

Validating a technique for post-hoc estimation of a listener's focus in music structure analysis

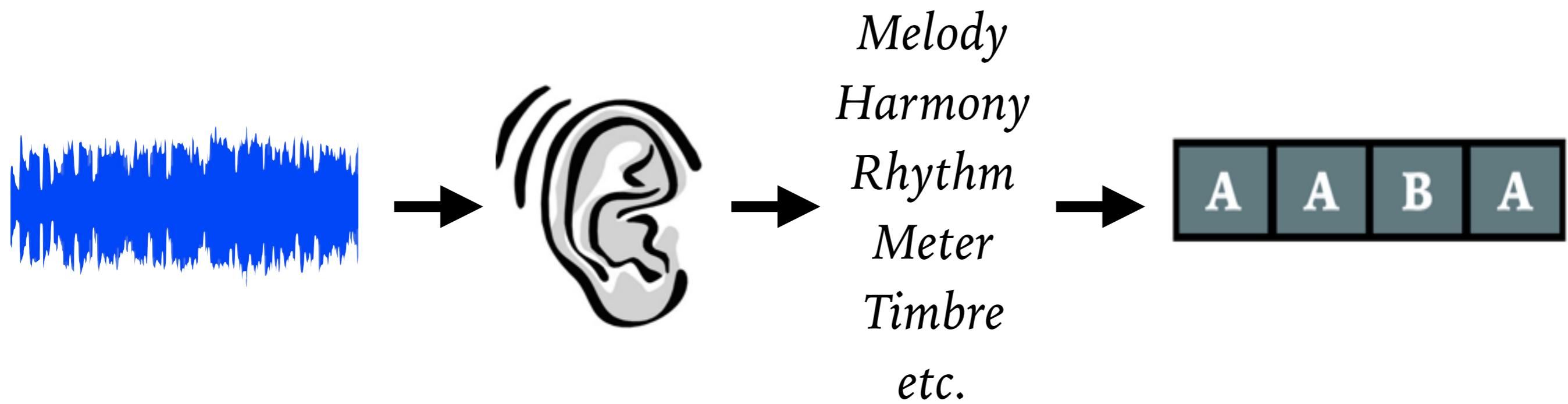
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National Institute of Advanced Industrial Science and Technology (AIST), Japan

