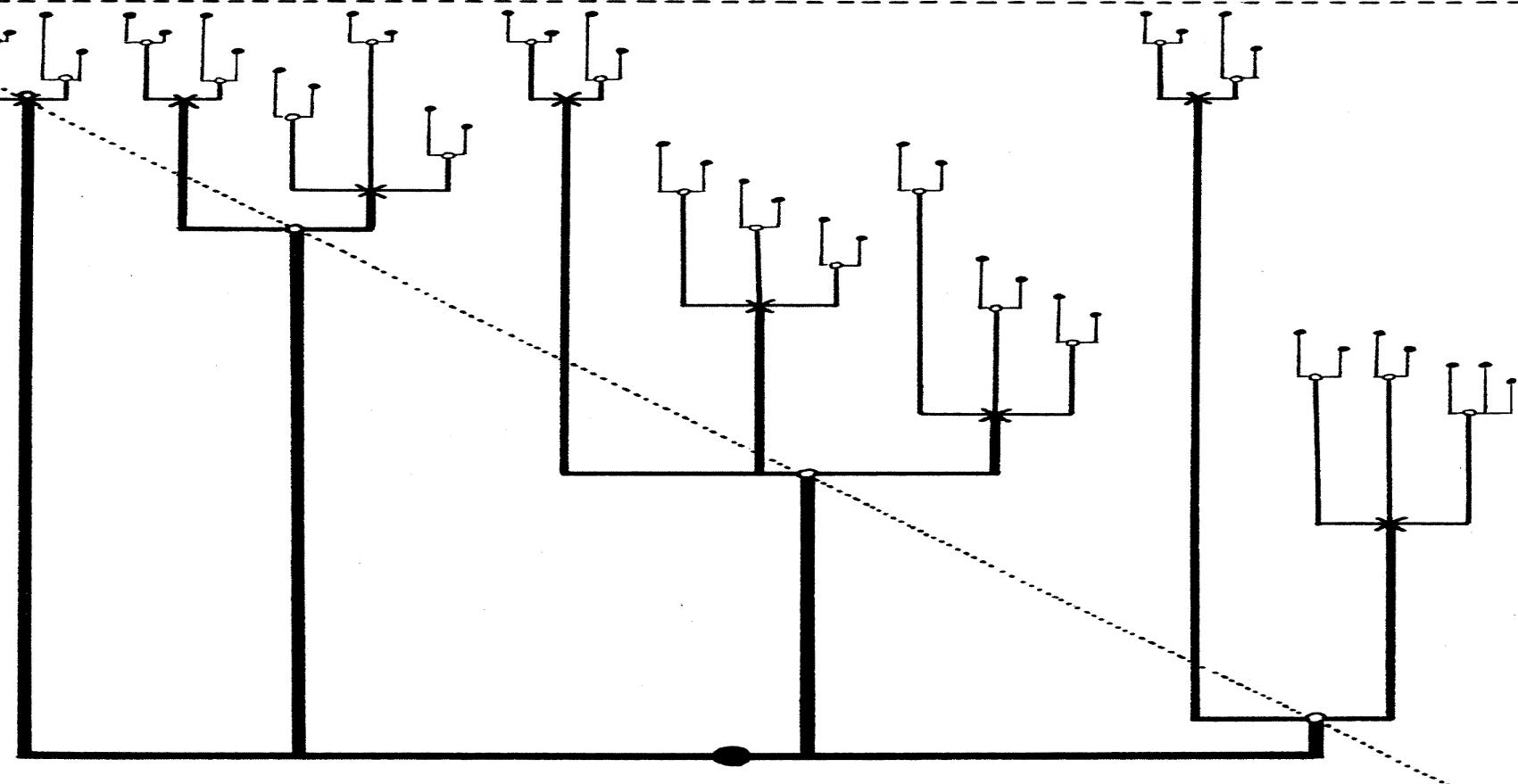


c

d



0 5 10 25 30 25 30 35 40 45 50 55 60 65 70 temps
[mesures]



a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
q a b a' c r s r s' t t u

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
a a a a' a' a r s a' s' t t u a', a a'
ba a'
c b b b'
db
e c c
f c
g
h
i
j
k
l
m
n
o
p
q
r
s
t
u q

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
g a b a' c r s r s' t t u a', a a'
a a a a' a a' a a' a a'
b a b a' a a' a a' a a'
c b b b b b b b b b
db
e c c c c c c c c c
f c c c c c c c c c
g h i j k l m n o p q r s t u q
h i j k l m n o p q r s t u q
h' i' j k l m n o p q r s t u q
Etc.

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
q a b a' c r s r s' t t u a', a a' a'
b a a' a' a' a'
c b b b b
d b b b b
e c c c c
f c c c c
g h i j k l m n o p q r s t u q
h i j k l m n o p q r s t u q
i j k l m n o p q r s t u q
j k l m n o p q r s t u q
k l m n o p q r s t u q
l m n o p q r s t u q
m n o p q r s t u q
n o p q r s t u q
o p q r s t u q
p q r s t u q

The diagram illustrates a grid of letters with various boxes drawn around them:

- A large red rectangle covers the first four columns of the first two rows.
- A blue rectangle covers the last three columns of the first two rows.
- Red boxes highlight the first four letters of the first two rows: 'a', 'a', 'a', 'a', 'a', 'a', 'a', 'a'.
- Blue boxes highlight the last three letters of the first two rows: 'c', 'r', 's', 'r', 's', 't', 't', 'u'.
- Red boxes highlight the first four letters of the third row: 'a', 'a', 'a', 'a'.
- Blue boxes highlight the last three letters of the third row: 'b', 'b', 'b'.
- Red boxes highlight the first four letters of the fourth row: 'b', 'b', 'b', 'b'.
- Blue boxes highlight the last three letters of the fourth row: 'b', 'b', 'b'.
- Red boxes highlight the first four letters of the fifth row: 'c', 'c', 'c', 'c'.
- Blue boxes highlight the last three letters of the fifth row: 'c', 'c', 'c'.
- Red boxes highlight the first four letters of the sixth row: 'c', 'c', 'c', 'c'.
- Blue boxes highlight the last three letters of the sixth row: 'c', 'c', 'c'.
- Red boxes highlight the first four letters of the seventh row: 'f', 'f', 'f', 'f'.
- Blue boxes highlight the last three letters of the seventh row: 'f', 'f', 'f'.
- Red boxes highlight the first four letters of the eighth row: 'g', 'g', 'g', 'g'.
- Blue boxes highlight the last three letters of the eighth row: 'g', 'g', 'g'.
- Red boxes highlight the first four letters of the ninth row: 'h', 'h', 'h', 'h'.
- Blue boxes highlight the last three letters of the ninth row: 'h', 'h', 'h'.
- Red boxes highlight the first four letters of the tenth row: 'i', 'i', 'i', 'i'.
- Blue boxes highlight the last three letters of the tenth row: 'i', 'i', 'i'.
- Red boxes highlight the first four letters of the eleventh row: 'j', 'j', 'j', 'j'.
- Blue boxes highlight the last three letters of the eleventh row: 'j', 'j', 'j'.
- Red boxes highlight the first four letters of the twelfth row: 'k', 'k', 'k', 'k'.
- Blue boxes highlight the last three letters of the twelfth row: 'k', 'k', 'k'.
- Red boxes highlight the first four letters of the thirteenth row: 'l', 'l', 'l', 'l'.
- Blue boxes highlight the last three letters of the thirteenth row: 'l', 'l', 'l'.
- Red boxes highlight the first four letters of the fourteenth row: 'm', 'm', 'm', 'm'.
- Blue boxes highlight the last three letters of the fourteenth row: 'm', 'm', 'm'.
- Red boxes highlight the first four letters of the fifteen row: 'n', 'n', 'n', 'n'.
- Blue boxes highlight the last three letters of the fifteen row: 'n', 'n', 'n'.
- Red boxes highlight the first four letters of the sixteen row: 'o', 'o', 'o', 'o'.
- Blue boxes highlight the last three letters of the sixteen row: 'o', 'o', 'o'.
- Red boxes highlight the first four letters of the seventeen row: 'p', 'p', 'p', 'p'.
- Blue boxes highlight the last three letters of the seventeen row: 'p', 'p', 'p'.

RONDO.
Allegretto.

(ab)(a'c)(ab)(a'c)(de)(a''b')(fg)(ab)(a'c)(hi)(jk)(lm)(h'i')(no)(pq)
(a b) (a b) (c a' d) (a b) (e f g) (e' h i) (a
A (A B) (A C D)

	1					1	1k
						2j1	
				1	1i		
				1	1h		
			1	1g			
		1	1f				
	1		2e		1		
1			1d				
	1	1e					
4	4b						
5a	1	1	1				1

1				1e
		1	1d	
1			1c	
1	1b			
4al	1		1	

a>b; (ba)>c / b>a; e((z
 ((ab)(ac))>a; c((ab)(a
 g((ab)(ac))>h; q((ab))
 d>e / e>a / f>g / g>a
 i>j; (hi)>n / j>k / k>l ,
 m>h / n>o / o>p / p>
 / r>s / s>r; s(rs)>t / t
A>a; A>d; A>h; A>r

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
q a b a' c r s r s' t t u

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
(ab)(a'c)(ab)(a'c)(de)(a"b')(fg)(ab)(a'c)(hi)(jk)(lm)(h'i')(no)(pq)(ab)(

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
(ab)(a'c)(ab)(a'c)(de)(a"b')(fg)(ab)(a'c)(hi)(jk)(lm)(h'i')(no)(pq)(ab)(
a b a b c a' d a b e f g e' b i a b j j k

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
(ab)(a'b')(ab')(a'b)(a'c)(de)(a'b')(fg)(ab)(a'c)(hi)(jk)(lm)(h'i')(no)(pq)(ab)(a'b')(a'b)(a'b)(c a' d)(a b)(e f g)(e' b i) (a b)(j j k)
k)

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
(ab)(a'b')(ab')(a'b)(a'c)(de)(a'b')(fg)(ab)(a'c)(hi)(jk)(lm)(h'i')(no)(pq)(ab)(a'b')(a'b)(c a' d)(a b)(e f g)(e' b i) (a b)(j j k)
A A B A C D A E

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p

(ab)(a'b')(ab')(a'b)(a'c)(de)(a'b')(fg)(ab)(a'c)(hi)(jk)(lm)(h'i')(no)(pq)(ab)(a'b')(a'b)(a'b)(c a' d)(a b)(e f g)(e' b i) (a b)(j j k)

a b a b c a' d a b e f g e' b i a b j j k

(a b)(a b)(c a' d)(a b)(e f g)(e' b i) (a b)(j j k)

A A B A C D A E

A (A B) (A C D) (A E)

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
(ab)(a'b')(ab')(a'c)(de)(a'b')(fg)(ab)(a'c)(hi)(jk)(lm)(h'i')(no)(pq)(ab)(a'b')(a'b')(a'b')(a'b')(a'b')(e f g)(e' b i) (a b)(j j k)

$k)$ A A B A C D A E

A (A B) (A C D) (A E)

a	b	a'	c	a	b	a'	c	d	e	a''	b'	f	g	a	b	a'	c	h	i	j	k	l	m	h'	i'	n	p
(ab)	(a'c)	(ab)	(a'c)	(de)	(a''b')	(f)	(g)	(a'b)	(b)	(a'b)	(c)	(rs)	(rs')	(t)	(t)	(u)											
a	b	a	b	c	a'	d	a																				
(a b)	(a b)	(c a'	d)	(a																							
I)	A	A	B		A																						
a>b;	(ba)>c	/																									
b>a;	e(ab)>f	/																									
((ab)ac)>a;	c((ab)ac)>d;																										
g((a)baç)>h;	q((a)baç)>r/																										
d>e	/	e>a	/	f> a	//	g>																					
h>i	/	i>j;	(hi)>n	/																							
j>k	/	k>l	/	l>m	/	m>h	/																				
n>o	/	o>p	/	p>q	/	q>a	/	r>s	/																		
s>r;	s(rs)>t	/																									
t>t;	tt>u																										

diagramme de phase formel au niveau "1" (matériau de 2 mesures environ) du Rondo (Allegretto) de la sonate K. 545 de W. A. Mozart.
(présentation « diagonale »)

a b a' c a b a' c d e a'' b' f g a b a' c h i j k l m h' i' n o p
 $(ab)(a'b')(ab)(a'b)(a'b)(de)(a'b')(fg)(ab)(a'c)(hi)(jk)(lm)(h'i')(no)(pq)(ab)(a'b')$

a b a b c a' d a b e f g e' b i a b j j k

$(a\ b)(a\ b)(c\ a')\ d)(a\ b)(e\ f\ g)(e'\ b\ i)\ (a\ b)(j\ j$

$k) a > b ; ca > d /$

$b > a ; b(ab) > c ; d(ab) > e ;$

$i(ab) \geq k /$

$c > a /$

$d > a /$

$be > f ; ge > b /$

$f > g /$

$g > e /$

$h > i /$

$i > a /$

$j > j ; jj > k$

A A B A C

	1								1	lk
								1	l	
									1	
					1				h	
						1		lg		
						1	f			
	1					2		1		
1					ld					
	1		1							
4	4b									
5a	1	1	1	1					1	

diagramme de phase formel au niveau "2"
 (matériau de 4 mesures environ)
 du Rondo (Allegretto) de la sonate
 K. 545 de W. A. Mozart.

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
 $(ab)(a'b')(ab')(a'b)(a'b)(de)(a'b')(fg)(ab)(a'c)(hi)(jk)(lm)(h'i')(no)(pq)(ab)(a'b')$

a b a b c a' d a b e f g e' b i a b j j k

$(a\ b)(a\ b)(c\ a')\ d)(a\ b)(e\ f\ g)(e'\ b\ i)\ (a\ b)(j\ j\ k)$

A A B A C D A E

A (A B) (A C D) (A E)

A>A ; A A>B ; B A>C ; D A>E/

B>A/

C>D/

D>A/

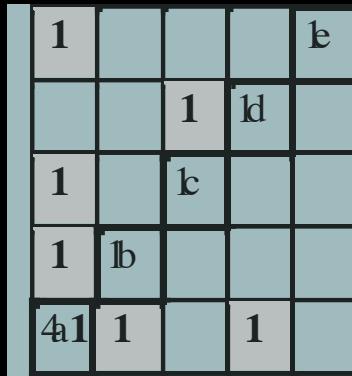


diagramme de phase formel
au niveau "3" du Rondo
(Allegretto) de la sonate K. 545
de W. A. Mozart

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
(ab)(a'c)(ab)(a'b)(de)(a'b')(fg)(ab)(a'c)(hi)(jk)(lm)(h'i')(no)(pq)(ab)(

a b a b c a' d a b e f g e' b i a b j j k

(a b)(a b)(c a' d)(a b)(e f g)(e' b i) (a b)(j j
k)

A A B A C D A E

A (A B) (A C D) (A E)

((ab)(ac))>a; c((ab)(ac))>d; g((ab)(ac))>h; q((ab)(ac))>r

peut s'écrire également

A>**a**; **A**>**d**; **gA**>**h**; **qA**>**r**.

