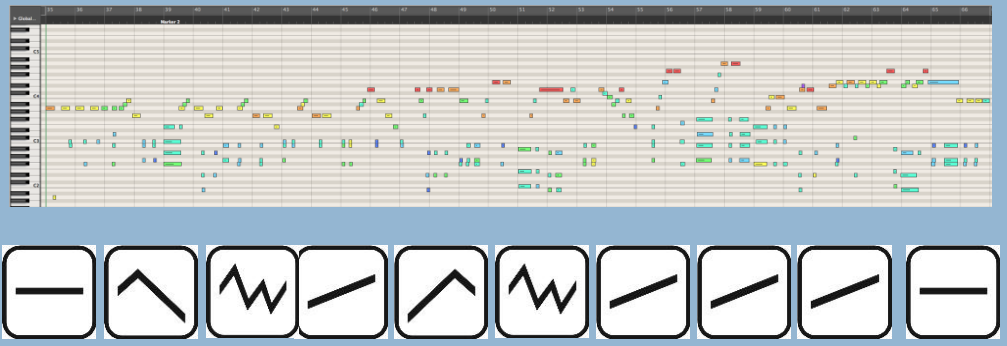
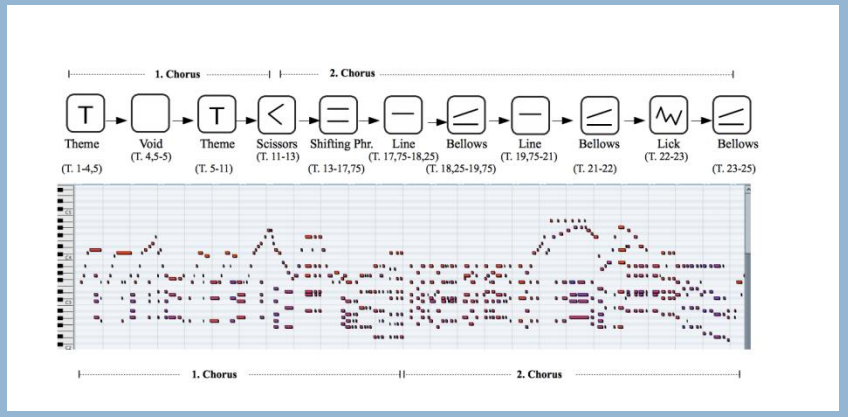
The Ideational Flow Model (IFM). A new model for jazz improvisation





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„A simple description of the process runs as follows: ideas are generated and realized into sound via technique. This produces continuous aural and proprioceptive feedback, which allows continuous evaluation, on the basis of which the current ideas are either repeated, developed or discarded. In this way a long-term improvisation can be built up.“

(Pressing, 1984: 353)

OUTLINE

- Introduction: Musical Improvisation
- Models of Music Generation
- Midlevel Analysis
- The IFM-Model
- Discussion and Outlook

MUSICAL IMPROVISATION

- Music psychology focuses on
  - Structure – Interaction – Cognition

...but:

- only few connections between research fields
- accentuation of cognitive perspective
- empirical research is important
- experimental approaches bear integrative potential