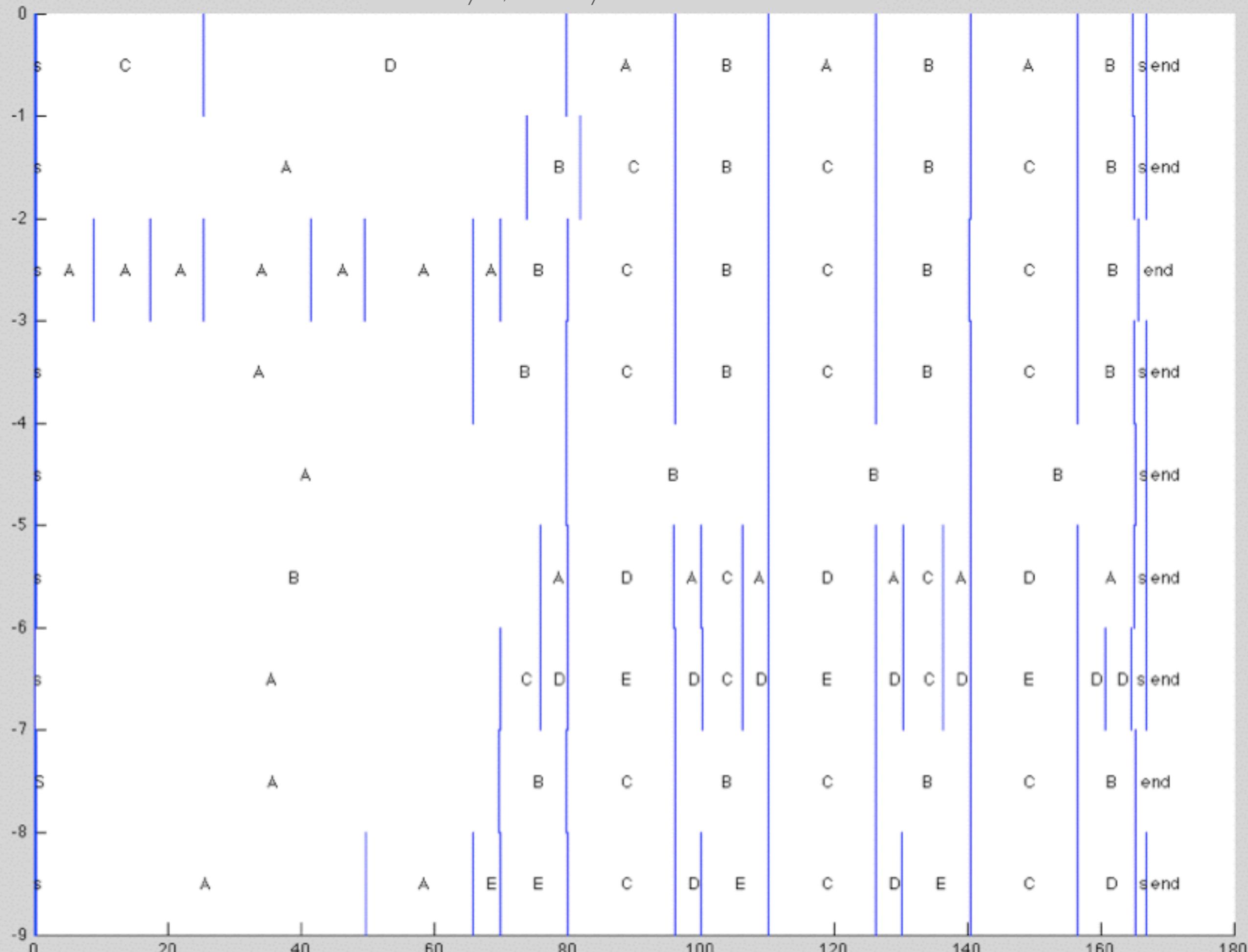
Elaine Chew

Queen Mary University of London

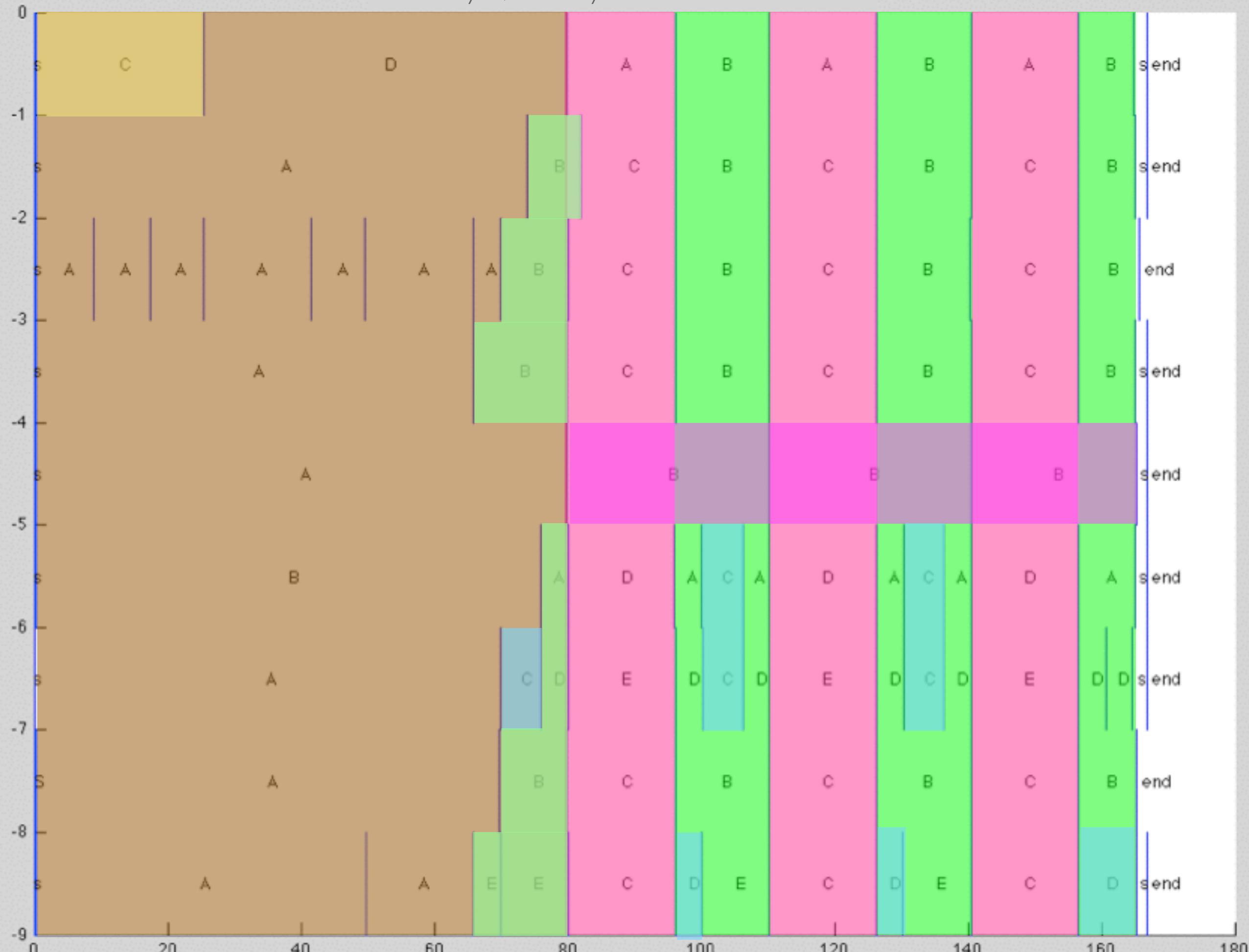
What was the listener thinking? (when they annotated musical structure)