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
(ab)(a'c)(ab)(a'c)(de)(a'b')(fg)(ab)(a'c)(hi)(jk)(lm)(h'i')(no)(pq)(ab)(
a b a b c a' d a b e f g e' b i a b j j k
(a b)(a b)(c a' d)(a b)(e f g)(e' b i) (a b)(j j
k)
A A B A C D A E

A (A B) (A C D) (A E)

Les variantes des paradigmes dépendent du contexte. Ces variantes accompagnent des situations syntagmatiques différentes. Le cas de a>b et a'>c (a est suivi par b et a' par c) est caractéristique, la variante matérialisant en quelque sorte une spécificité transitionnelle. L'écriture « grammaticale » de la séquence devient, en tenant compte des variantes :

a>b>a'>c / ((ab)(a'c))>a; c((ab)(a'c))>d; g((ab)(a'c))>h; q((ab)
d>e>a"b'>f>g>h>i>j>k>m>h'i'>n>o>p>q>a'>s>r>t'>t>u.

a b a' c a b a' c d e a" b' f g a b a' c h i j k l m h' i' n o p
(ab)(a'c)(ab)(a'c)(de)(a'b')(fg)(ab)(a'c)(hi)(jk)(lm)(h'i')(no)(pq)(ab)(
)

a b a b c a' d a b e f g e' b i a b j j k

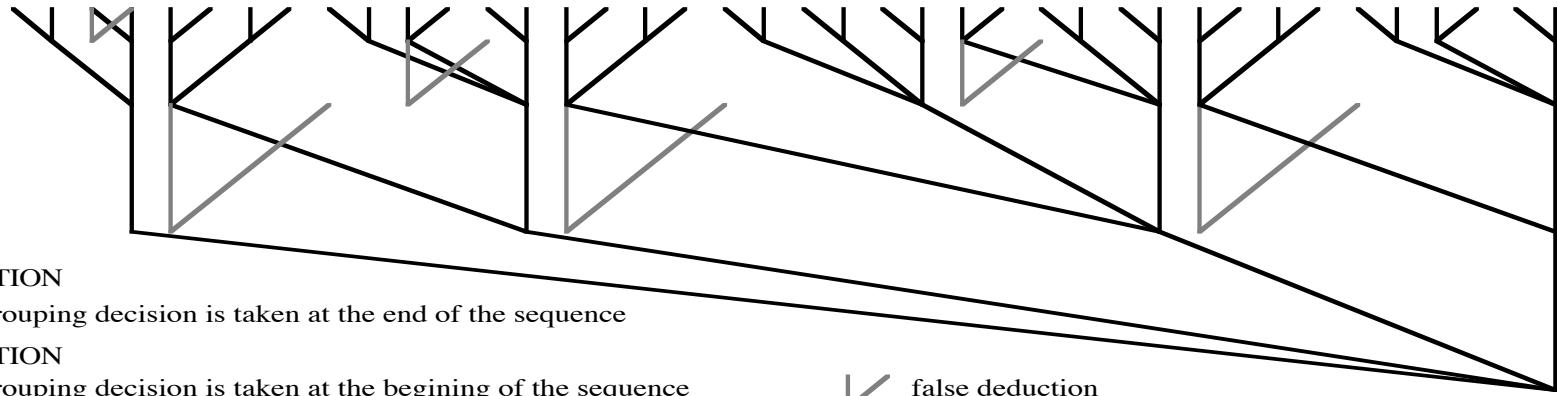
(a b)(a b)(c a' d)(a b)(e f g)(e' b i) (a b)(j j
k)

A A B A C D A E

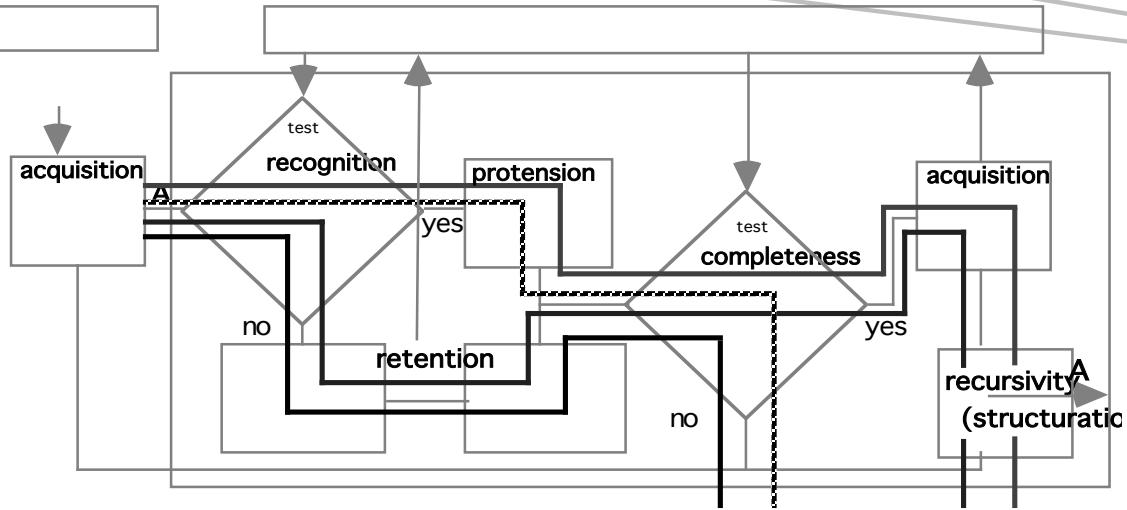
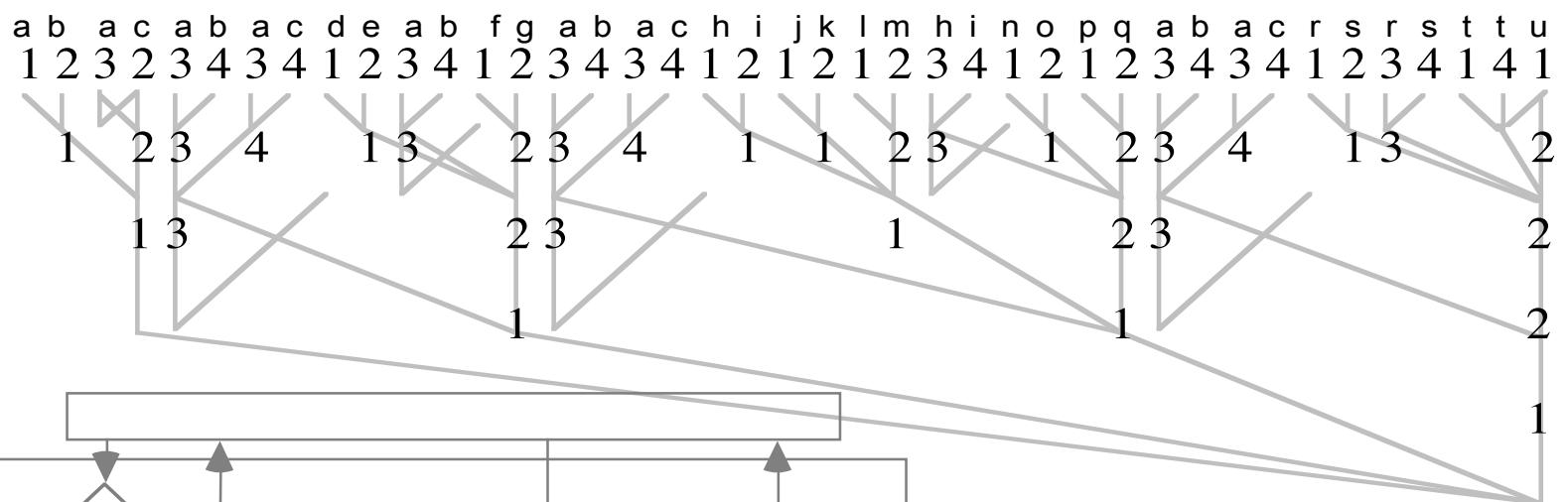
A (A B) (A C D) (A E)

Les variantes des paradigmes dépendent du contexte. Ces variantes accompagnent des situations syntagmatiques différentes. Le cas de a>bet a'>c (a est suivi par bet a' par c) est caractéristique, L'apparente simplification au niveau des règles ne doit pas masquer l'alourdissement en termes de mémoire statique que représent la transitionnelle. L'écriture « grammaticale » de la sequence de - présente la prise en compte des variantes comme matériau. viennent, en tenant compte des variantes :

a>b>a'>c / ((ab)(a'c))>a; c((ab)(a'c))>d; g((ab)(a'c))>h; q((ab)
d>e>a">b'>f>g>h>i>j>k>m>h'i'>n>o>p>q>a'>s>r>t'>t>u.



Representation of structure giving a temporal meaning to the grouping links



PHASES OF THE COGNITIVE PROCESS :

- | | | |
|----|---|--|
| 1: | no similitude memorisation/integration
no completeness (= retention) | <i>waiting unknown</i> |
| 2: | no similitude retention
completeness acquisition/recursivity | <i>waiting unknown</i> |
| 3: | similitude realisation (= protension)
no completeness | <i>waiting for something already known</i> |
| 4: | similitude realisation (= protension)
completeness acquisition/recursivity | <i>waiting for something already known</i> |

Mozart's rondo described with cognitive phases

4. Structure, catégorie et fenêtre d'intégration

Jörg Langner, *Multidimensional Dynamic Shaping*, Proceedings of the Third Triennial ESCOM Conference, Uppsala, 1997, pp. 713-718. Also : Jörg Langner, Reinhard Kopiez, Martin Wilz, « realtime analysis of dynamic shaping » <<http://www.youscribe.com/catalogue/tous/art-musique-et-cinema/autres/realtime-analysis-of-dynamic-shaping-jorg-langner-humboldt-427995>>

The Effect of Smoothing

window size:

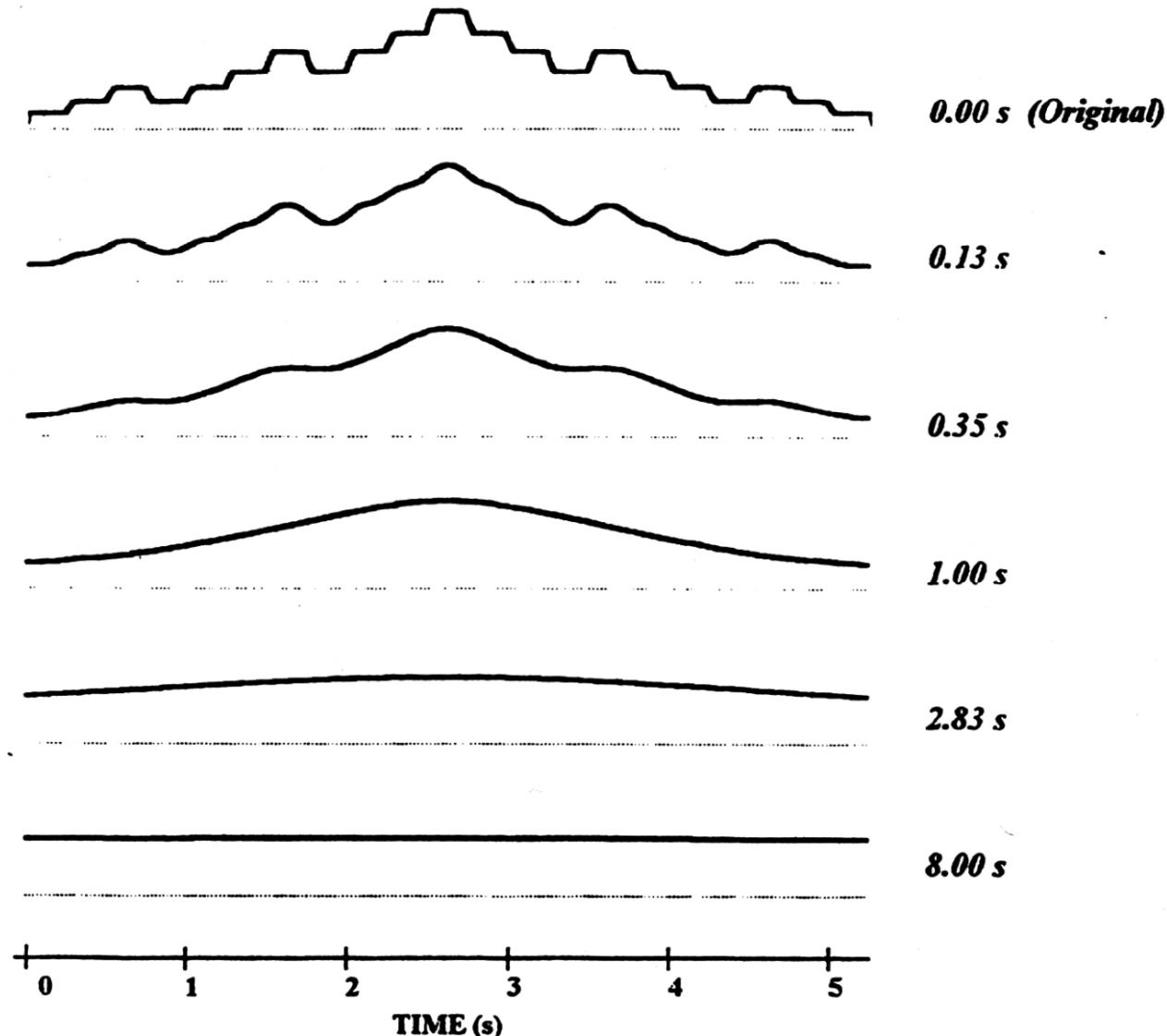


Fig. 5: The effect of smoothing. The original curve is similar to the loudness curve of [former figure] (merely the gaps between the onsets are filled). Smoothing with a window size of 1.00 seconds leads to a curve showing purely the one wide arc of the original. Smoothing with a window size greater than the duration of the example results in a horizontal line representing the mean value of the whole curve. (J. Langner, 1997, op. cit. p. 713-718)