MUSICIAN PERFORMANCE LISTENER

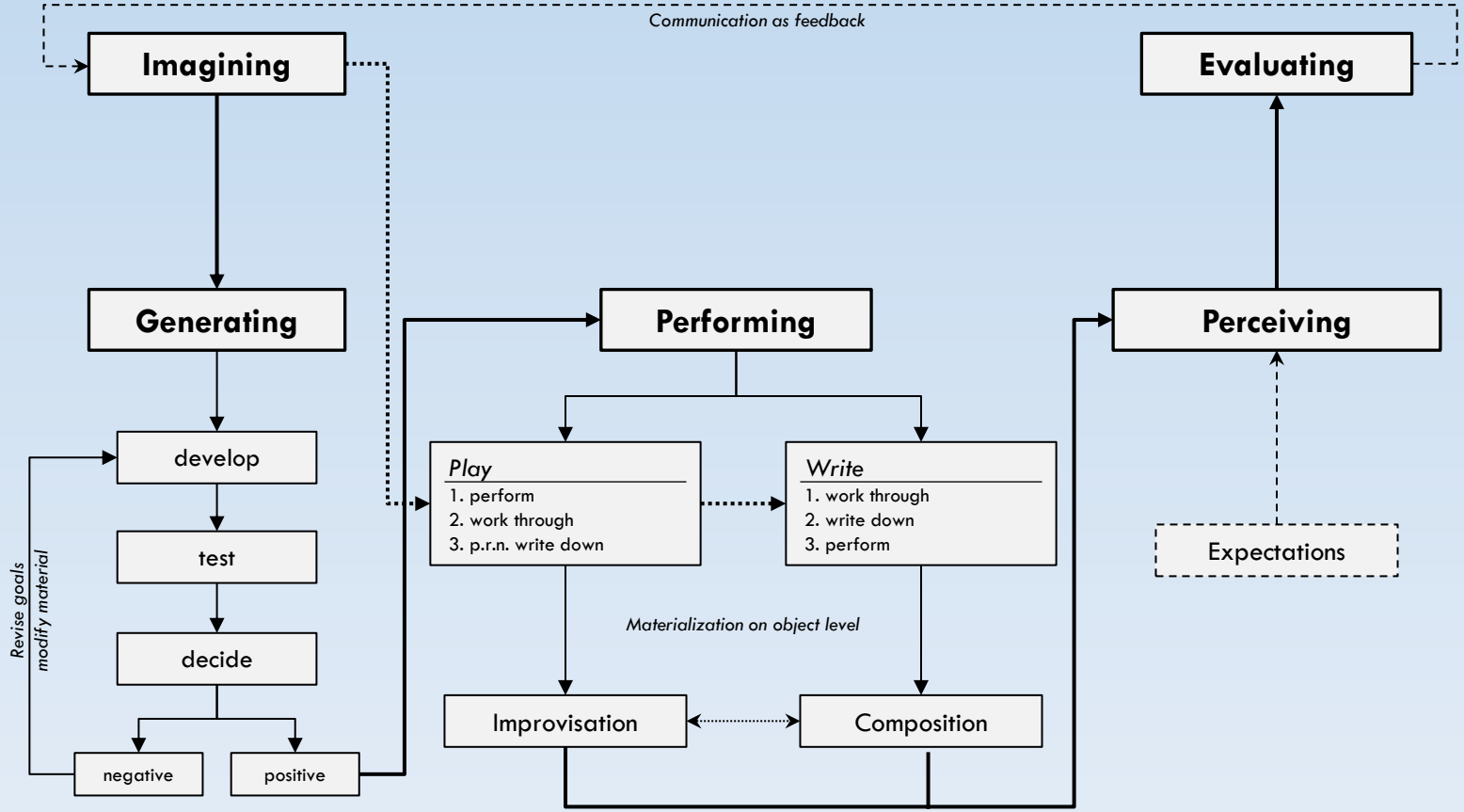


Fig. 1: Performative model of music generation (Lothwesen & Lehmann, in prep).

MODELS OF MUSIC GENERATION

- Cognitive models use jazz as exemplification
- Conditions for jazz improvisation
  - cognitive abilities (memory, attention, …)
  - motor abilities (automated playing, …)
  - knowledge (music theory, composition, …)

→ situated generative actions in music

- elements and categories of improvisation
- creative actions of musical behavior