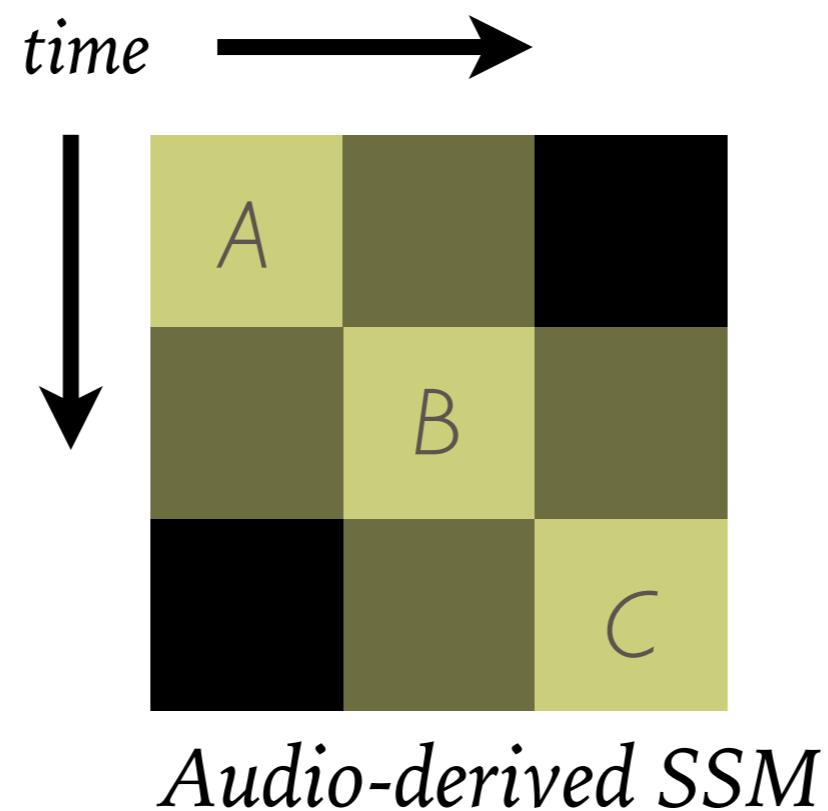
Isaac Hayes, Run Fay Run



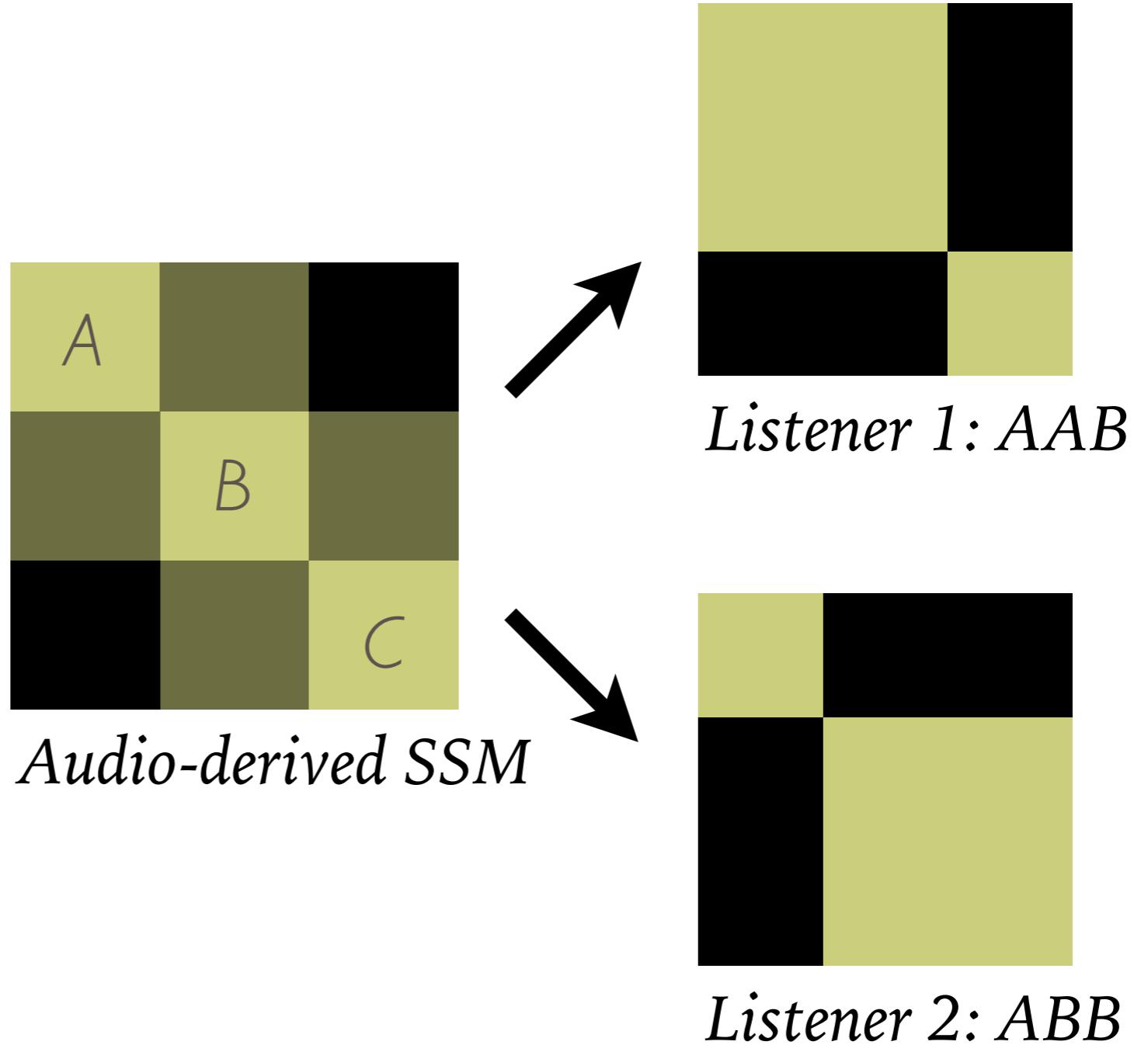
Isaac Hayes, Run Fay Run



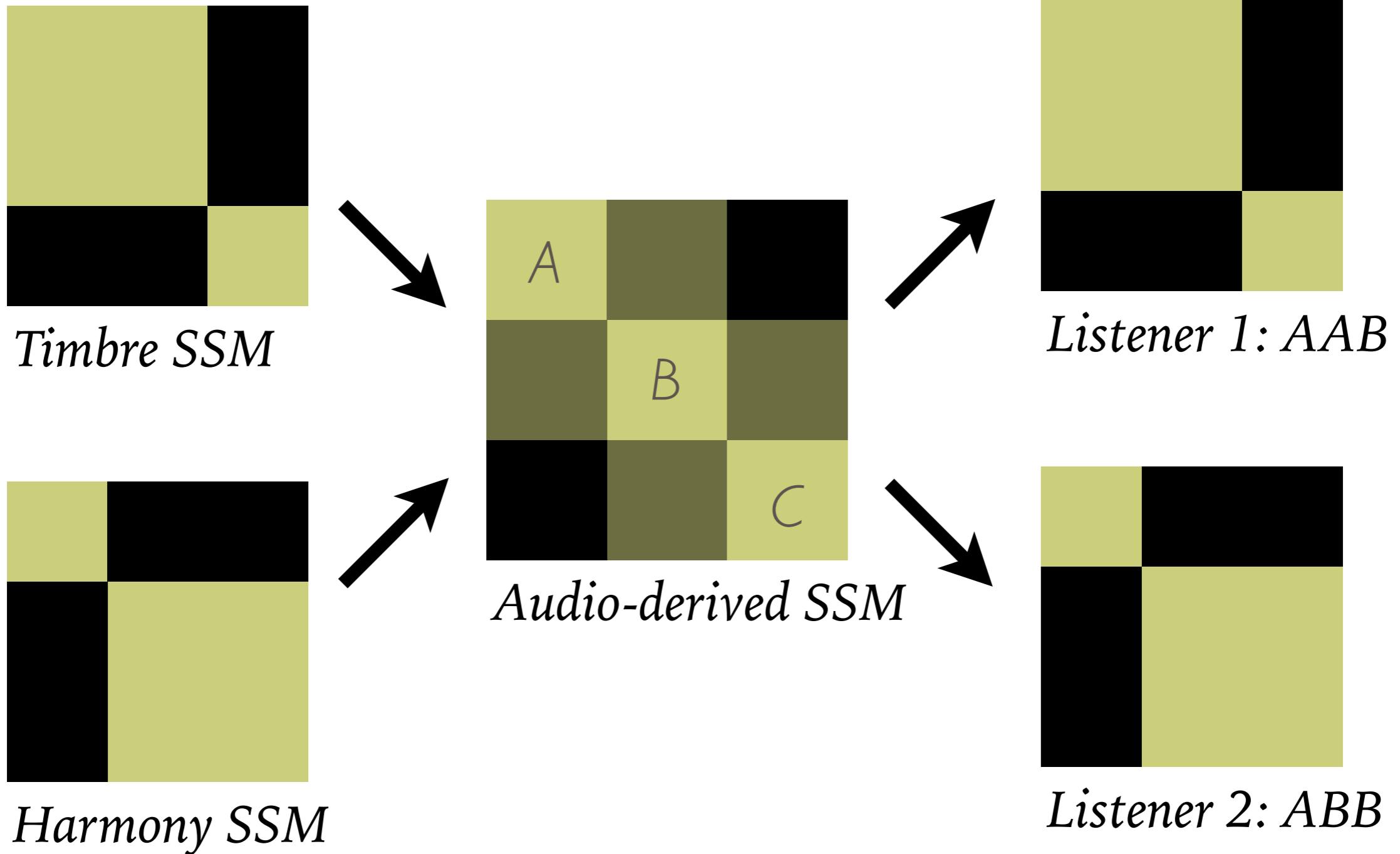
RELATING GROUPING STRUCTURE TO MUSICAL FEATURES



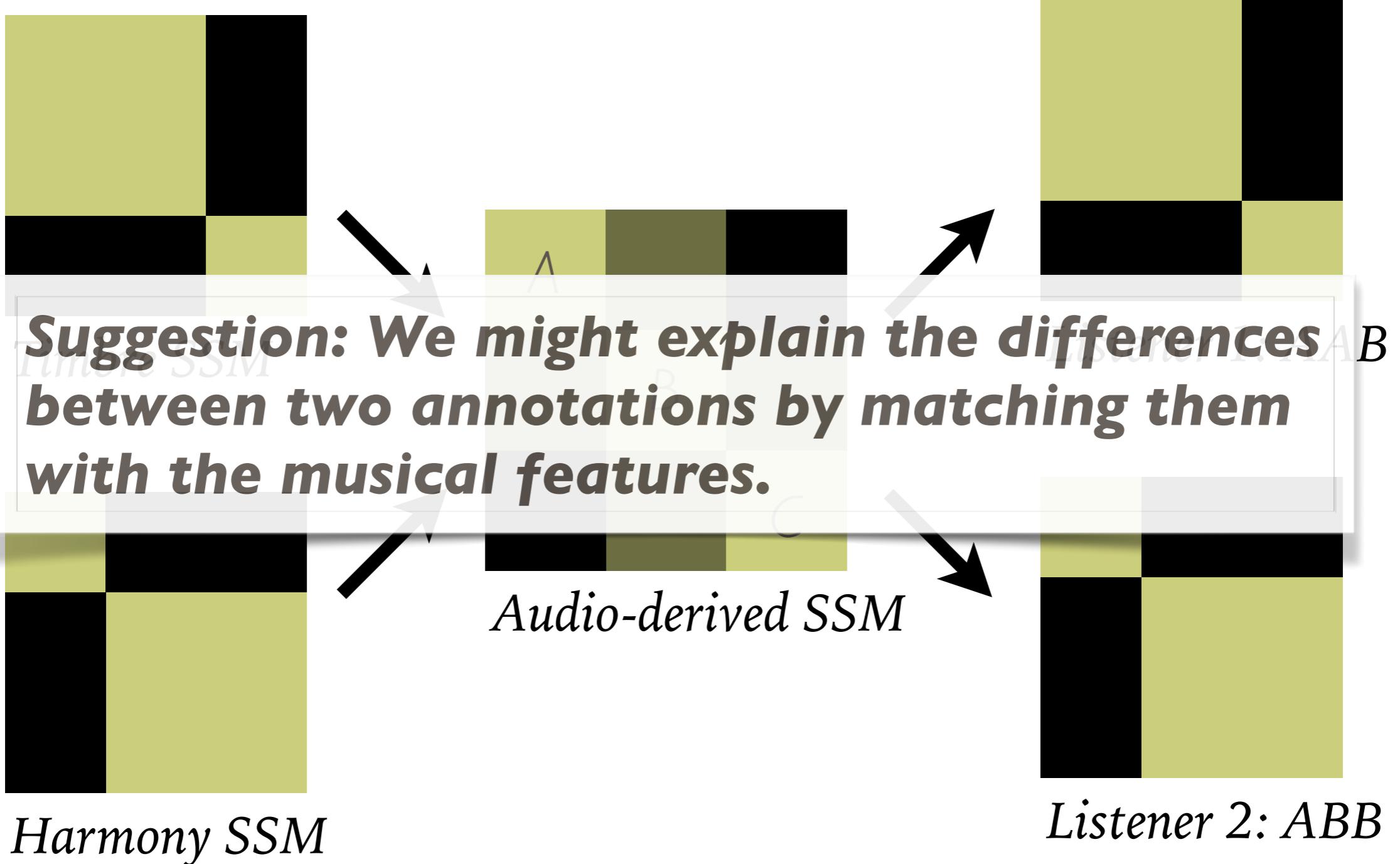