Dynagram of a Professional Drum Performance



Dynagram of a Non-Professional Drum Performance

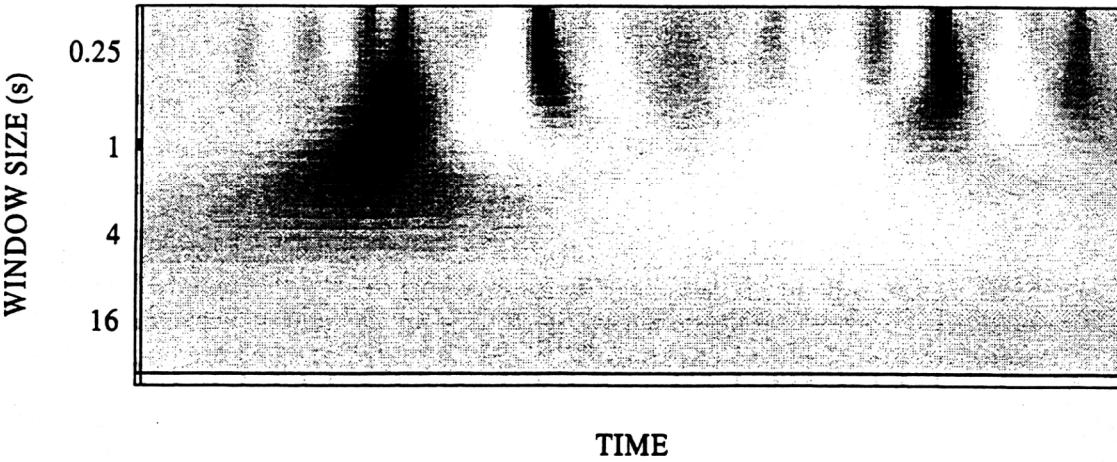


Fig. 6: Dynagrams of a professional and a non-professional drum performance of the rhythm notated [in the former figure] (dark shading: crescendo; middle gray: constant loudness; light shading: decrescendo). We can see the traces of the stronger and more extensive dynamic shaping of the professional. Note that the horizontal axis in these figures show no markings for the timeunit (seconds) but for the onsets of the notes. (J. Langner, 1997, op. cit. p. 713-718

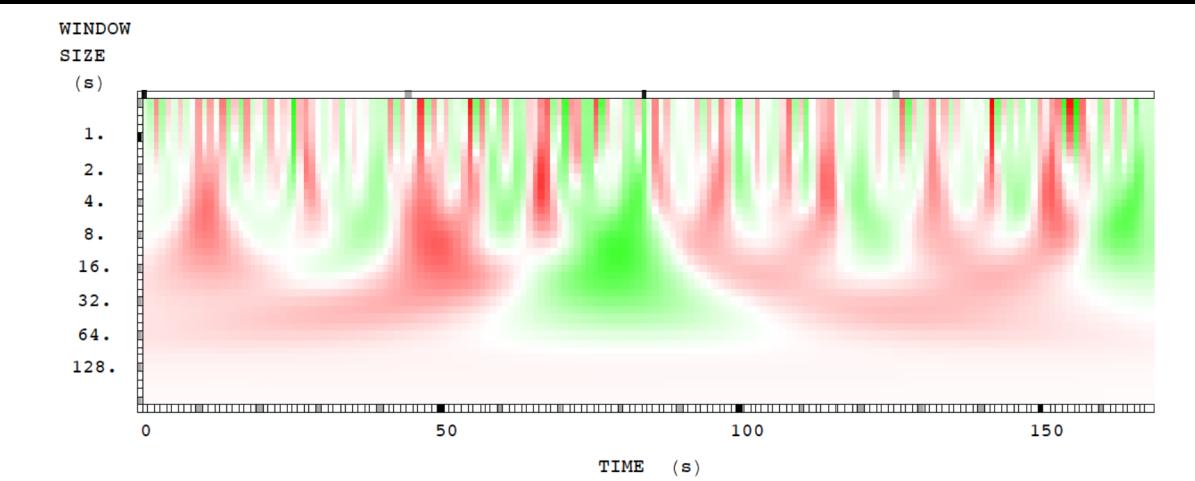


Fig. 1: Dynagram of a professional performance of Erik Satie's *Gymnopédie No.1*. The different colours have the following meaning: intense red = strong crescendo, pale red = weak crescendo, white = constant loudness, pale green = weak decrescendo, intense green = strong decrescendo. The dynamic shaping reflects clearly the formal structure of the composition (the formal breaks are marked in the upper horizontal frame).

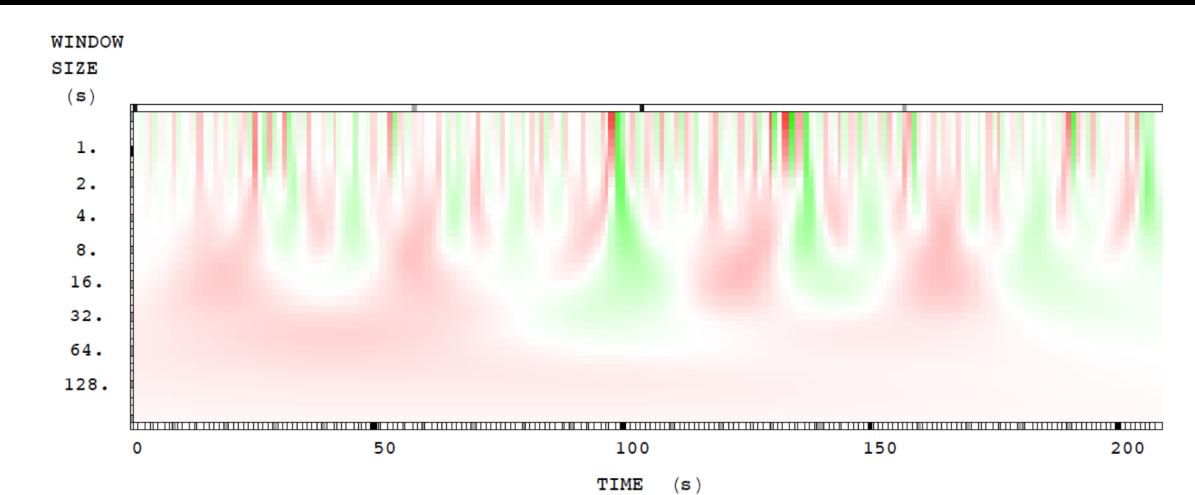


Fig. 2: Dynagram of a non-professional performance of Erik Satie's *Gymnopédie No.1*. The dynamic shaping is not as strong as in the professional performance and reflects the formal structure of the composition less clearly.

5. Vers une représentation continue ?



http://imtr.ircam.fr/imtr/Audio_Oracle

Audio Oracle:

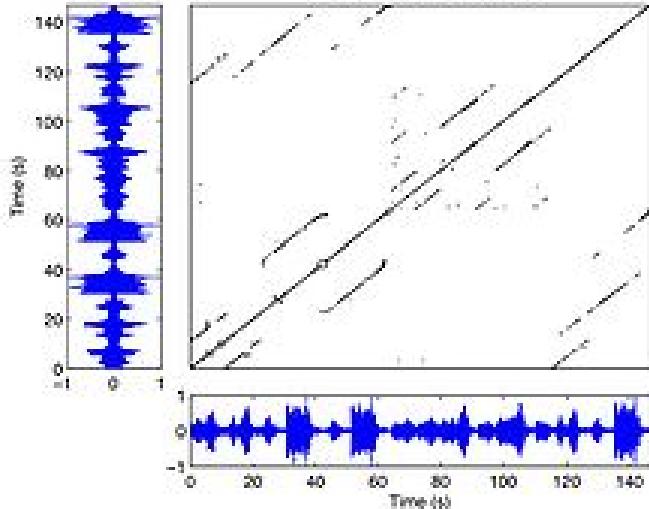
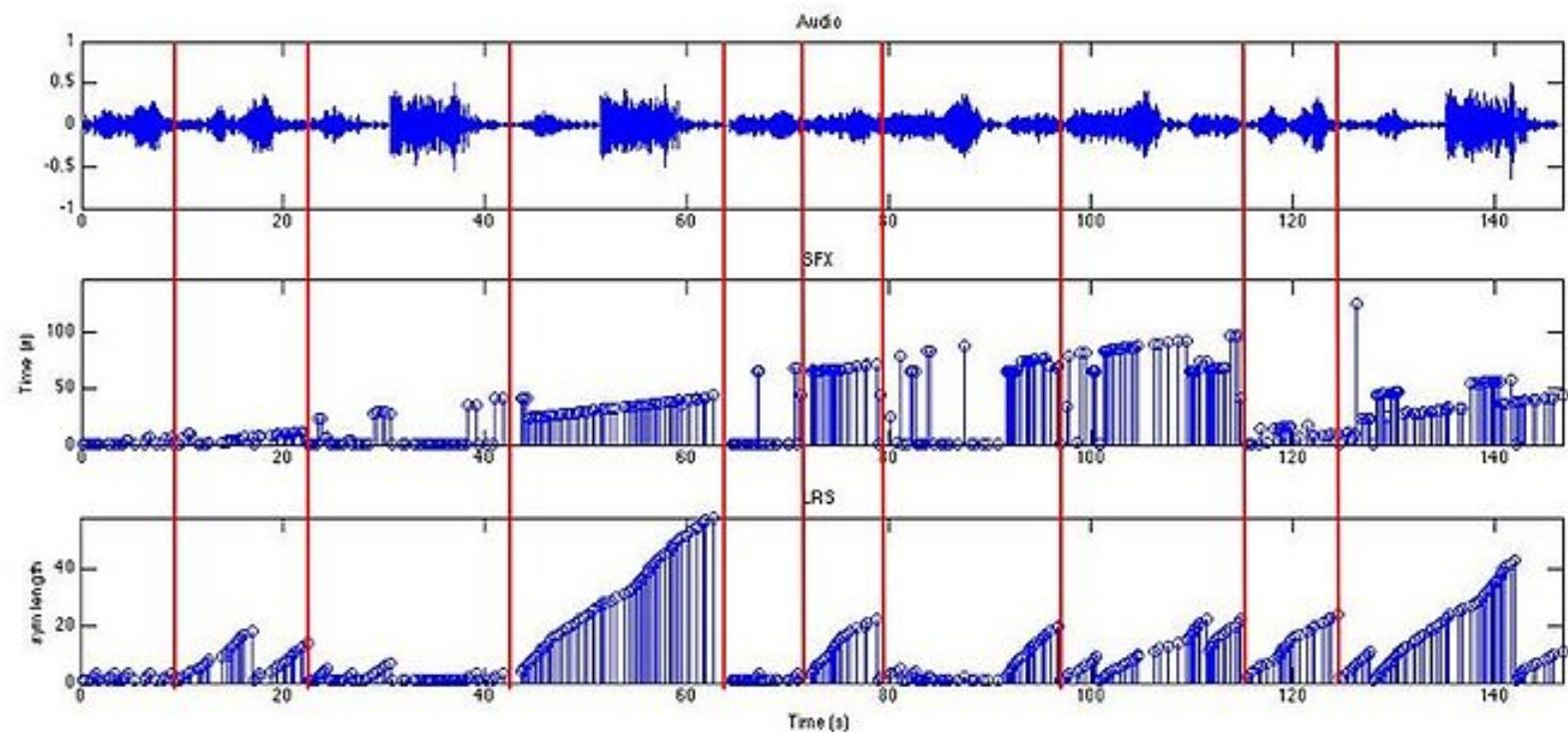
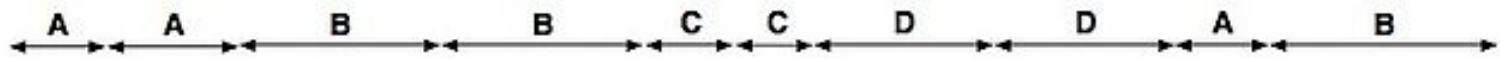
Provides a unified approach to segmentation and structure analysis of audio signals

Has well grounded geometric motivation thanks to Music Information Geometry

Links symbolic string matching techniques (Factor Oracles) with probabilistic / information theoretic approaches

Provides robust and fast structure discovery (realtime) and without exhaustive computations as is the case in general Music Information Retrieval

Provides direct and fast access to sub-structures of interest in audio.



Audio Description: Beethoven's 1st Piano Sonata, Movement 3, Performed by Friedrich Gulda (1950s) (same piece difference performance on youtube).

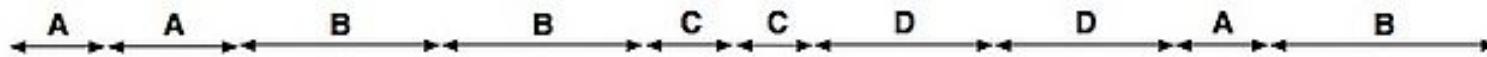
Style: Classical.