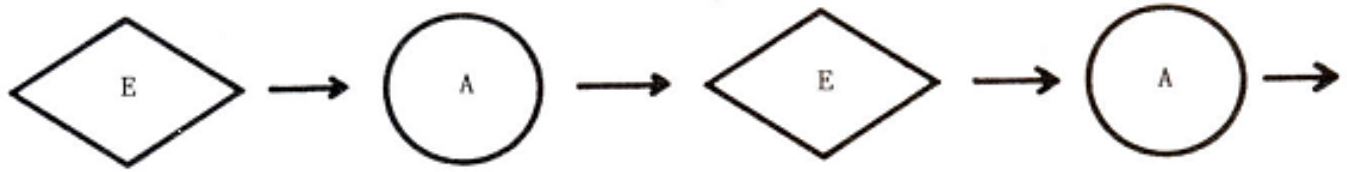


Abb. 1: Improvisieren als Kettenfolge von Entscheidungen und Aktionen.

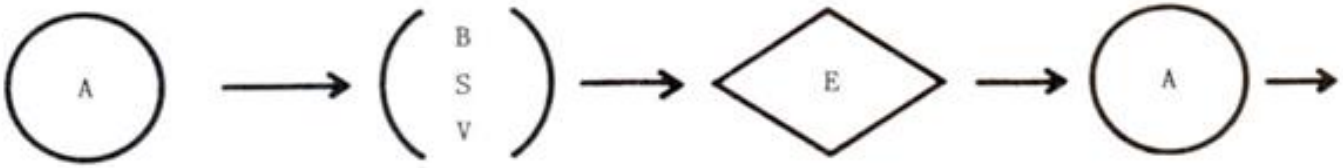


Abb. 2: Bewerten, Suchen und Vergleichen als vermittelnde Prozesse zwischen Aktionen und Entscheidungen.

Fig.2: Improvisation as chain of decisions and actions with intersections (evaluating, searching, comparing) (Behne, 1994).