RELATING GROUPING STRUCTURE TO MUSICAL FEATURES



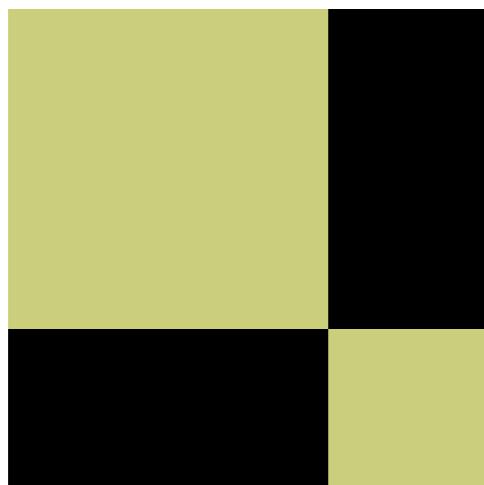
RELATING GROUPING STRUCTURE TO MUSICAL FEATURES



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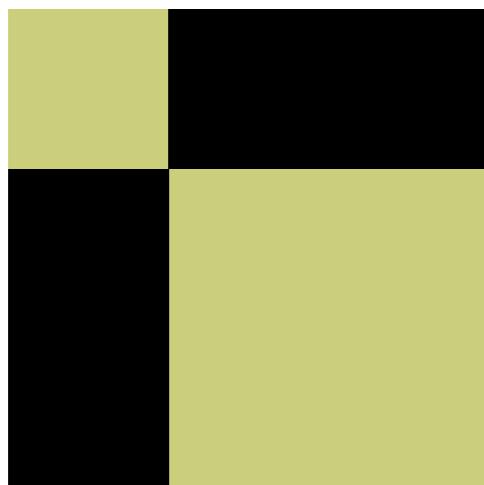
RELATING GROUPING STRUCTURE TO MUSICAL FEATURES