Instrumentation: Piano

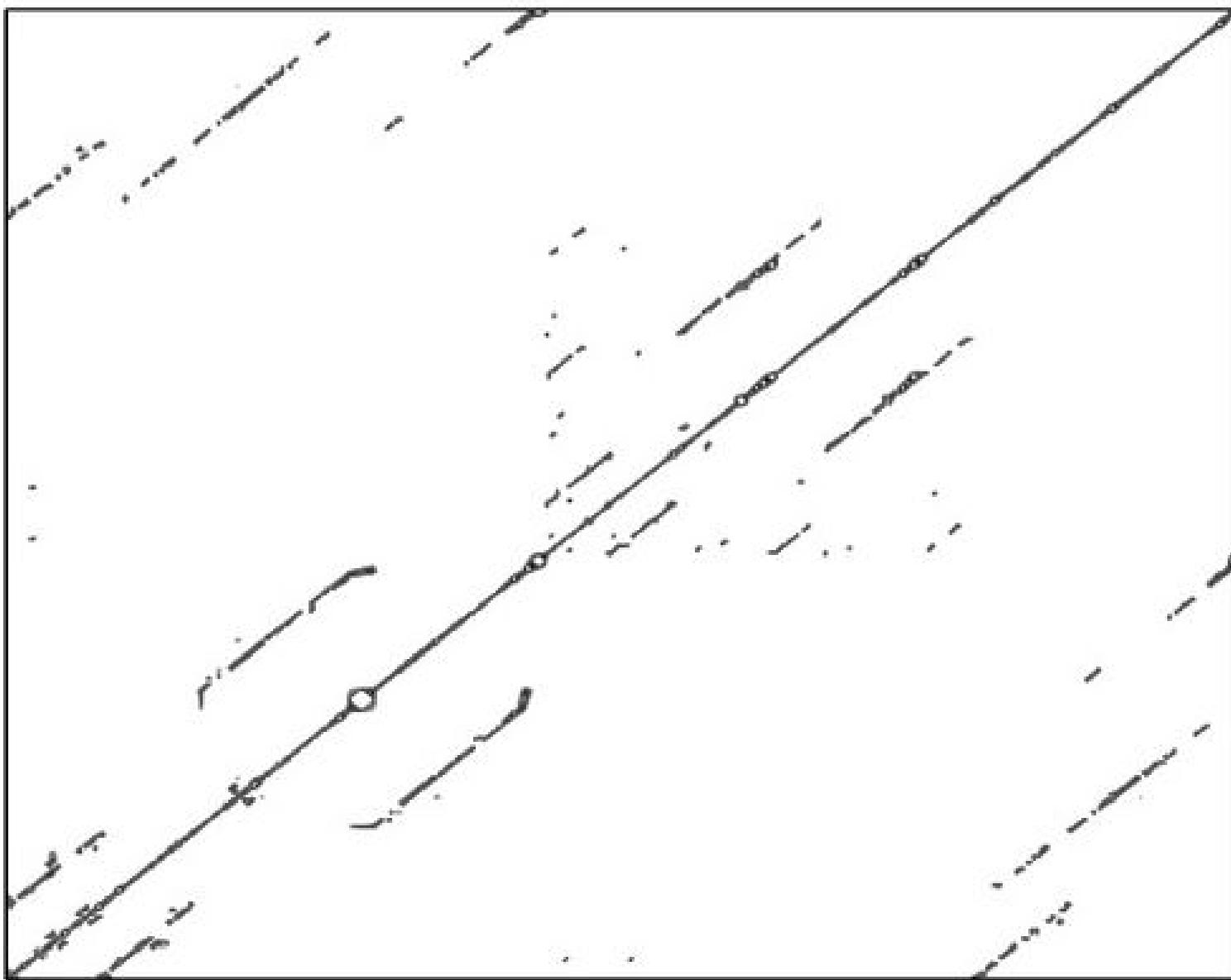
Number of Analysis Frames: 9500

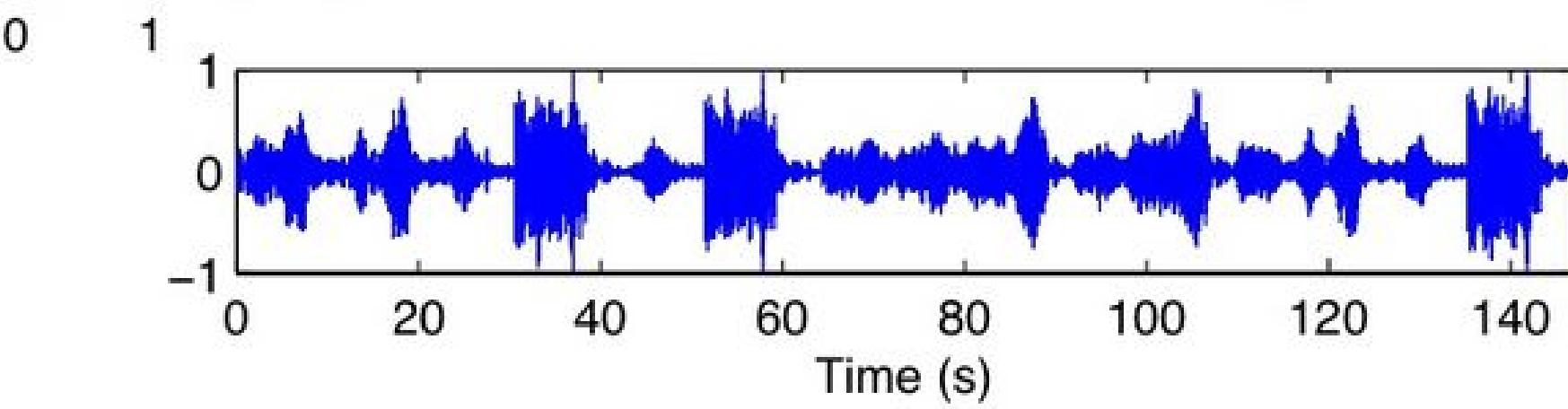
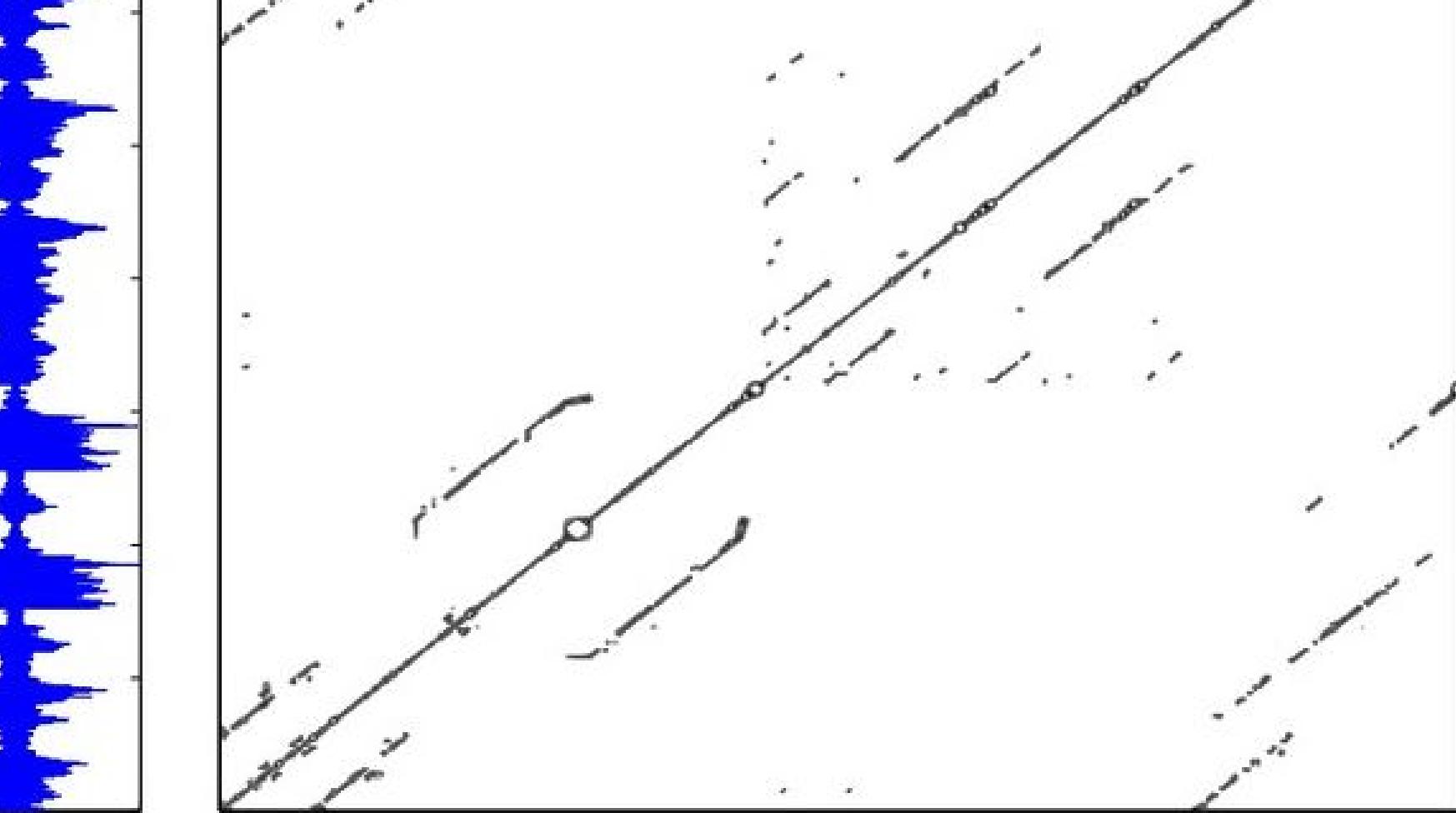
Number of states in Audio Oracle: 440

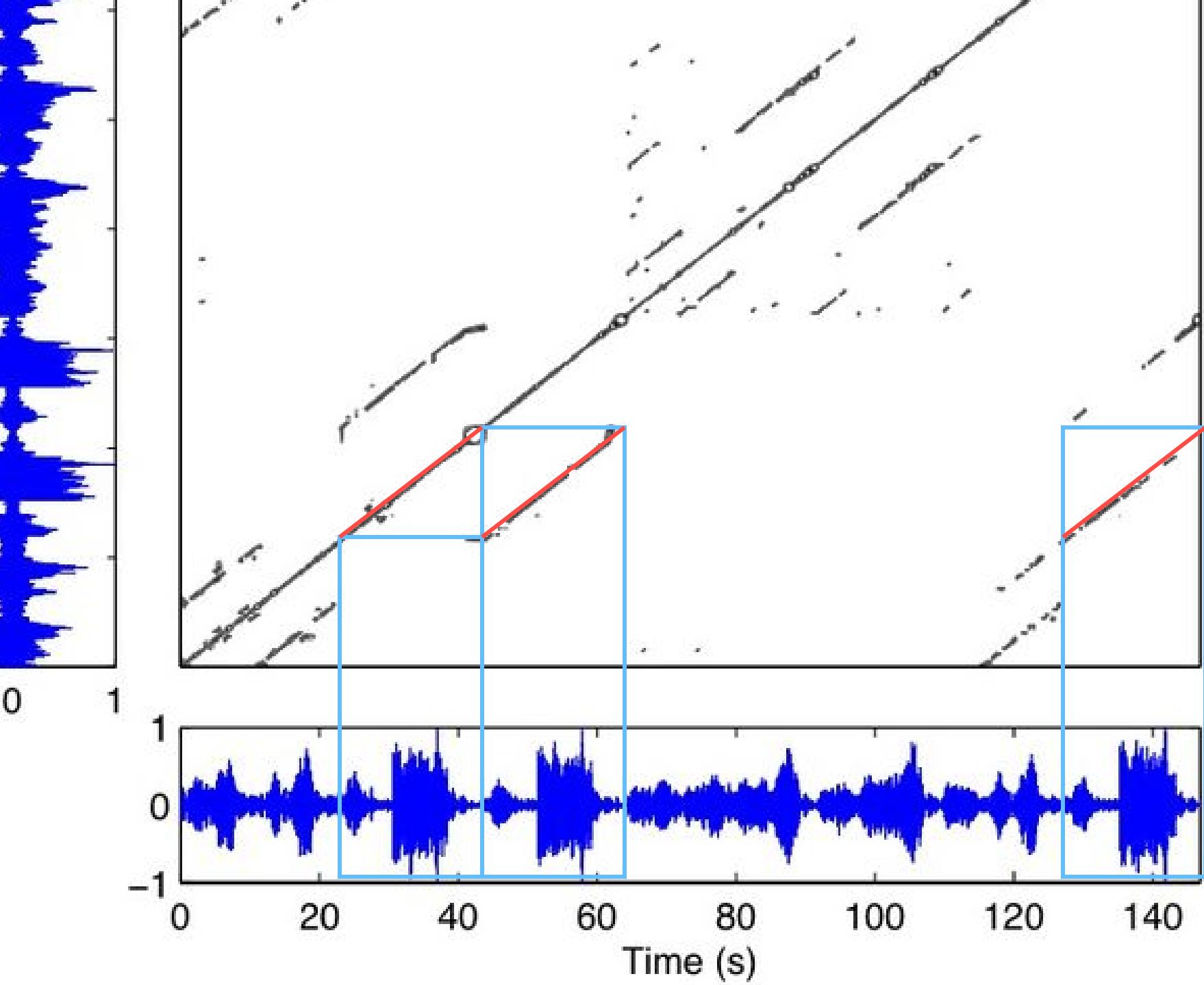
Notes: The similarity structure learned by AO (left) is similar to the classical similarity matrix (right). Except that it is much sparser, calculated in realtime and directly giving access to structural information in audio

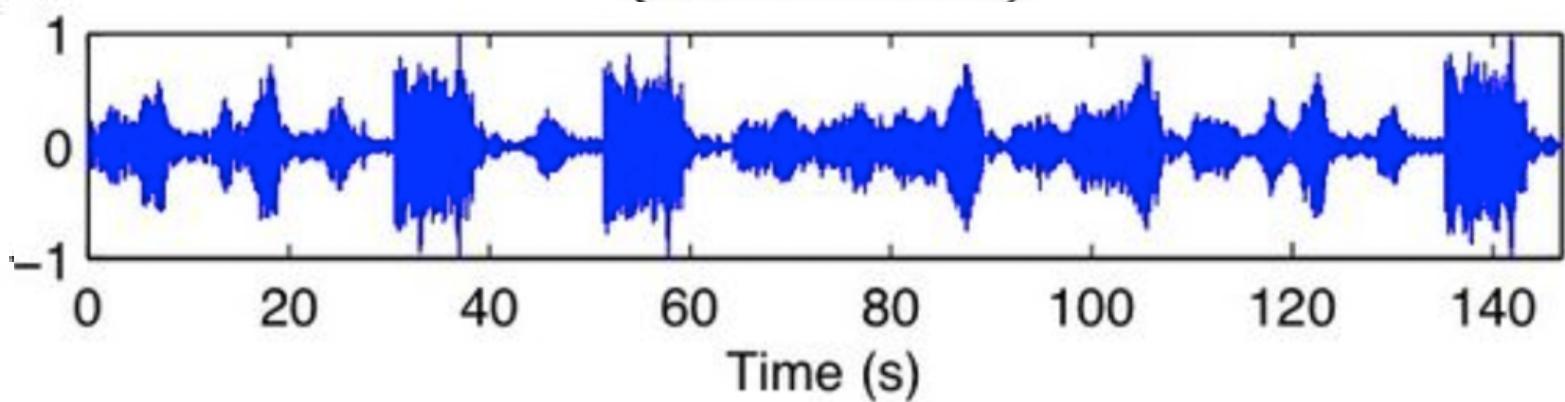
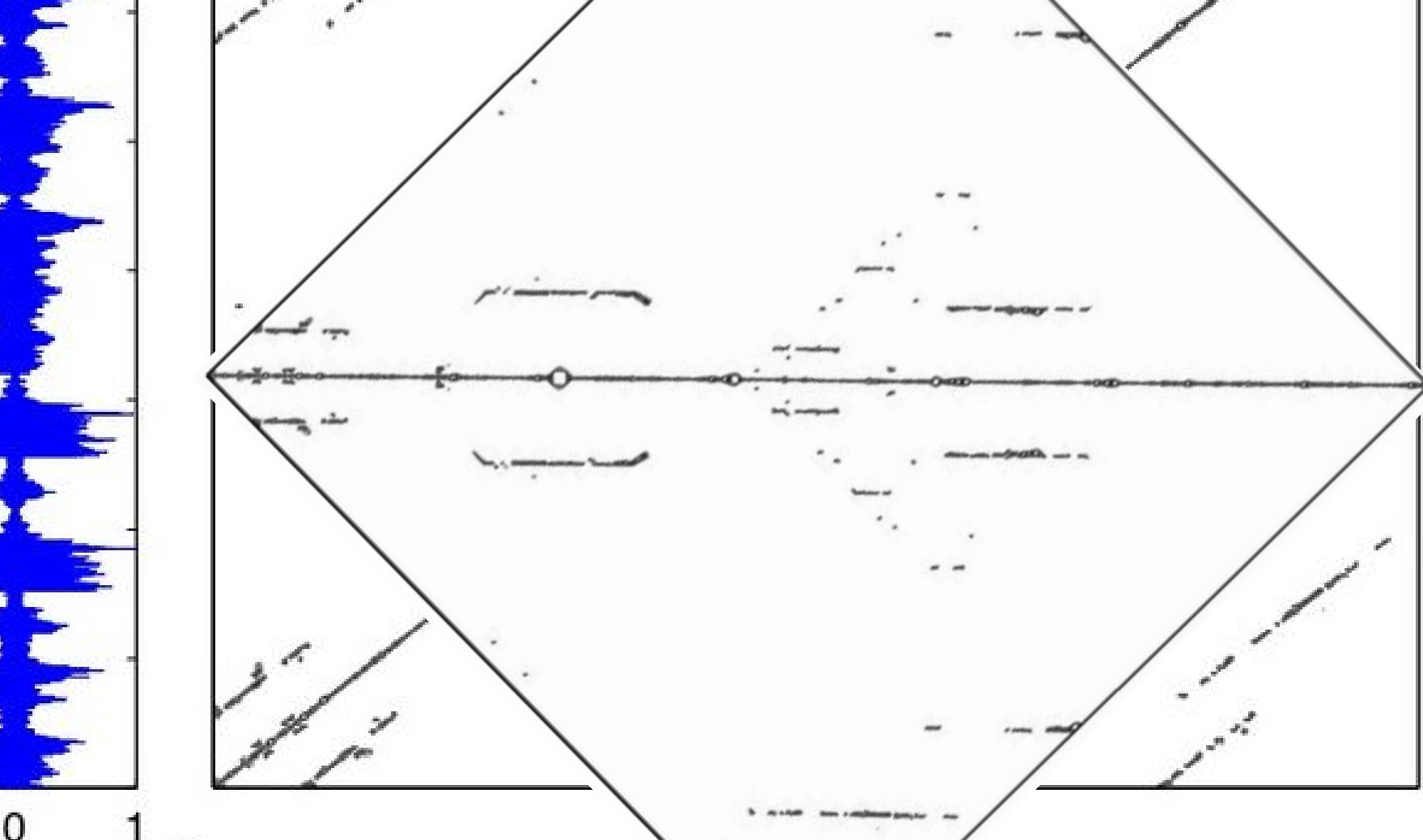