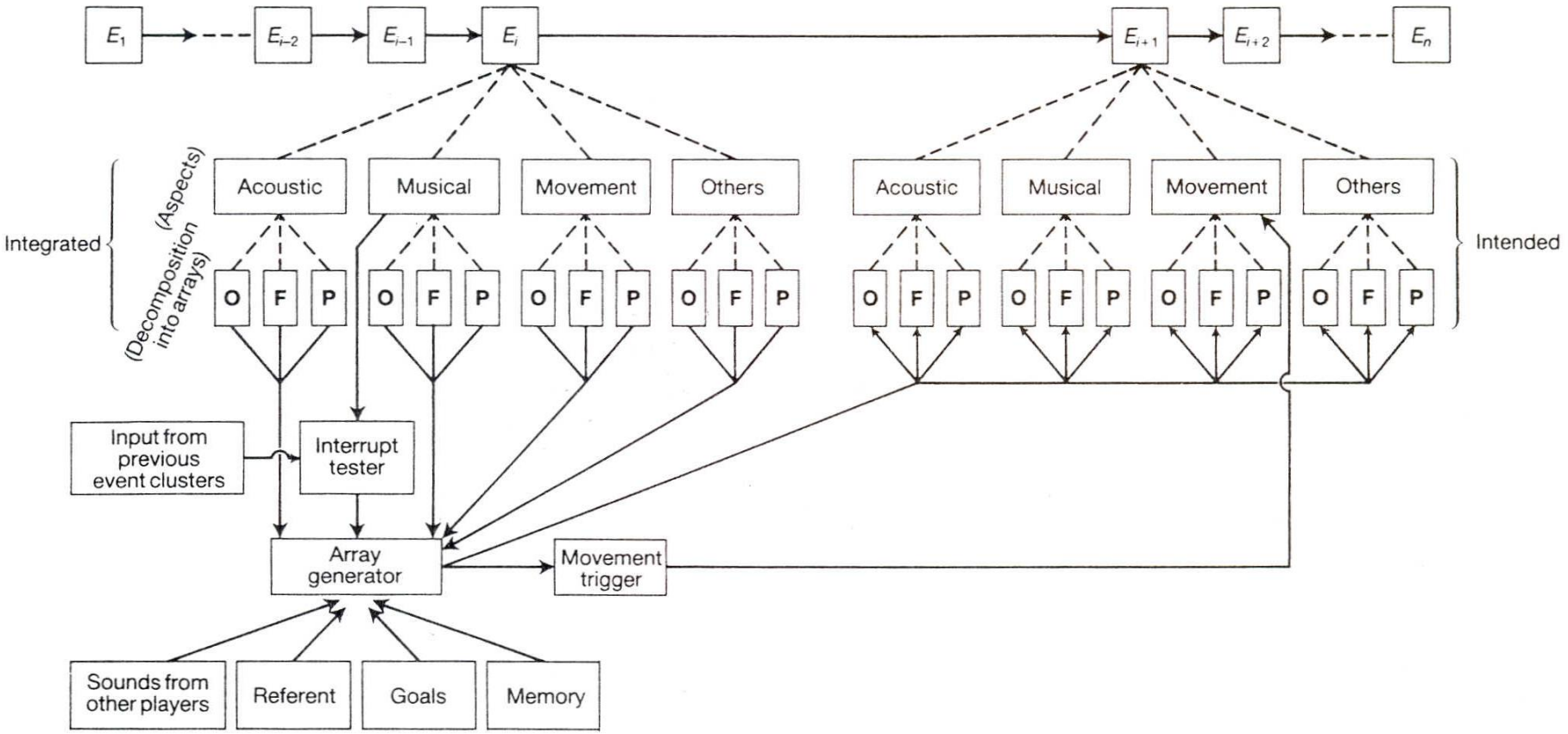


Fig.3: Improvisation as cognitive process (Pressing, 1988: 160).

„Der Improvisator muß sich nicht auf jeden Einzelton innerhalb des größeren Bewegungsbildes konzentrieren, sondern vornehmlich auf das innerlich vorgestellte Bewegungsbild. Dabei hat jeder Bewegungszug, Anstoß erfahrend durch den bzw. die vorangegangenen, seinen Stellenwert in einem musikalisch-sinnvollen Zusammenhang.“

(Schramowski, 1973: 239)