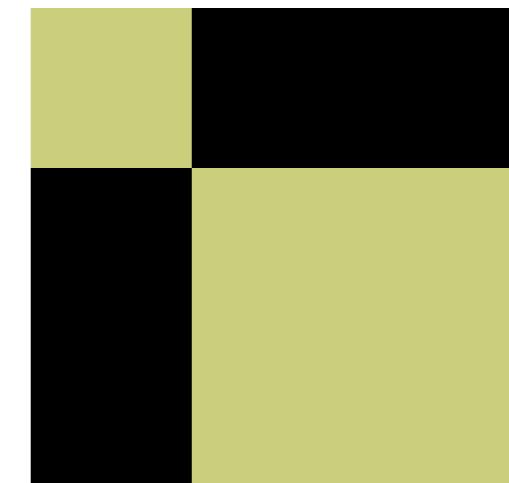
Timbre SSM



Listener 1: AAB

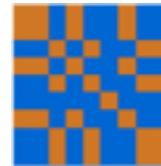


Harmony SSM



Listener 2: ABB

*Target SSM
(original
annotation)*



Feature-derived SSMs



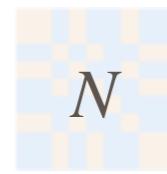
*Segment-based
masks*



*Reconstruction
components*



*Target SSM
(original
annotation)*



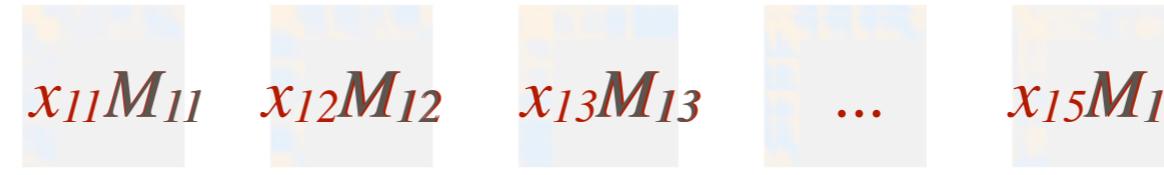
Feature-derived SSMs



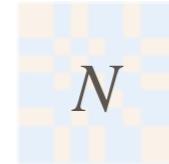
*Segment-based
masks*



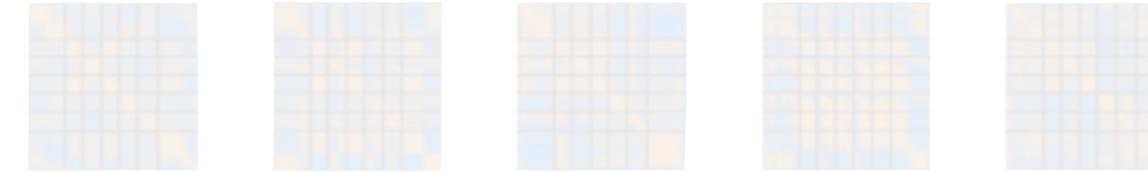
*Reconstruction
components*



*Target SSM
(original
annotation)*



Feature-derived SSMs



*Segment-based
masks*



$x_{11}M_{11}$ $x_{12}M_{12}$ $x_{13}M_{13}$... $x_{15}M_{15}$



$x_{21}M_{21}$



$x_{31}M_{31}$



\vdots



\vdots



\vdots



$x_{71}M_{71}$

find

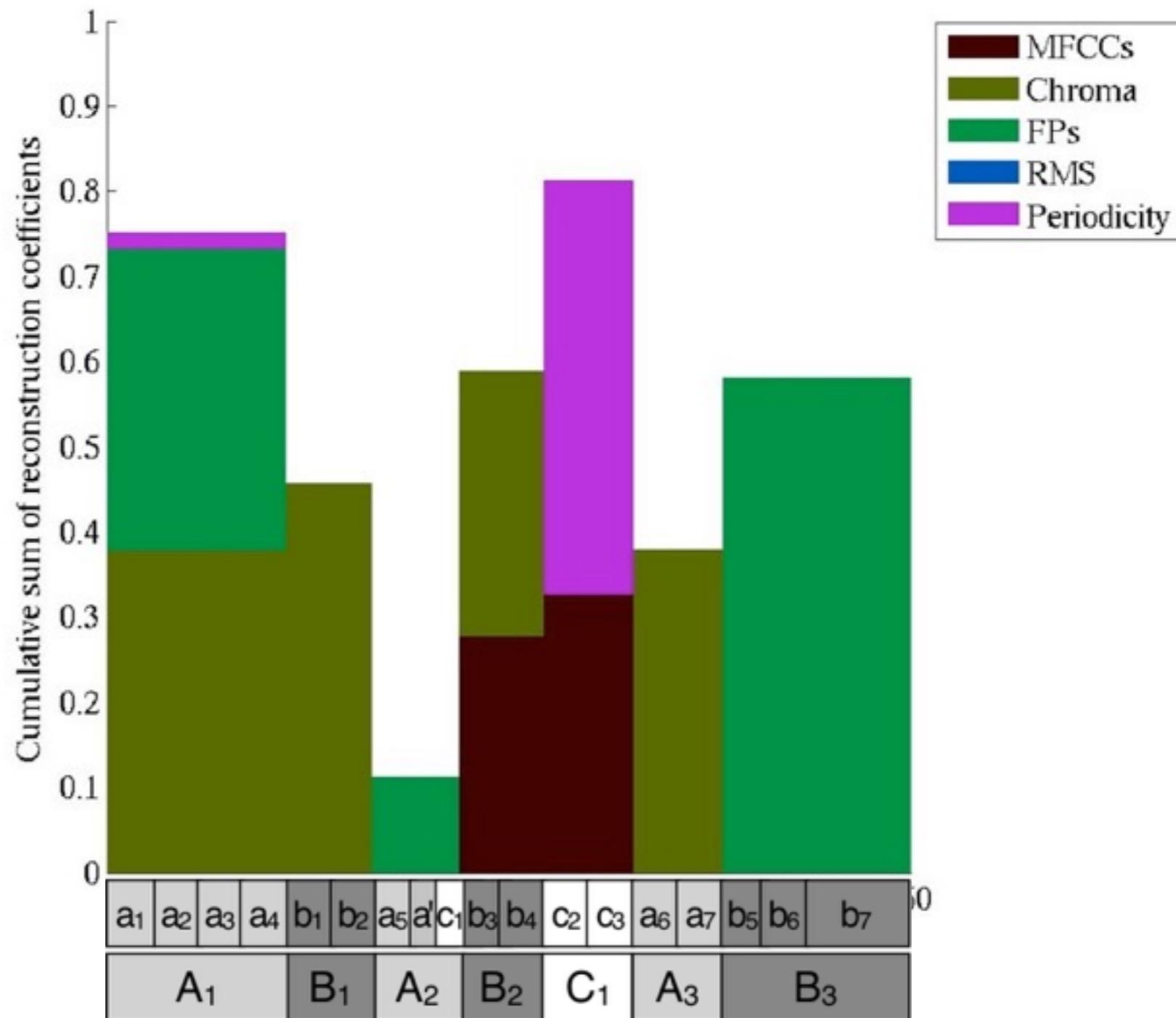
that minimizes

$$\left(\left(\sum_{j=1}^s \sum_{i=1}^f x_{i,j} M_{i,j} \right) - N \right)^2$$



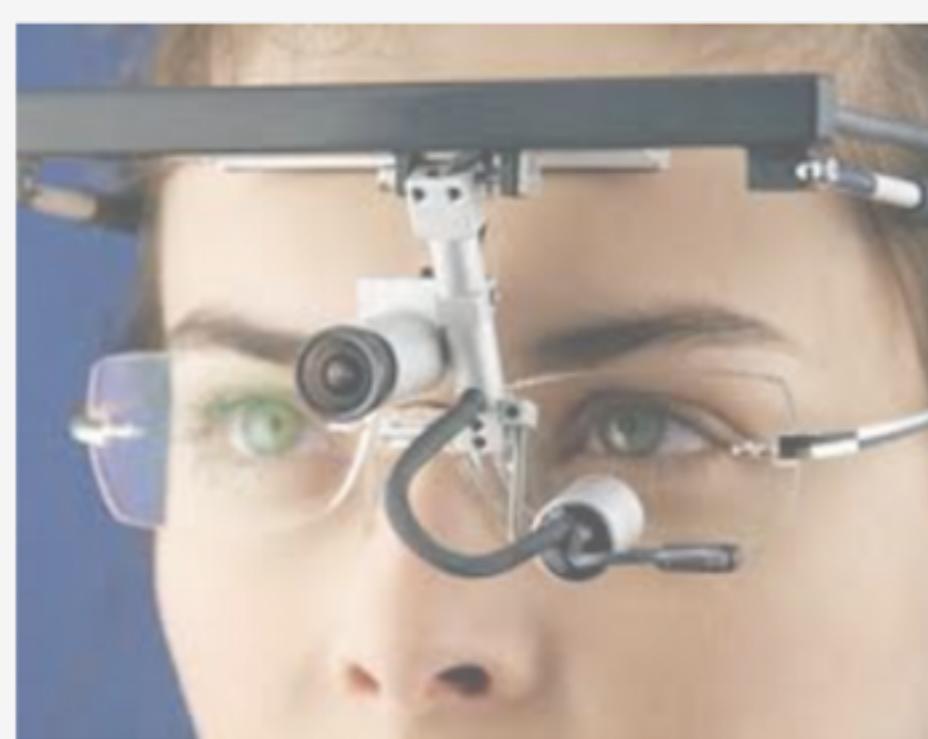
$x_{75}M_{75}$

WHICH FEATURE BEST EXPLAINS THE ANALYSIS?

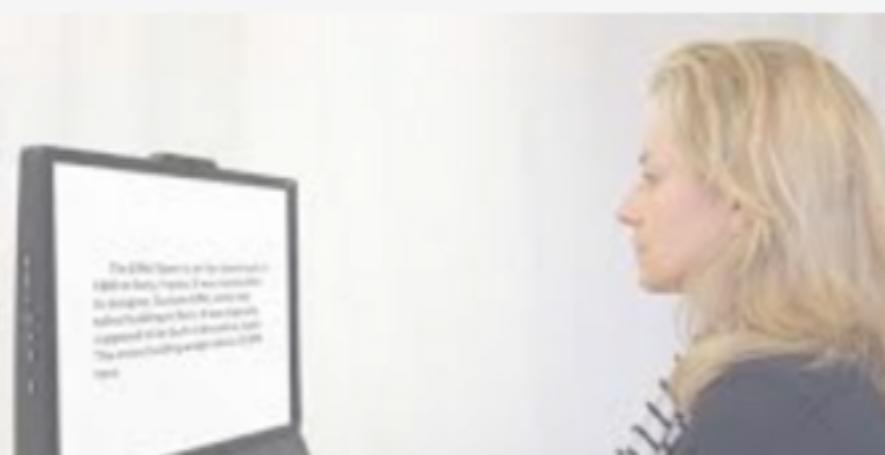
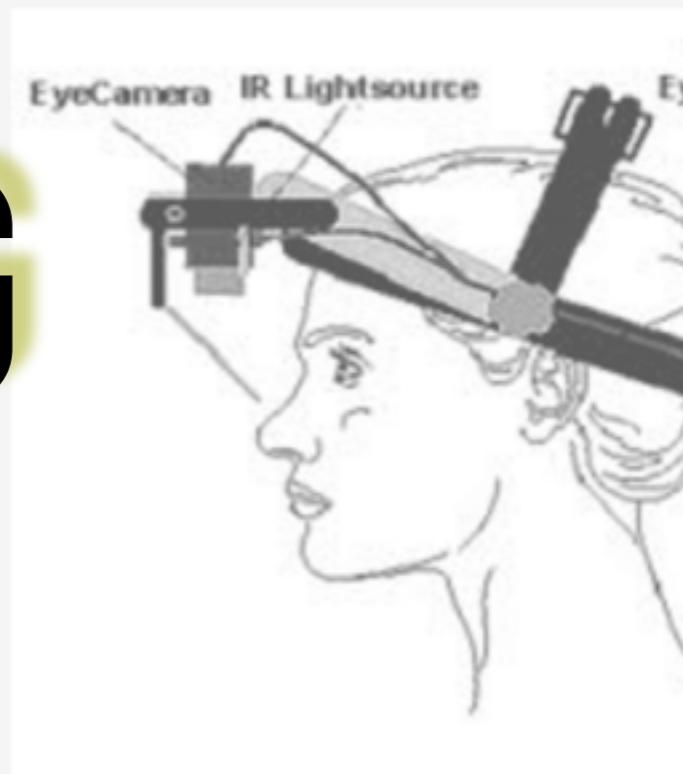