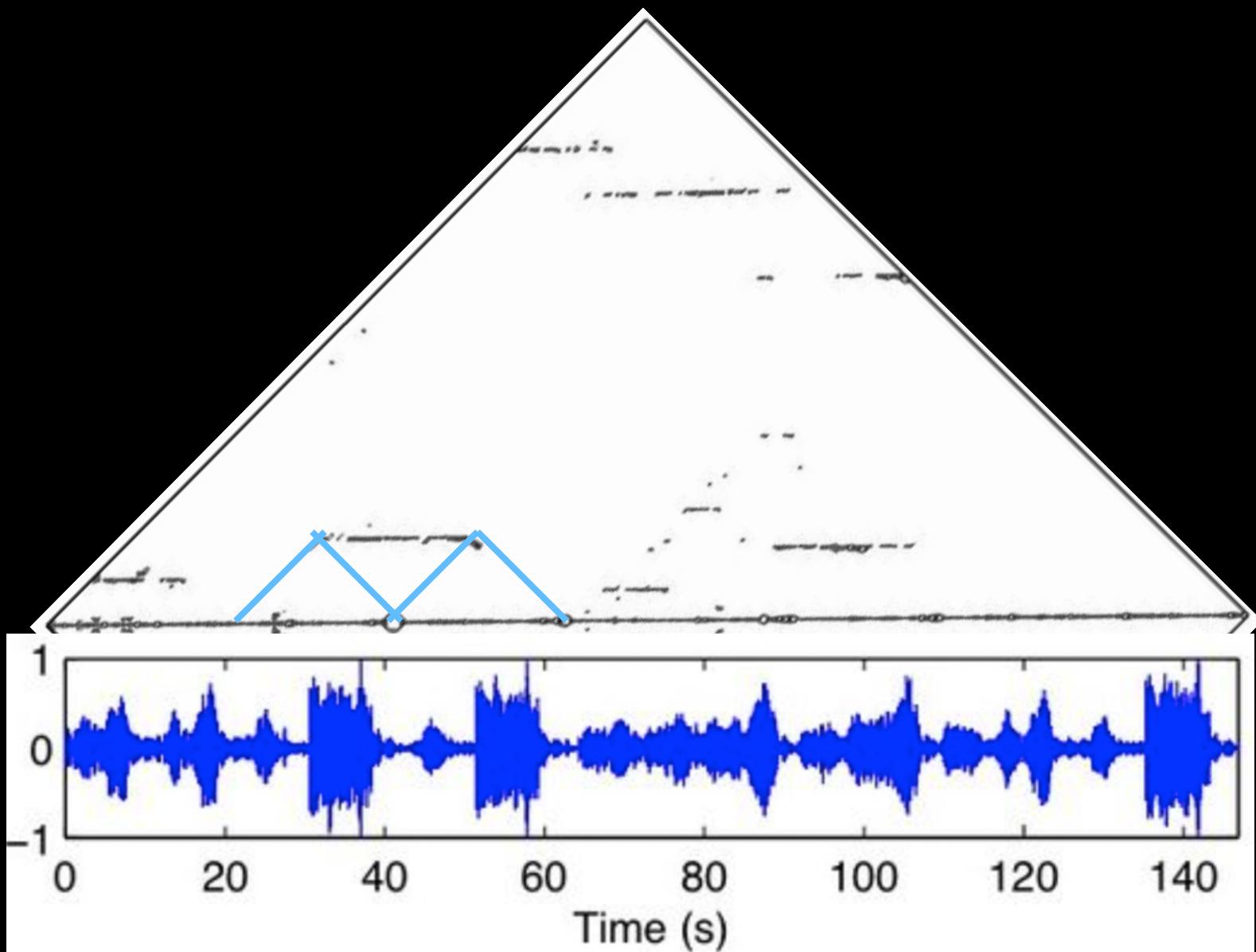
Audio Oracle Similarity Matrix





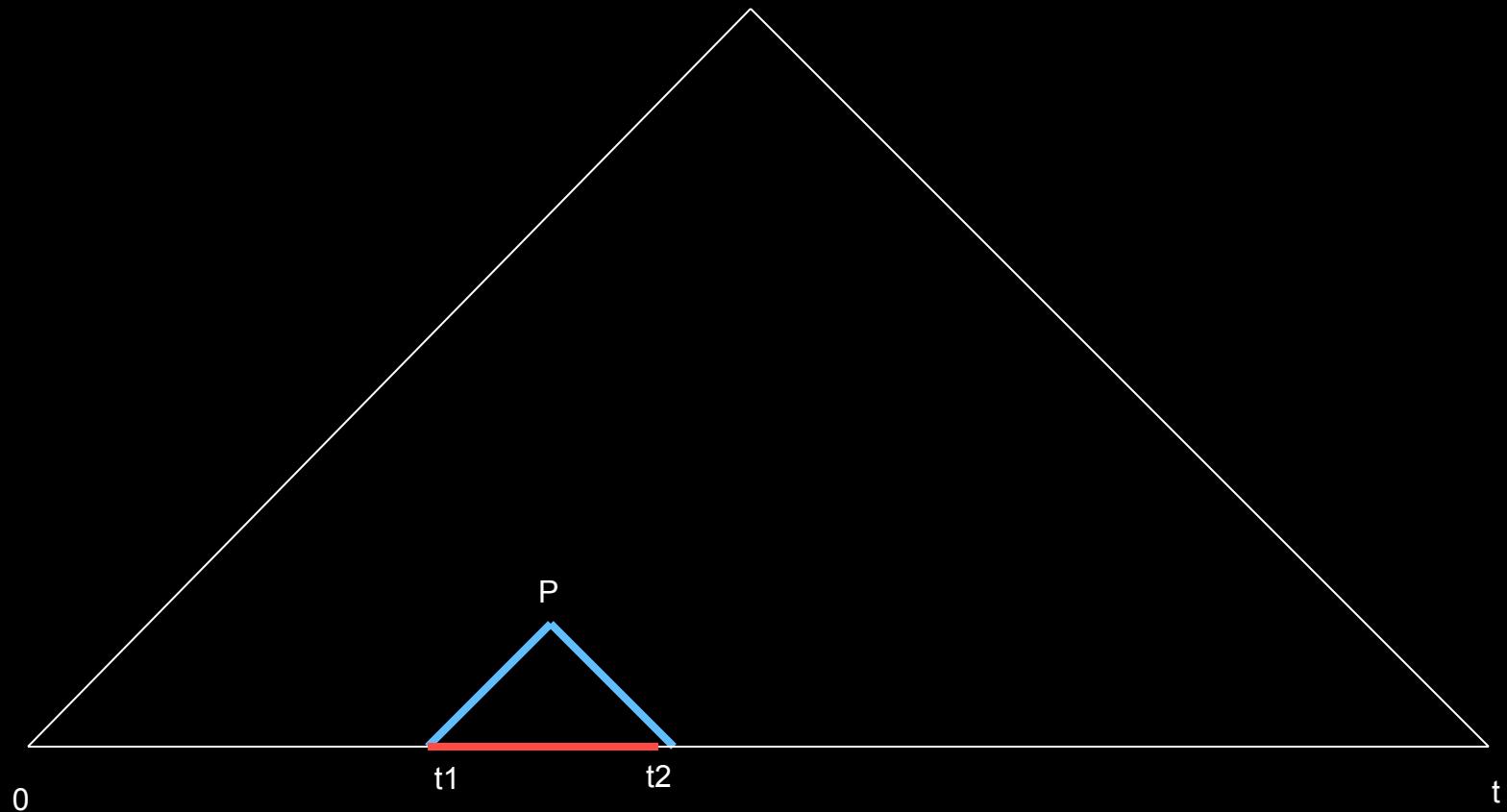






Un point P de la représentation \Leftrightarrow un segment $S = [t_1, t_2]$

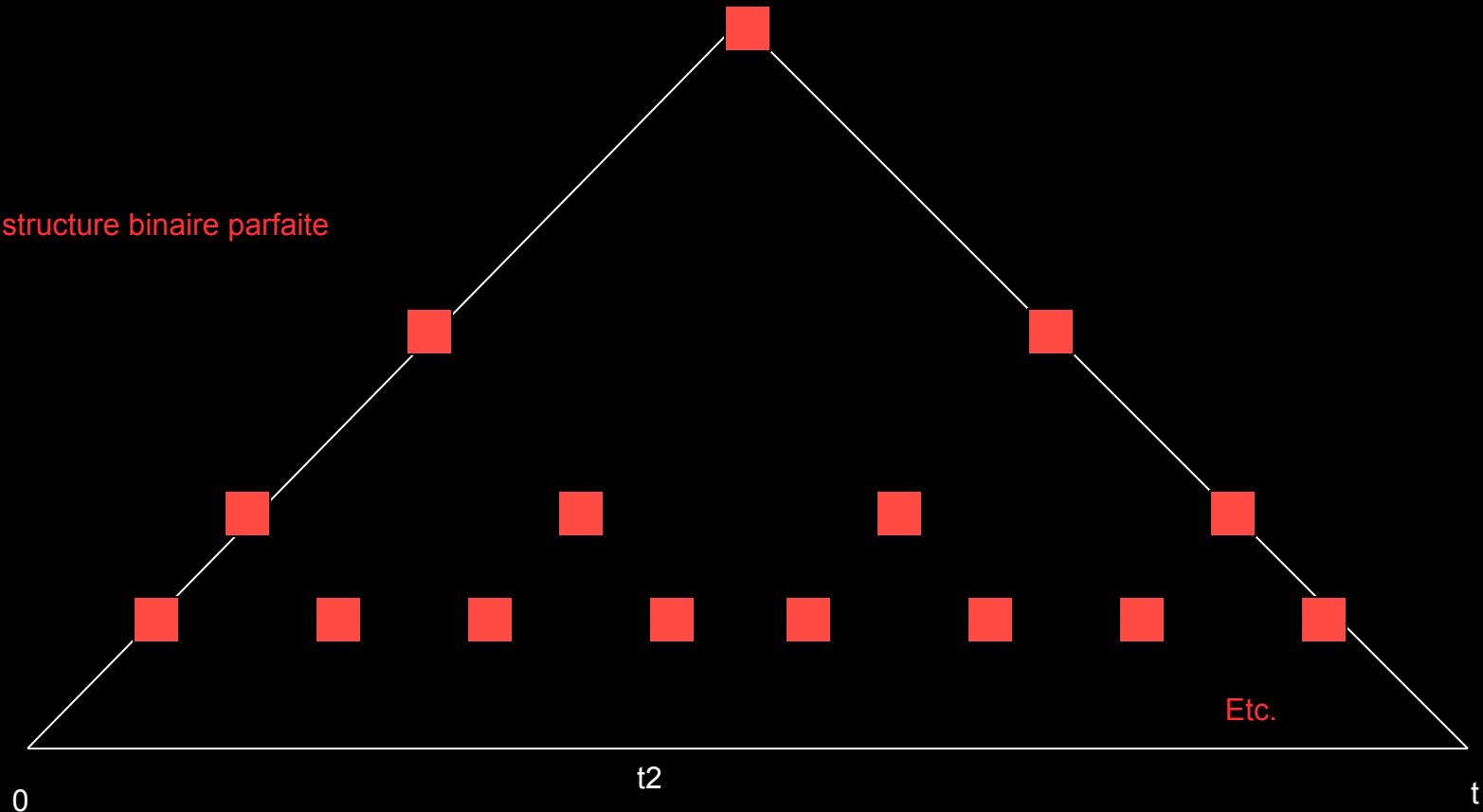
Z = probabilité pour que S soit un segment complet (groupement)



Un point P de la représentation \Leftrightarrow un segment $S = [t_1, t_2]$

Z = probabilité pour que S soit un segment complet (groupement)