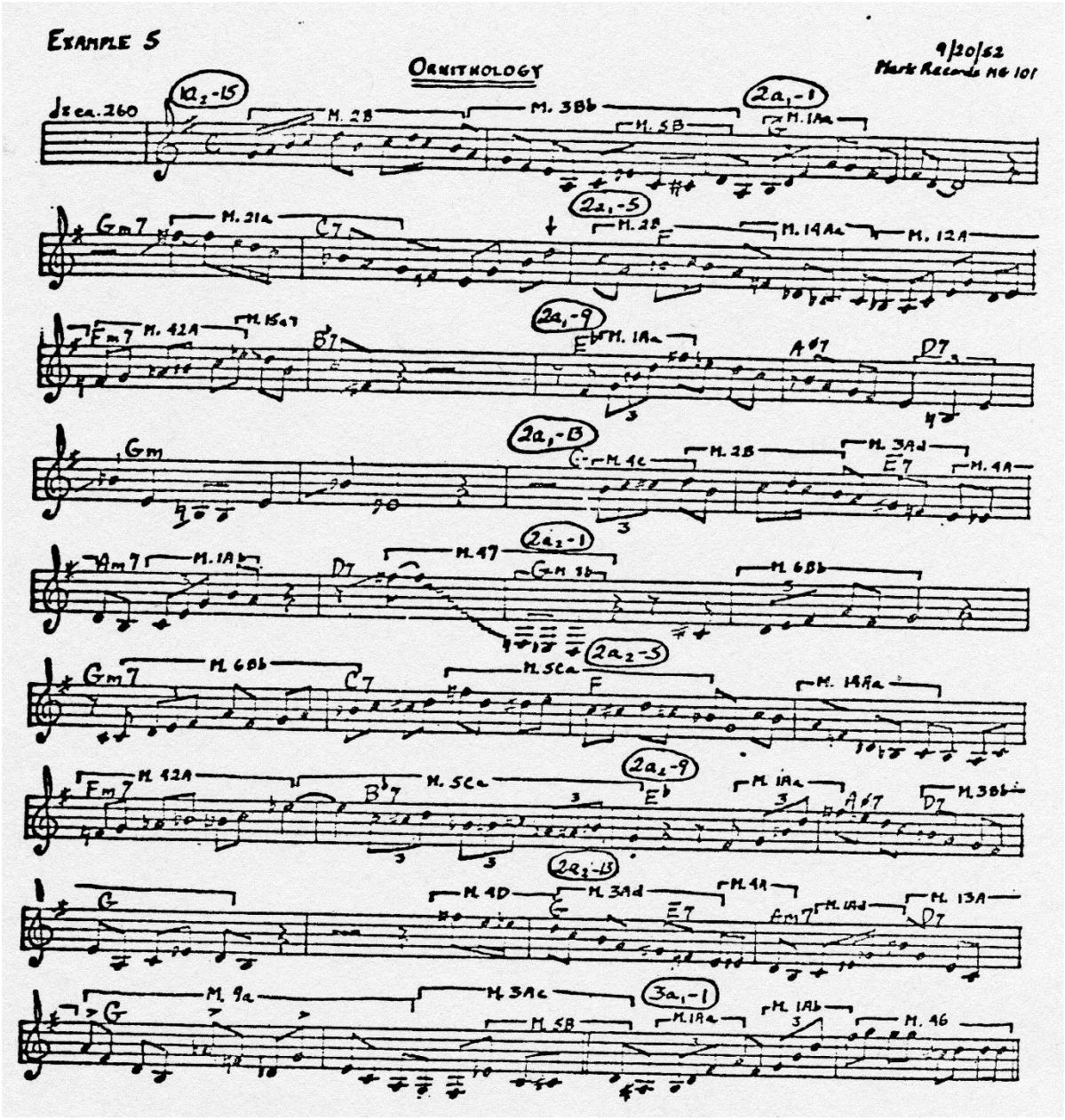


Fig.4: Motivic figurations in Charlie Parker's soloing (Owens, 1974: 34).