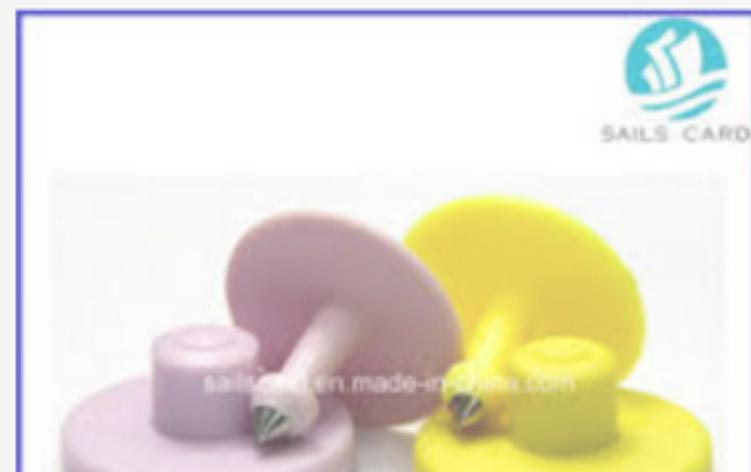
CRITICISM

- Model not validated with real-world data:
 - I.e., analyses paired with attention state of listener



EYE TRACKING





CRITICISM

- Model not validated with real-world data:
 - I.e., analyses paired with attention state of listener
 - One source of data:
 - Ran experiment testing whether focus of listener could affect perception of grouping

STIMULUS EXAMPLES

Melody ABB

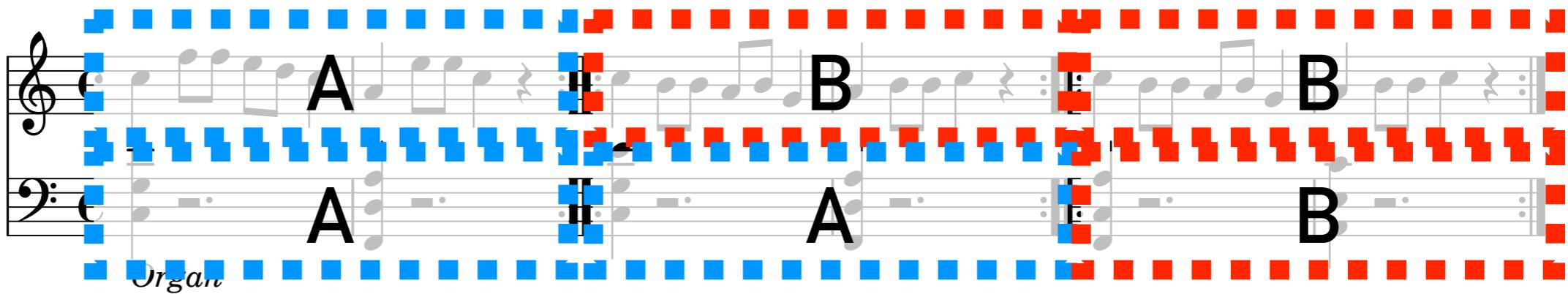
Harmony AAB

A musical score consisting of three staves. The top staff is a treble clef melody line with eighth-note patterns forming the sequence ABB. The middle staff is a bass clef harmony line with quarter-note patterns forming the sequence AAB. The bottom staff is labeled "Organ" and shows harmonic chords in common time (indicated by a 'C'). The score is divided into measures by vertical bar lines and features two double bar lines with repeat dots, indicating a repeating section.