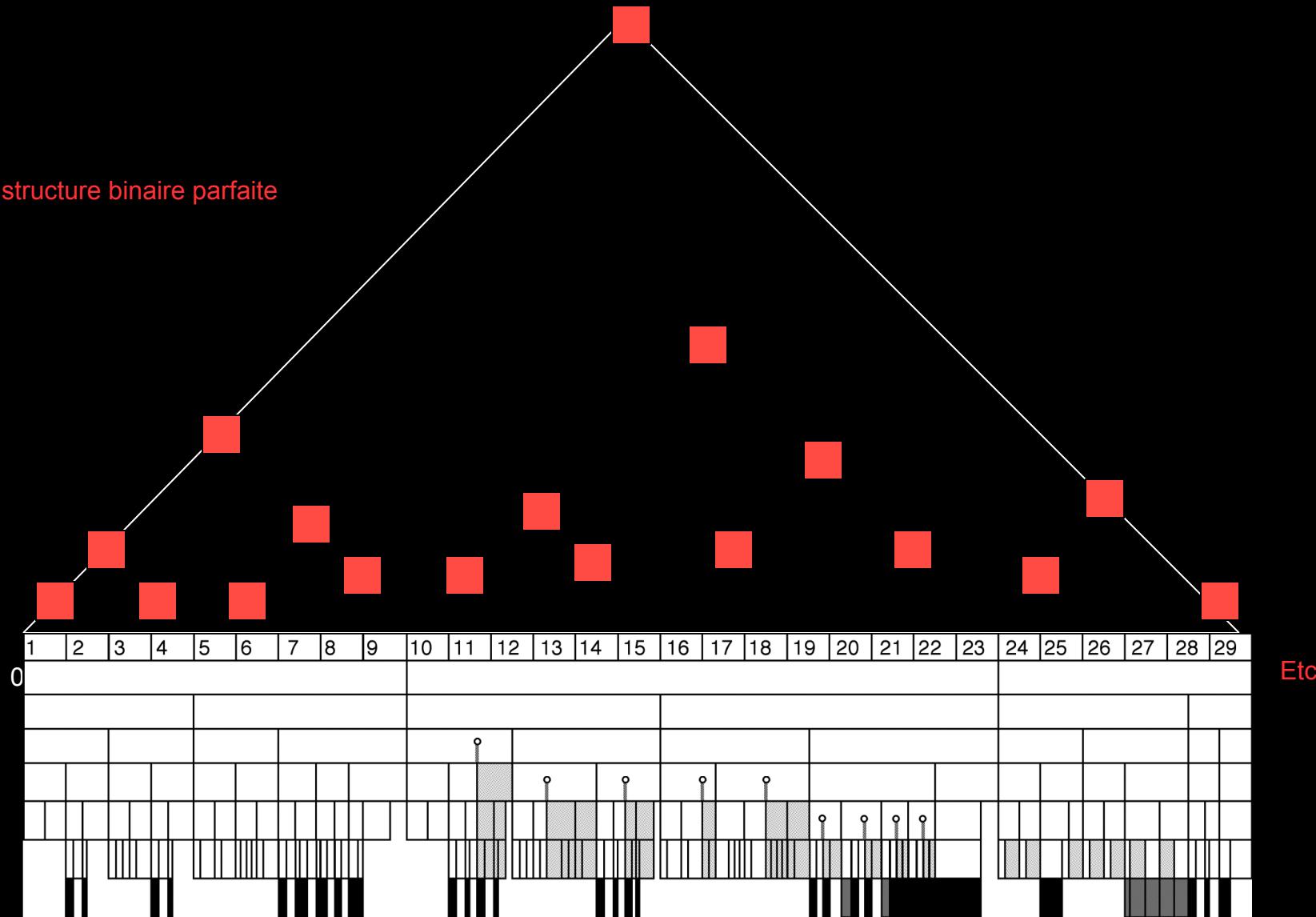
Exemple structure binaire parfaite



Un point P de la représentation \Leftrightarrow un segment $S = [t_1, t_2]$

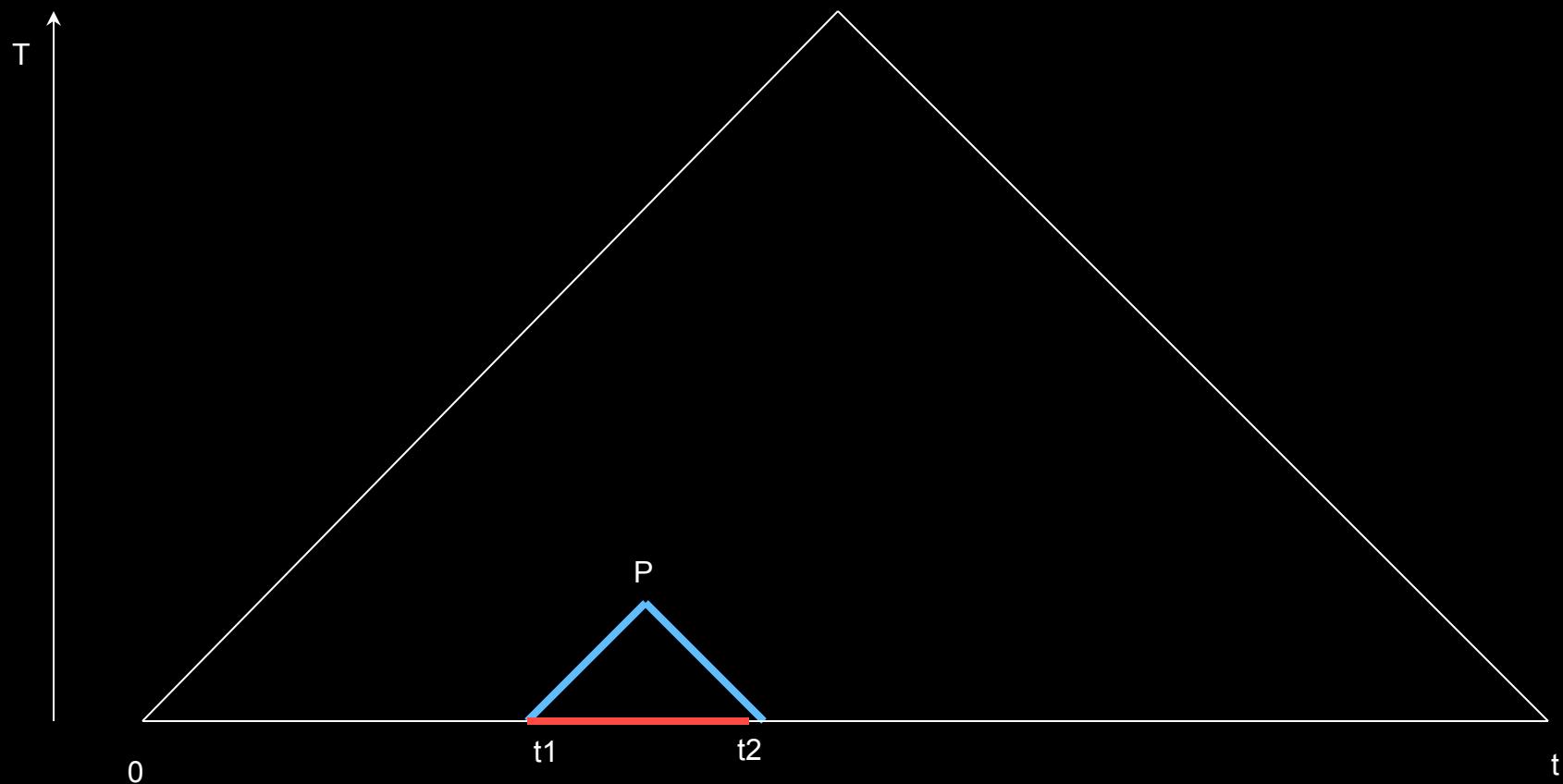
Z = probabilité pour que S soit un segment complet (groupement)

Exemple structure binaire parfaite



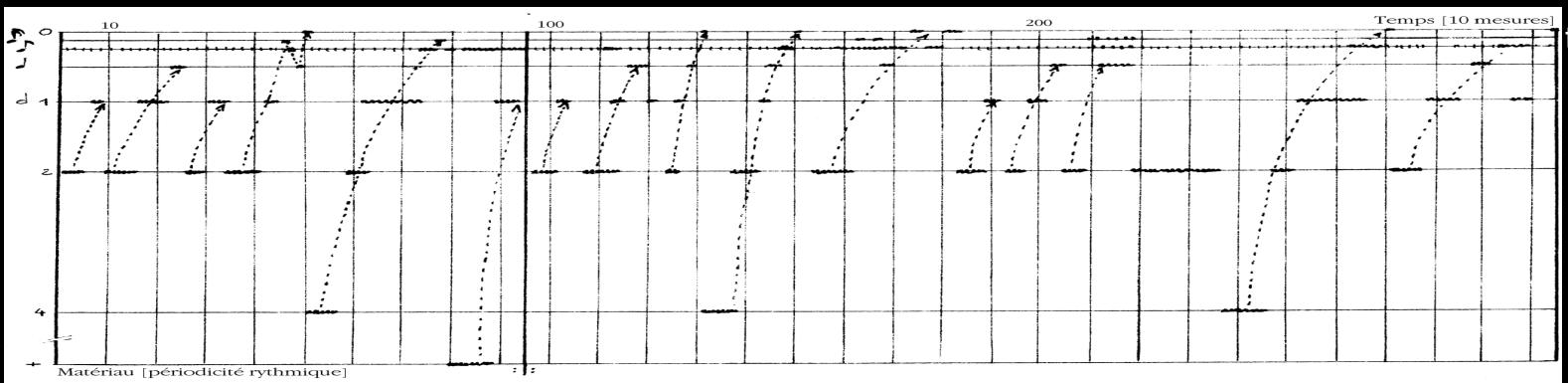
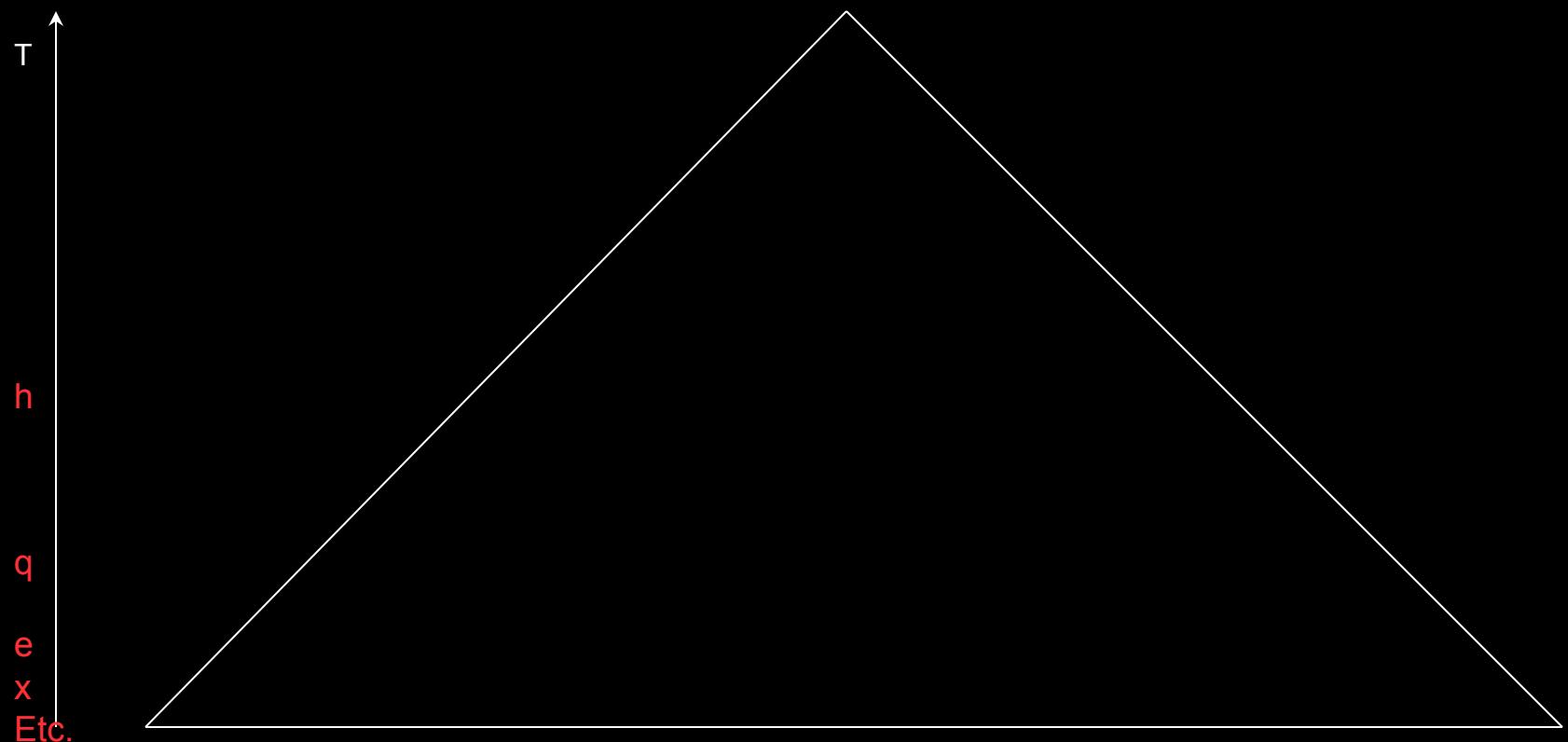
Un point P de la représentation \Leftrightarrow la musique se reproduit à une période $T = t_2 - t_1$

Z = saillance de l' énoncé de la périodicité T



Un point P de la représentation \Leftrightarrow la musique se reproduit à une période $T = t_2 - t_1$

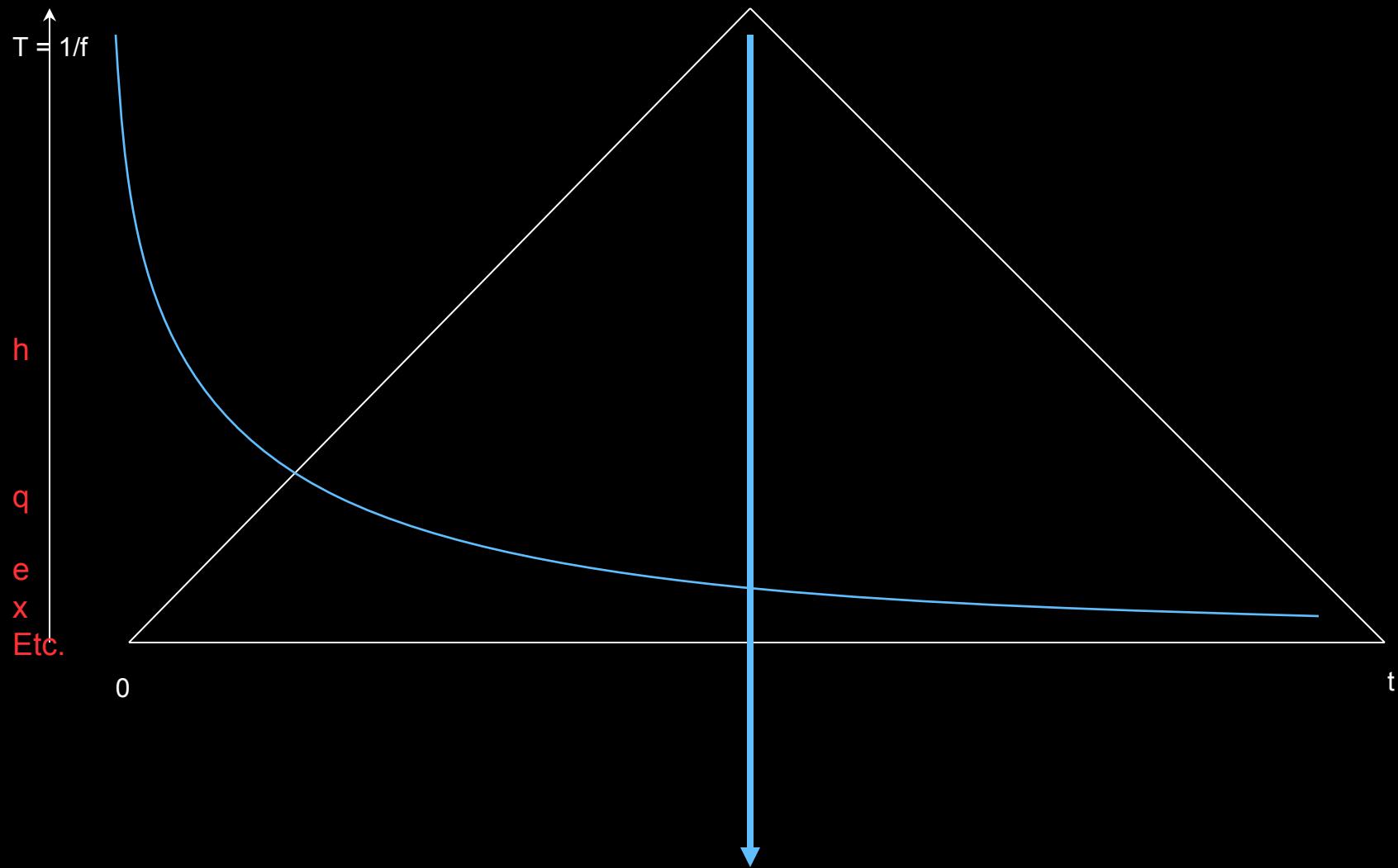
Z = saillance de l' énoncé de la périodicité T