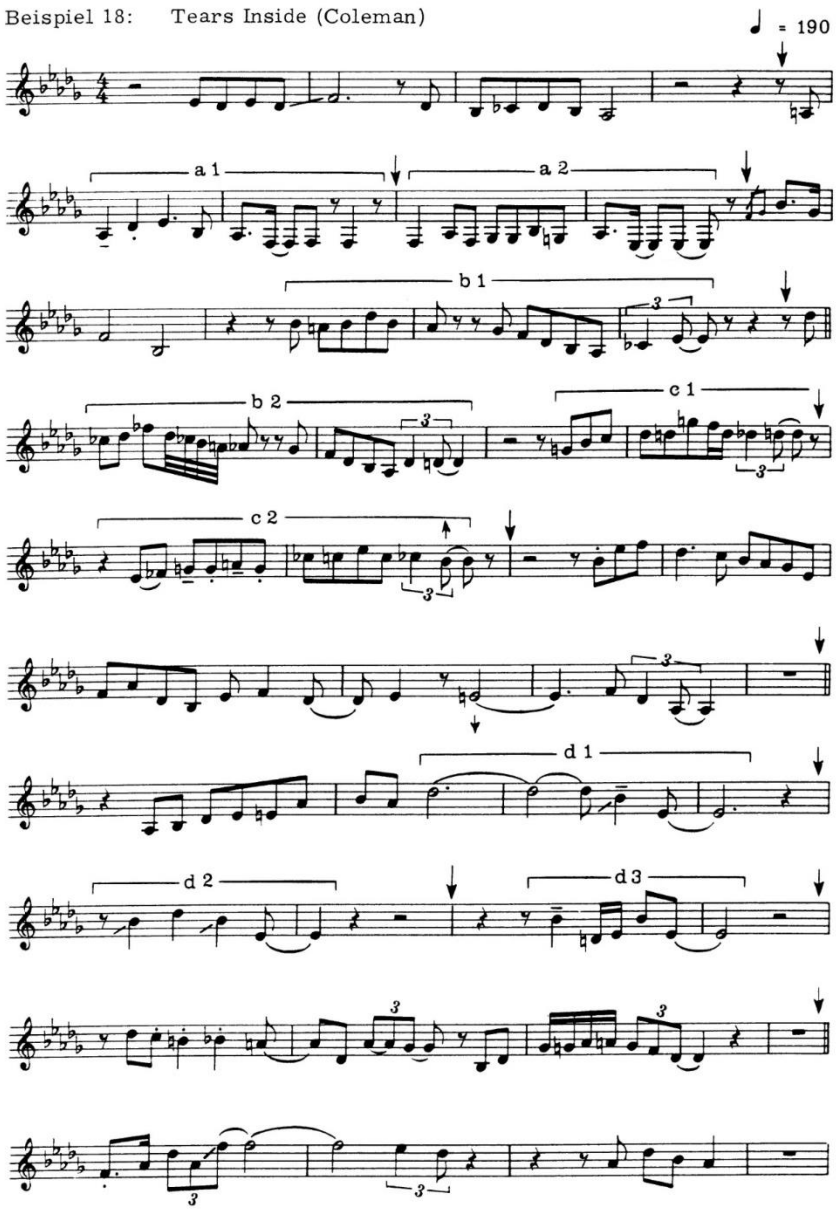
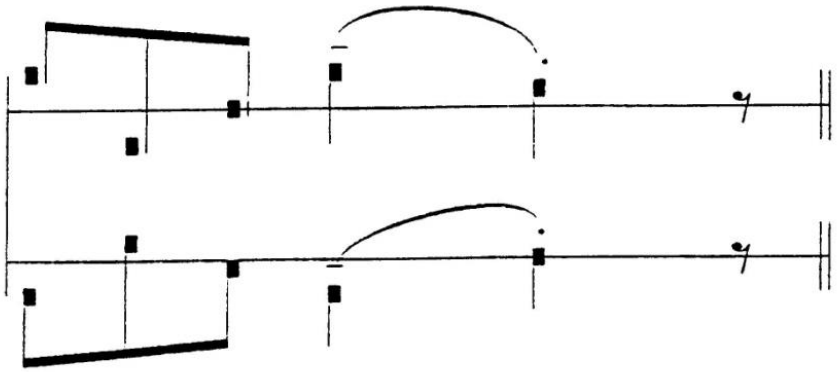


Fig.5: Motivic chain association in Ornette Coleman's playing (Jost, 1975: 55).