STIMULUS EXAMPLES

Melody ABB

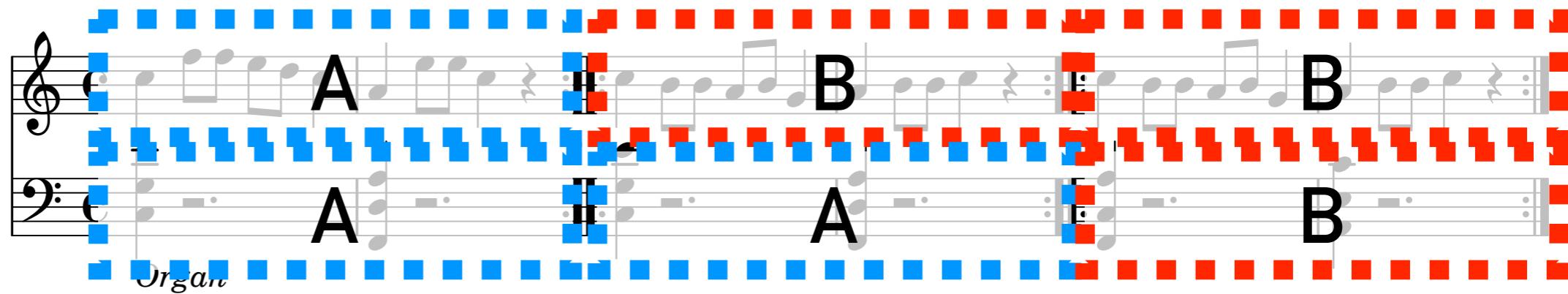
Harmony AAB



STIMULUS EXAMPLES

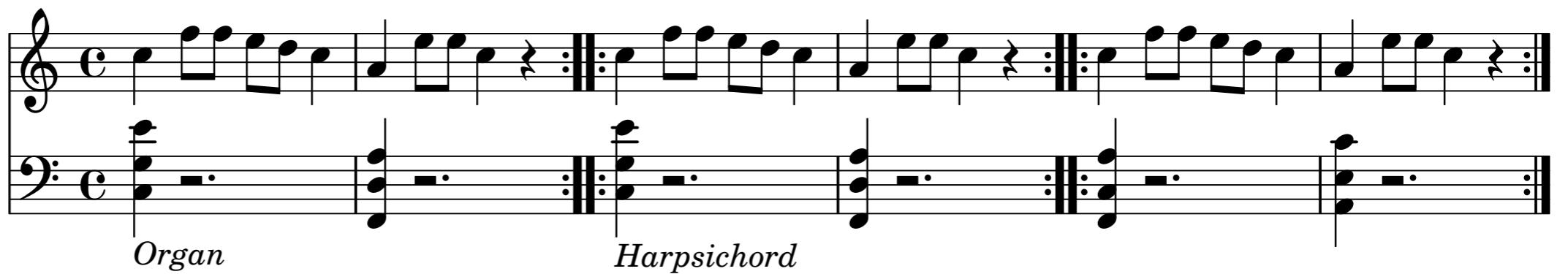
Melody ABB

Harmony AAB



Timbre ABB

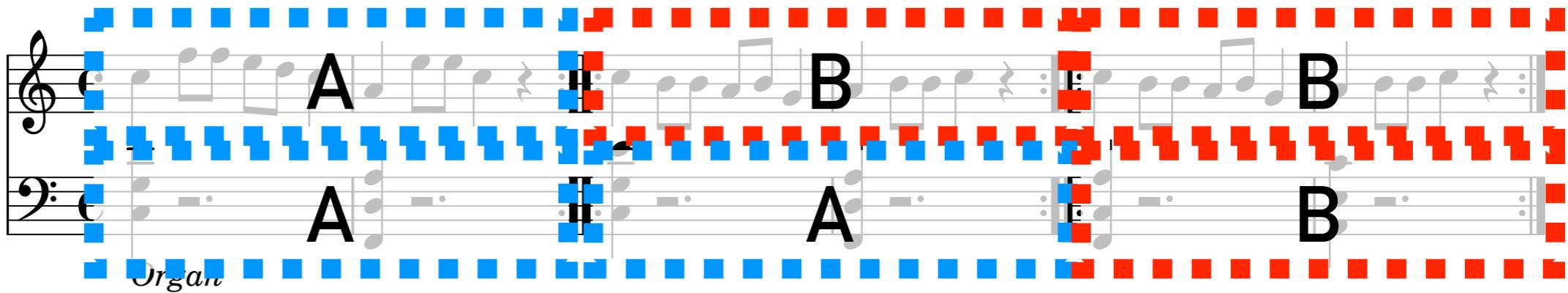
Harmony AAB



STIMULUS EXAMPLES

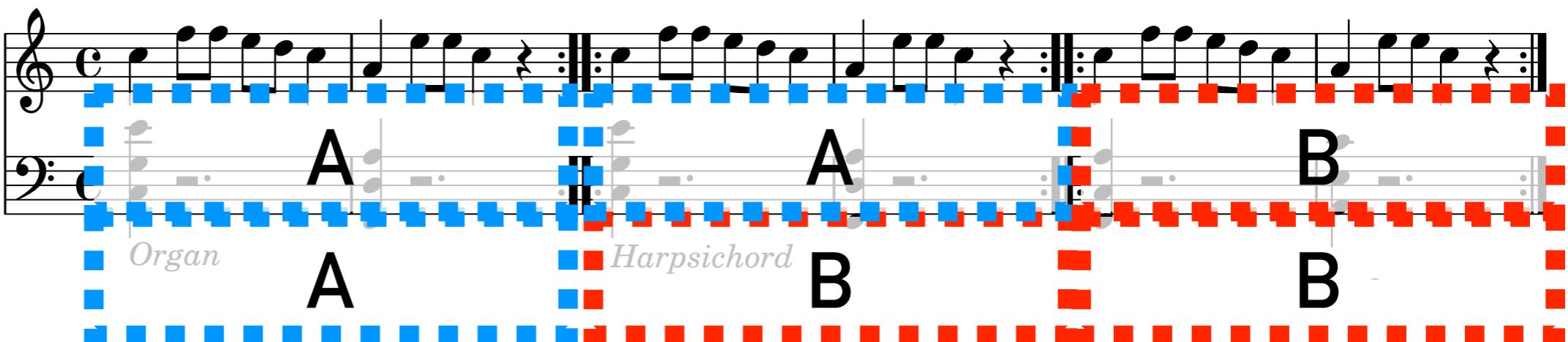
Melody ABB

Harmony AAB



Timbre ABB

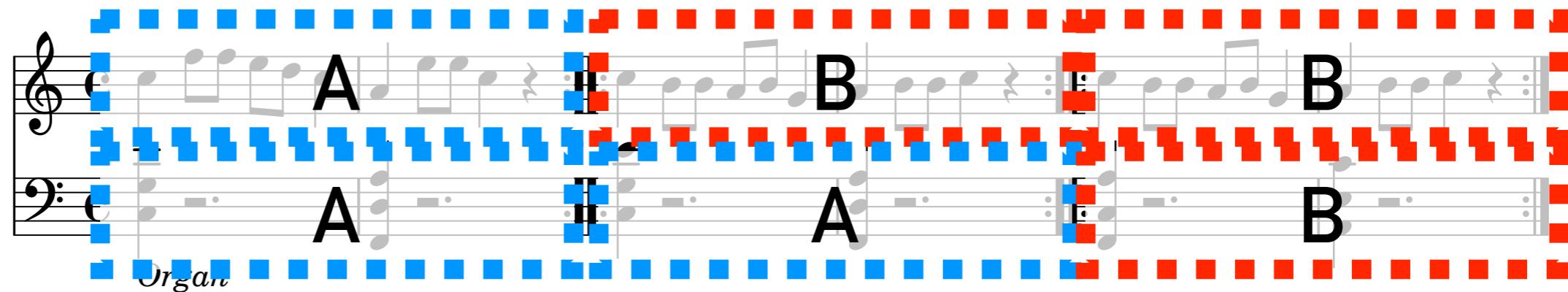
Harmony AAB



STIMULUS EXAMPLES

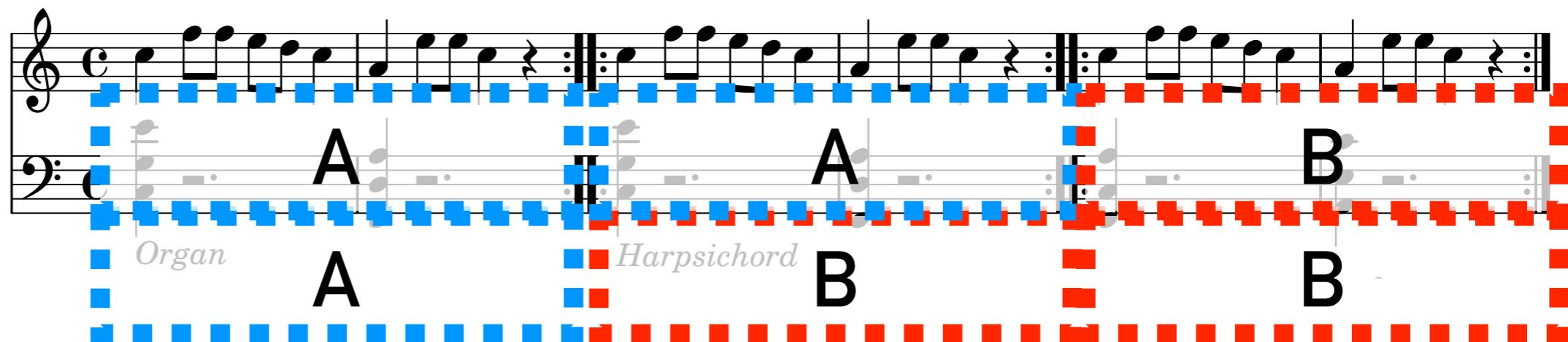
Melody ABB

Harmony AAB



Timbre ABB

Harmony AAB

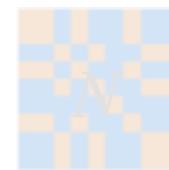


- Experiment outcome: giving listeners a distractor task (to fix attention) affected AAB vs. ABB decisions
 - “Does this chord progression occur in the stimulus?” → prefer AAB
- Note: sometimes, organizing features are convolved