Un point P de la représentation \Leftrightarrow la musique se reproduit à une période $T = t_2 - t_1$

Z = saillance de l' énoncé de la périodicité T

$$T_0 = 1/f_0$$



6. Continuité du concept ou *gap* structurel ?

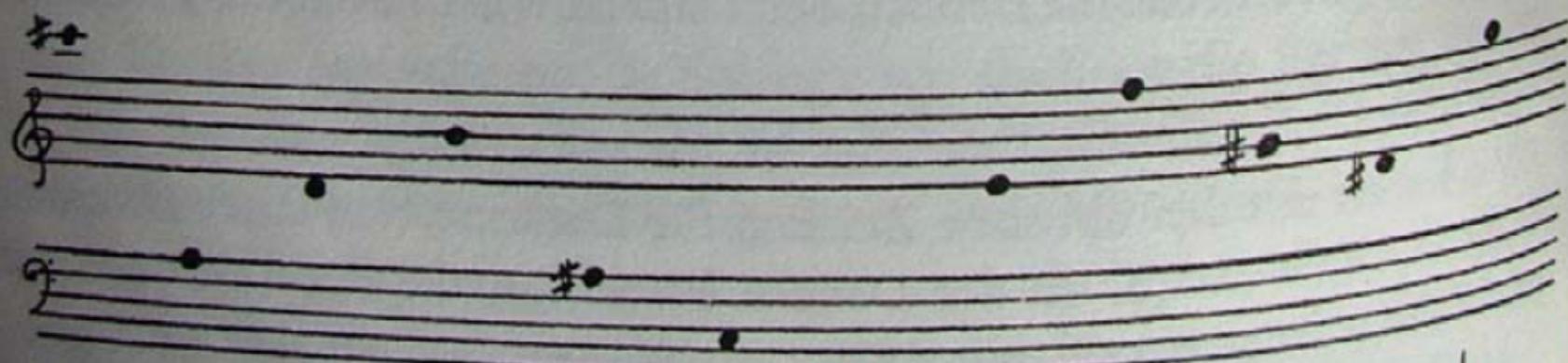
bei 1000

5,7	5,7	5,7	- 5
6,35	(4) $\sqrt[3]{\frac{2}{3}}$	6,55 (3) $\sqrt[3]{\frac{2}{3}}$	(2) $\sqrt[3]{\frac{2}{3}}$
7	7,5	7	(1) $\sqrt[3]{\frac{2}{3}}$
7,75			
8,6	8,6	8,6	8,6
	9,85	10,5	
	11,25		
	13	13	13
	14,75	15,75	
			250

8 Sek. 4 Sek. 2 Sek. 1 Sek. $\frac{1}{2}$ Sek. $\frac{1}{4}$ Sek. $\frac{1}{8}$ Sek. $\frac{1}{16}$ Sek.



Beispiel 7



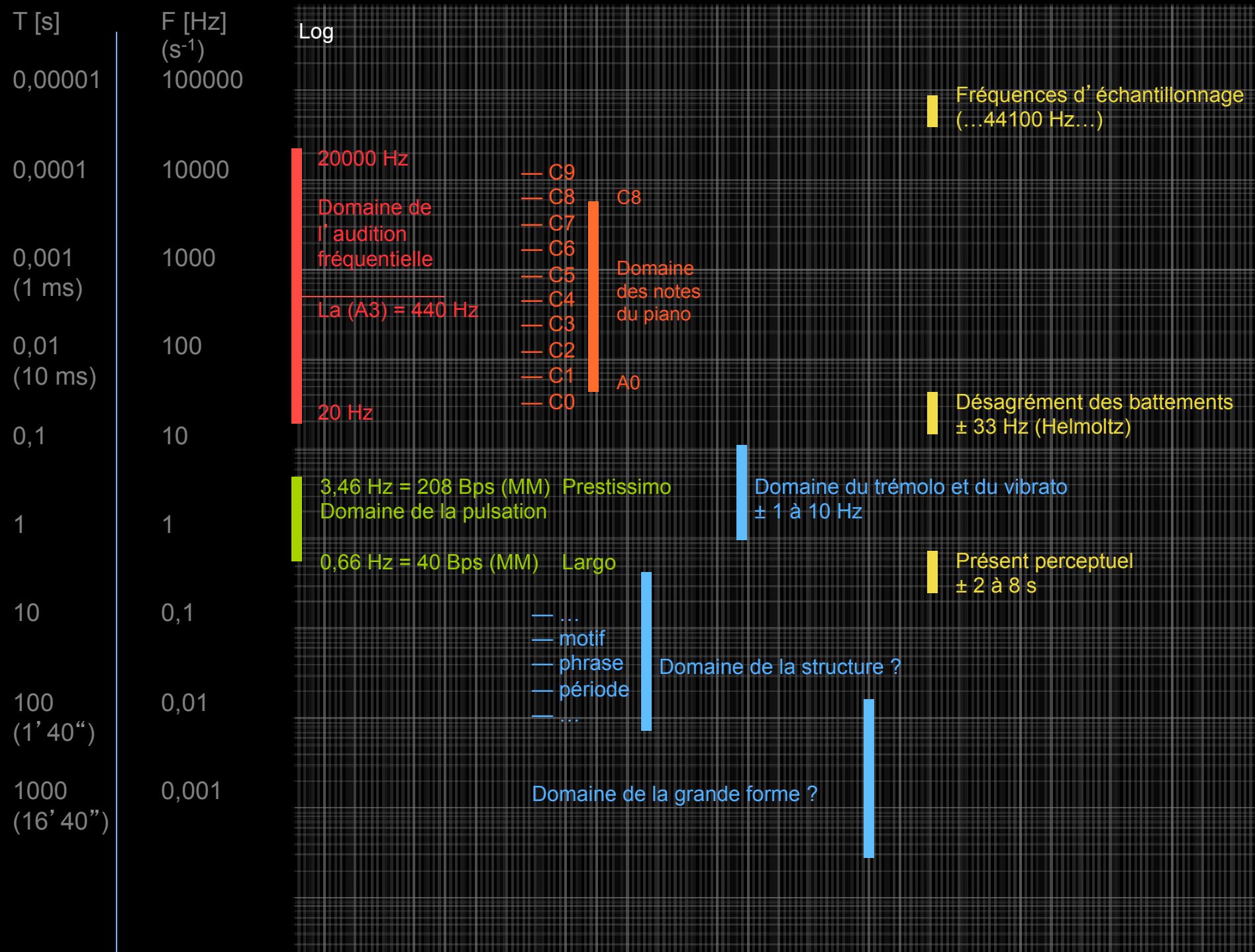
MM	$d =$	75,6	60	80,1	67,4	63,6	71,4	#	100,9	89,9	95,2	113,3	84,9	106,9
Einheit:		\downarrow	0	0	\downarrow	0	$=$	$=$	0	\downarrow	0	0	0	d

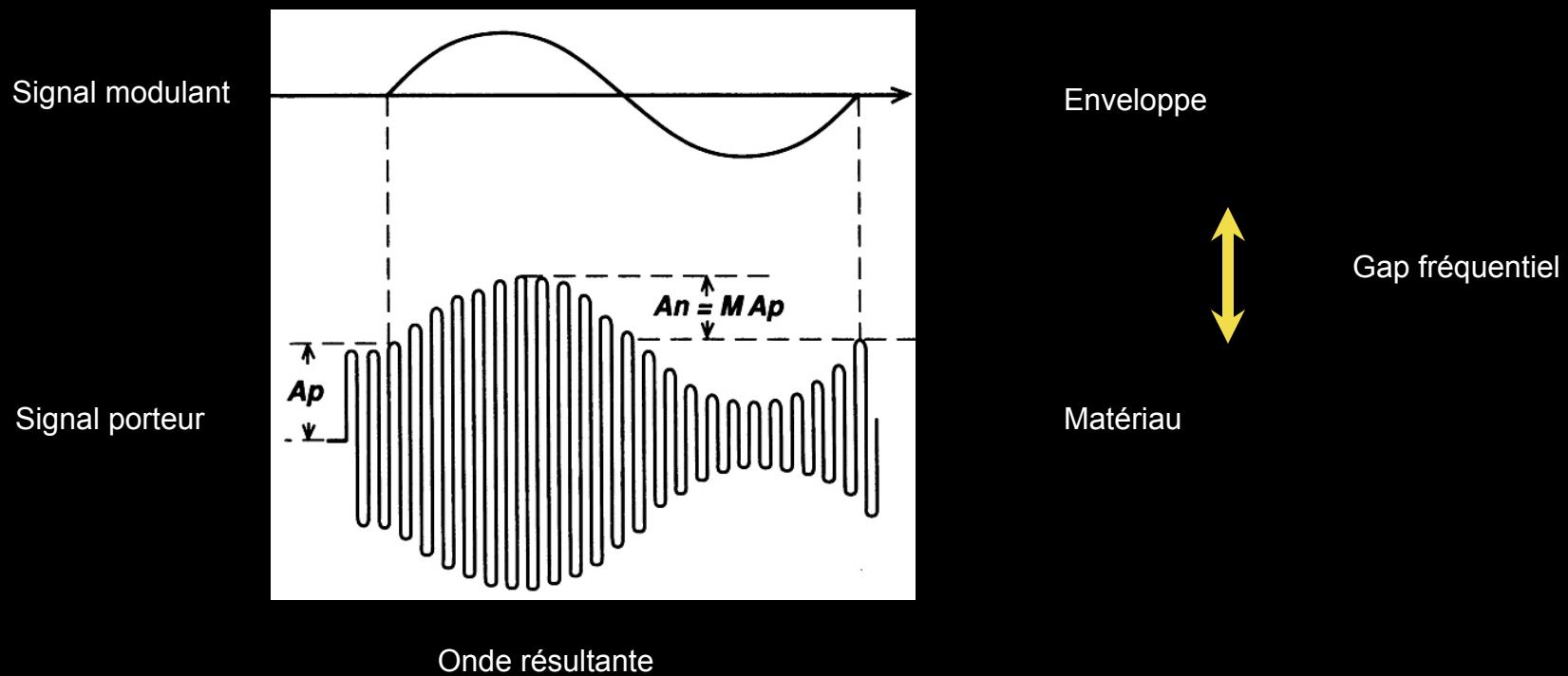
Beispiel 9

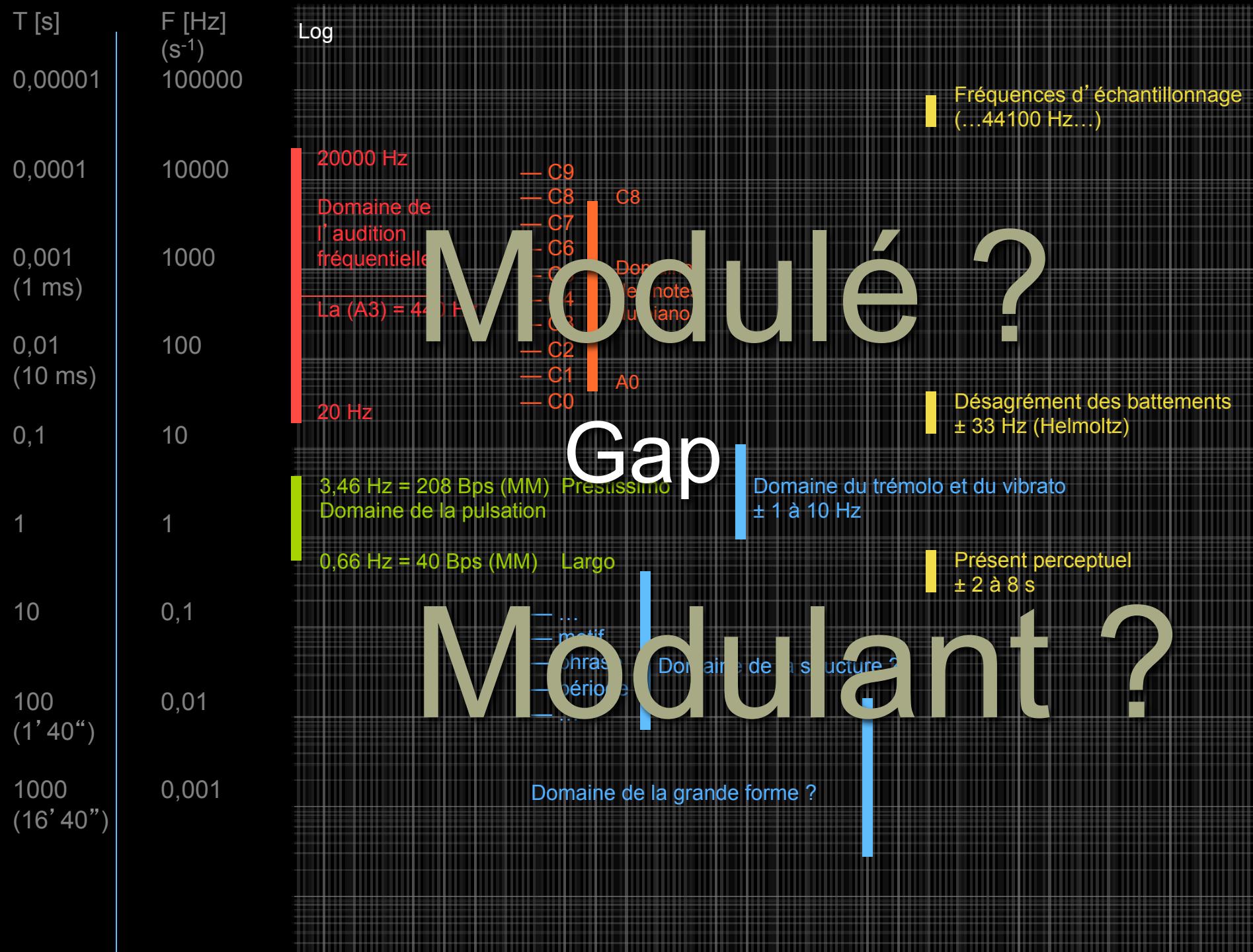
Table 1 Summary of structural levels in musical time, and their cognitive/perceptual properties.

<i>Level of Temporal Structure</i>	<i>Cognitive Representation</i>
1. Low-level: Expression.	<p><i>Perceptually represented</i> as departures from canonical proportional values; poorly quantified, and experienced as expressive rather than durational effects.</p> <p><i>In performance</i>, represented as programmed variations in the rate of the clock controlling beat duration (see level 2), and as modifications of the procedures specifying individual notes (see level 2).</p>
2. Middle-level: Rhythm and meter.	<p><i>Perceptually represented</i> as a collection of grouped durational equalities and inequalities organized around a metrical framework (when the music has a meter).</p> <p><i>In performance</i>, represented as a collection of untimed procedures, organized around metrical markers which are directly timed by a programmable clock.</p>
3. High-level: Form.	<p><i>Perceptually represented</i> as a structure of hierarchical relations, constructed by means of memory processes and perception, and distinguished from level 2 structures by exceeding the length of the perceptual present.</p> <p><i>In performance</i>, represented as a hierarchical memory structure that forms the highest levels of a motor program.</p>

Lalitte P. (2006).
Implications compositionnelles et perceptives des échelles temporelles locales et globales.
In Lalitte P. (Eds.), Le rythme (pp. 23-34). Paris: Observatoire Musical Français.



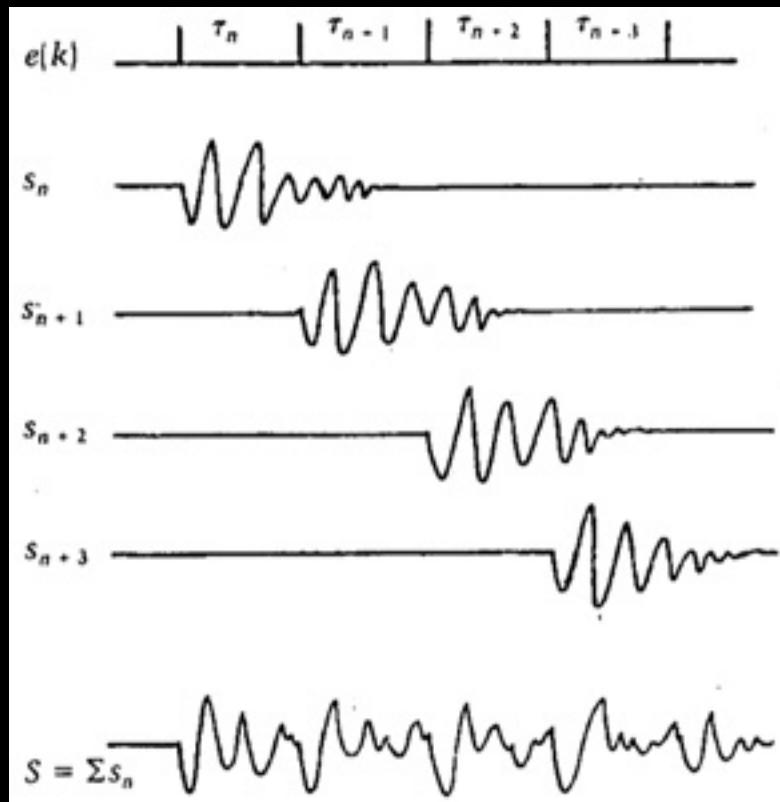




CHANT - de la synthèse de la voix chantée à la synthèse en général

Xavier Rodet, Yves Potard, Jean-Baptiste Barrière

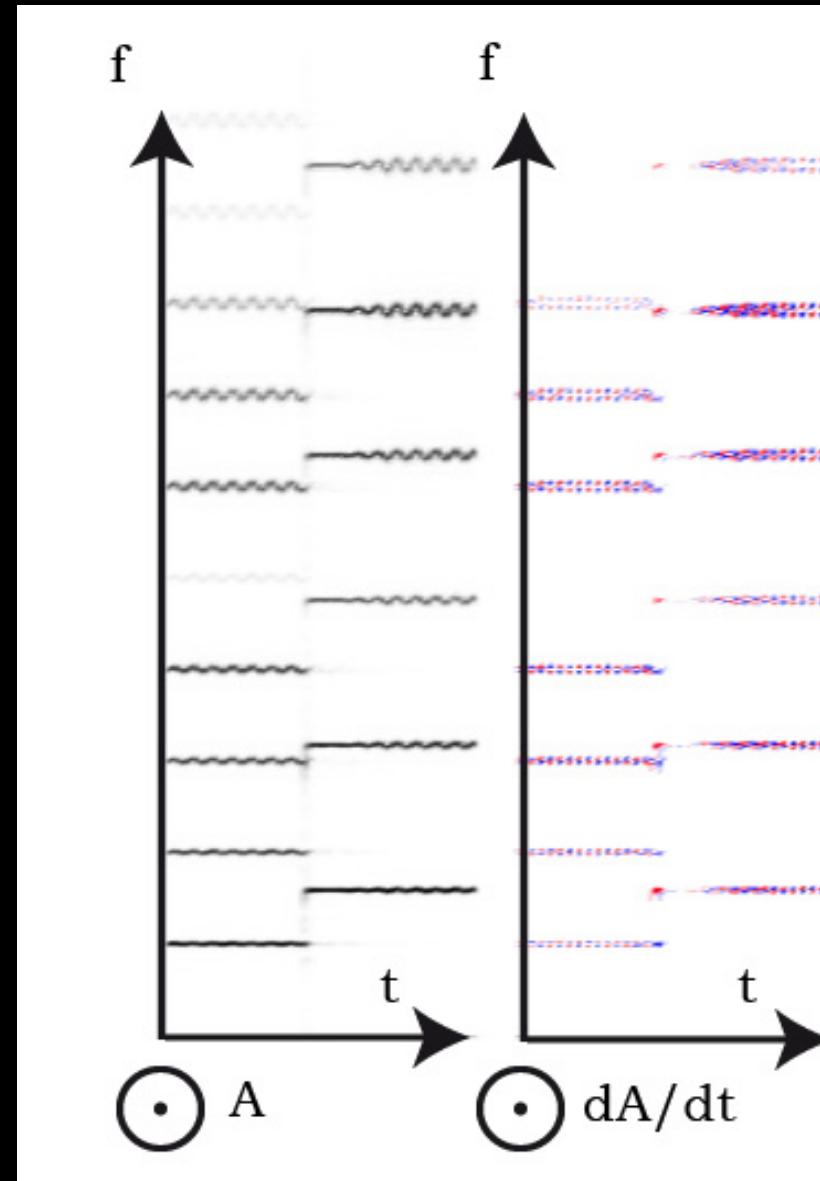
Rapport Ircam 35/85, 1985



$$S(k) = \sum_{i=1}^m s_{n,i}(k)$$

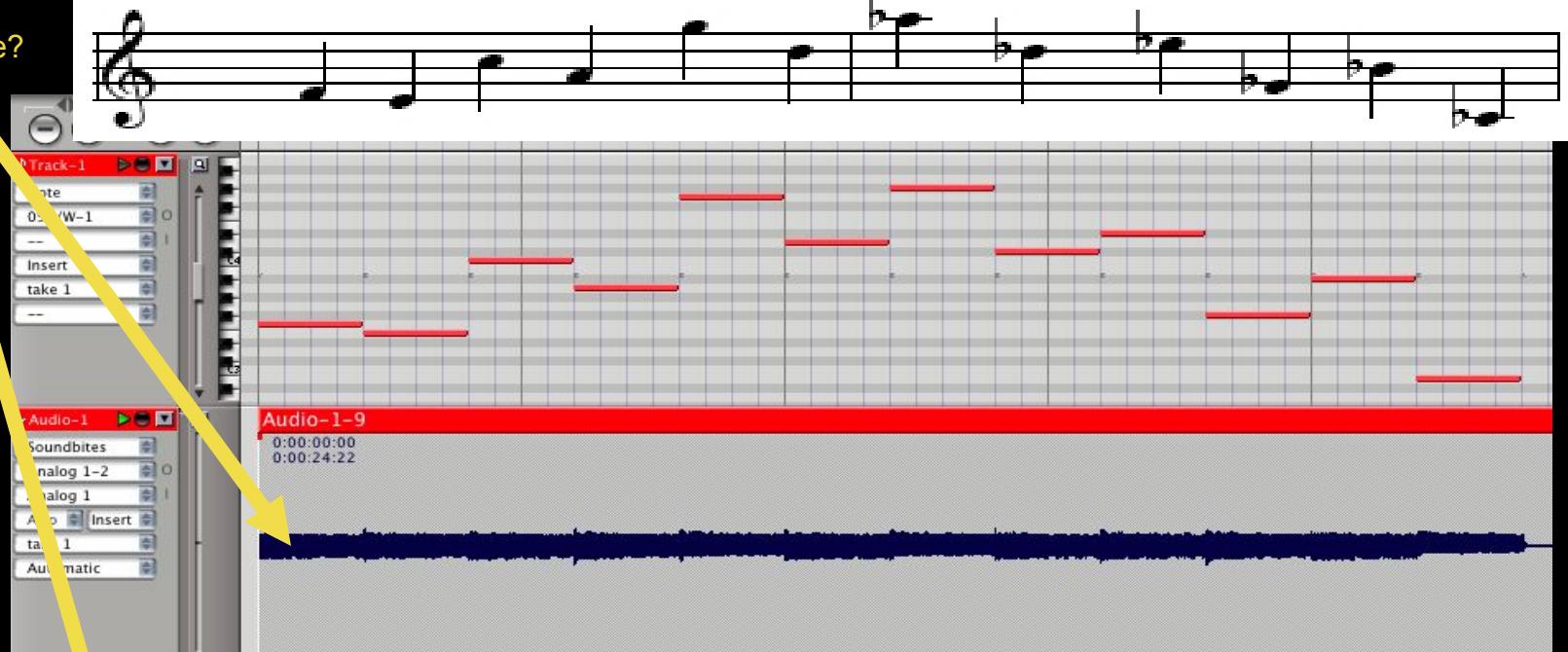
Construction de la réponse S comme somme des réponses S_n , où les $s_{n,i}(k)$ sont appelés fonctions d'onde formantiques (FOF) car elles correspondent en général aux formants ou modes de résonance principaux du système.

L'analyse musicale différentielle : principes, représentation et application à l'analyse de l'interprétation
Jean-Marc Chouvel
(Université de Reims -
CRLM - IDEAT UMR8153)
Jean Bresson (Ircam-
CNRS UMR 9912) Carlos
Agon (Ircam-CNRS UMR
9912) EMS Network

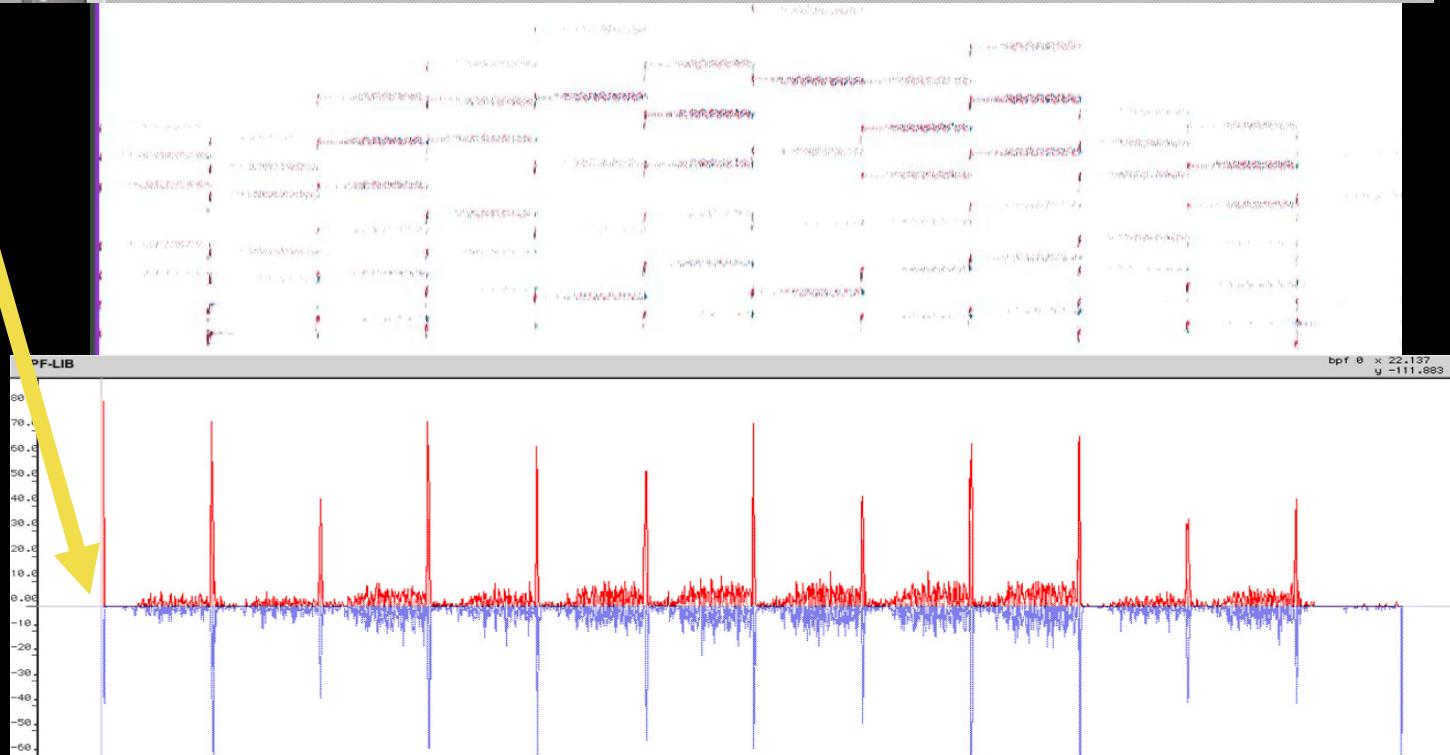


Sonogram and differential sonogram
of the transition in between two
harmonic sounds with vibrato.

Quelle enveloppe?



Alban Berg's serie from
Lyric suite, it's Differential
Fourier Transform (DFT)
with a synthetic musical
realisation and the resulting
change of energy
corresponding to each
interval.



Jean-Marc Chouvel

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<http://jeanmarc.chouvel.free.fr>