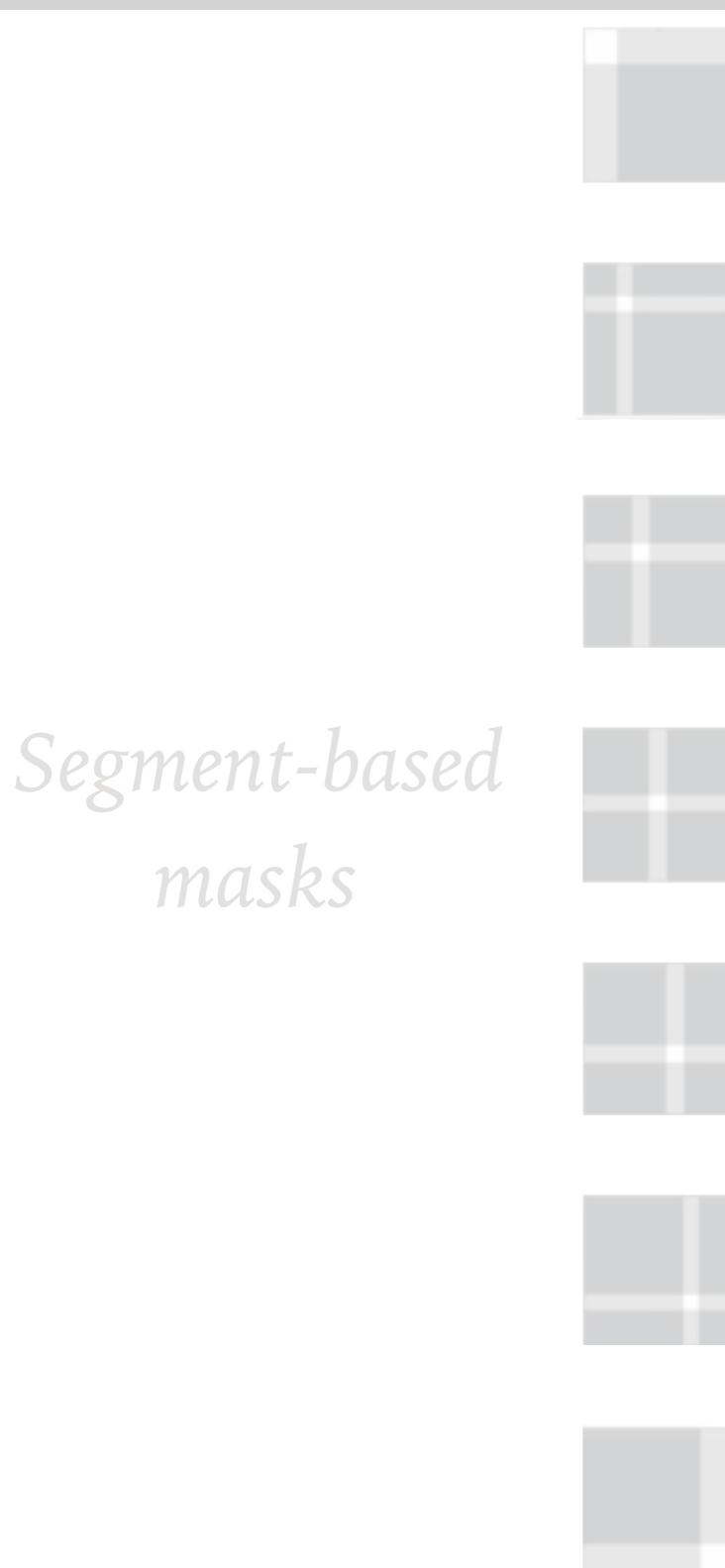
CRITICISM

- Model not validated with real-world data:
 - I.e., analyses paired with attention state of listener
 - One source of data:
 - Ran experiment testing whether focus of listener could affect perception of grouping
- Is model needlessly complicated?
 - Try simple correlation instead

*Target SSM
(original
annotation)*



Feature-derived SSMs



*Segment-based
masks*

QP approach:

- ***find sum of reconstruction components to generate target SSM***

interpret coefficients as relevance



*Reconstruction
components*

Correlation approach:

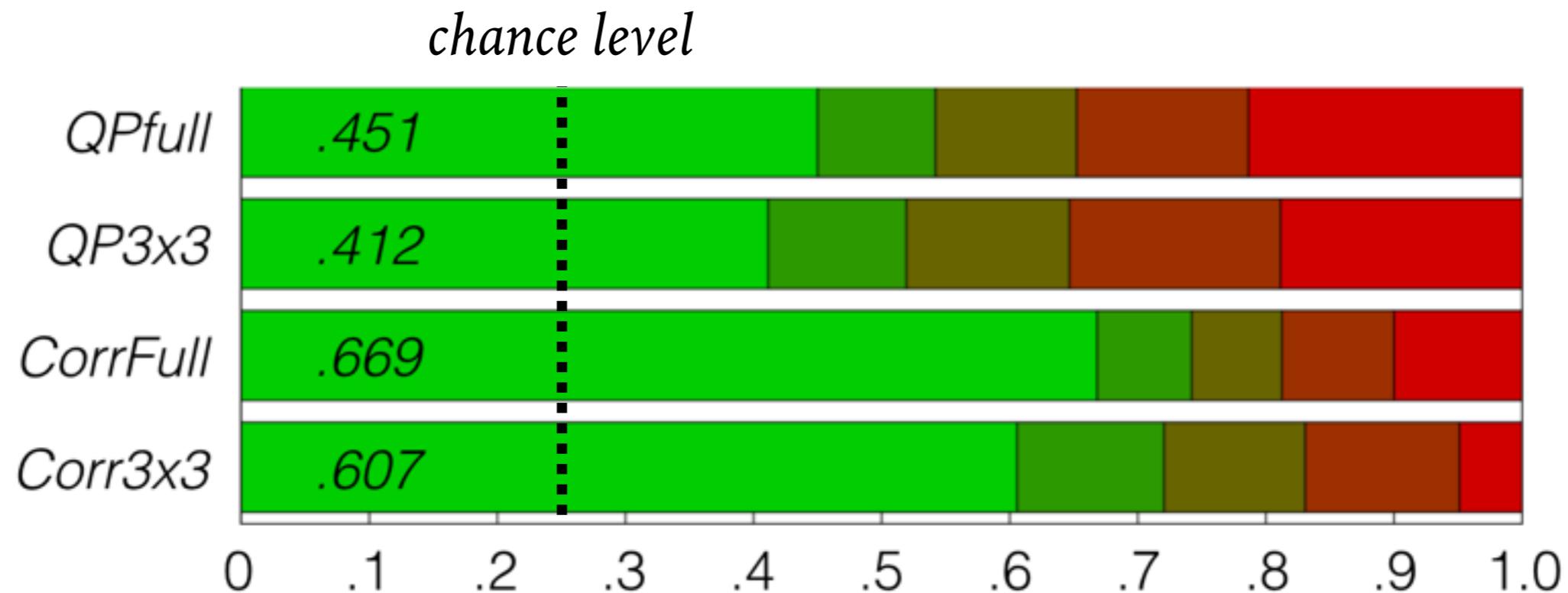
- ***compute correlation between feature SSMs and masks***

- ***interpret correlation as relevance***

EXPERIMENT

- Use algorithm to estimate relevance of features to analysis of experiment stimuli
- If the most relevant feature is the feature that changed, count correct

RESULTS



*What feature was found
to be most relevant?
(i.e., greatest QP weights
or correlation)*

- █ Correct
- █ Conv. w/correct
- █ Neither
- █ Conv. w/opposite
- █ Opposite

SUMMARY

- Past work:
 - 1. Algorithm to estimate feature relevance from analyses
(Smith and Chew, 2013)
 - 2. Artificial stimuli from psych experiment studying
attention
- Current work:
 - Use stimuli (2) to validate algorithm (1) and new
variations

SUMMARY

- Algorithm performs above baseline...
- ...but artificial context makes non-perfect performance a disappointment!
 - Random effect of small set of stimuli
 - Mismatch between features and musicological interpretations
- Future work:
 - re-optimize (or train) model with more features, more artificial stimuli
 - apply algorithm to investigate trends in large datasets

THANKS!

ADVERTORIAL SUPPLEMENT

Smith
Chew
Assayag

Lecture Notes Series, Institute for Mathematical Sciences,
National University of Singapore

Vol.
32

MATHEMUSICAL CONVERSATIONS

Mathemusical Conversations celebrates the understanding of music through mathematics, and vice versa. This volume is a compilation of the invited talks given at the workshop of the same name that took place in Singapore from 13–15 February 2015, organized by Elaine Chew in partnership with Gérard Assayag for the scientific program and with Bernard Lanskey for the artistic program. The contributors include world experts and leading scholars, all writing on the intersection of music and mathematics. They also focus on performance and composition, two topics which are foundational both to the understanding of human creativity and to the creation of tomorrow's music technologies. This book is essential reading for researchers in both music and mathematics. It should also appeal more broadly to scholars, students, musicians, and anyone interested in fresh perspectives on the intimate relationship between these two ubiquitous human activities.

MATHEMUSICAL CONVERSATIONS

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Imperial College Press
www.icpress.co.uk

World Scientific
www.worldscientific.com
10046 hc ISSN: 1793-0758

ISBN 978-981-3140-09-7

9 789813 140097



MATHEMUSICAL CONVERSATIONS
Mathematics and Computation in
Music Performance and Composition

REFERENCES

- Jordan B. L. Smith and Elaine Chew. Using Quadratic Programming to estimate feature relevance in structural analyses of music. In *Proceedings of the ACM International Conference on Multimedia*, 113–122, Barcelona, Spain, 2013.
- Jordan B. L. Smith. Explaining listener differences in the perception of musical structure. Ph.D. thesis. Queen Mary University of London. See Chapter 6: “The effect of attention on grouping decisions.”