Schema eines Abstraktmotivs

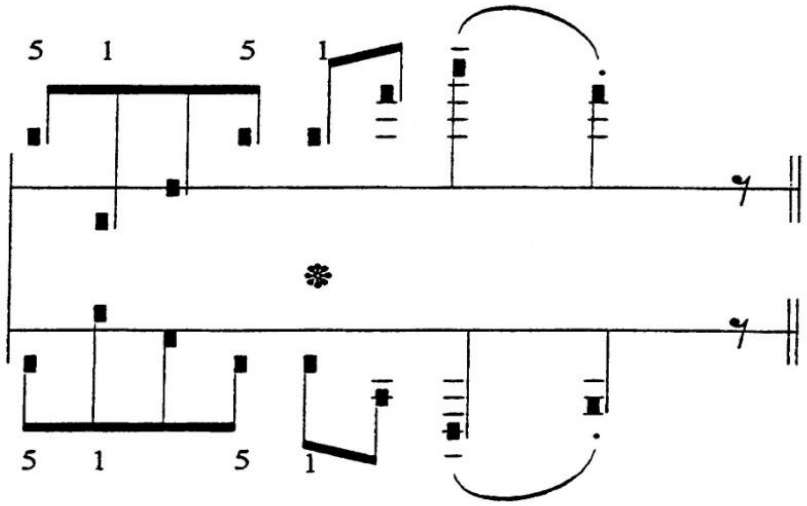
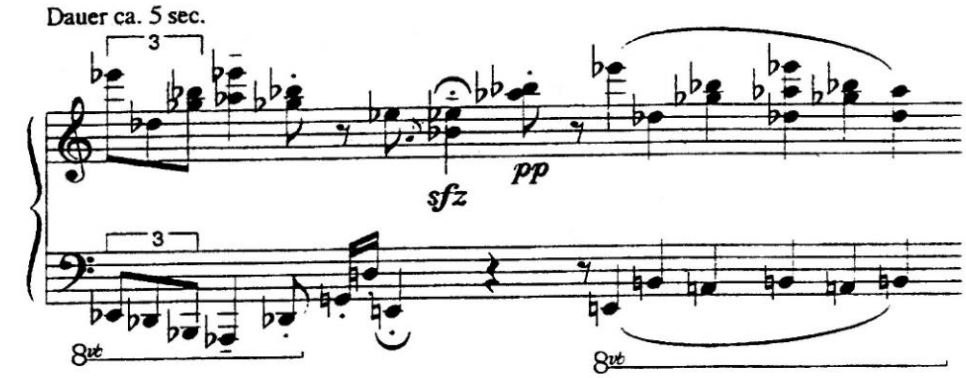
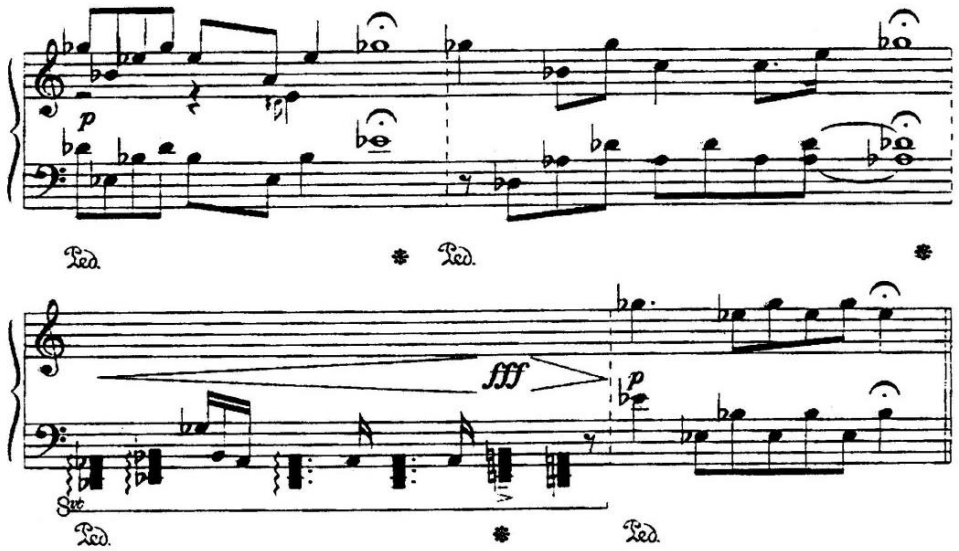


Fig.6: Abstract motive (motor-based scheme) from Cecil Taylor's repertoire (Spicker, 1998: 19, 20).



Pentatonisches Abstraktmotiv



Motivische Cluster in sonst tonalem Abstraktmotiv

Fig.7: Realisations of the abstract motive in Cecil Taylor's playing (Spicker, 1998: 20).

- Elaborative thinking in musical improvisation focuses rather on a gestalt-like events than on single notes.
  - feedback of great importance
  - flexible strategies for re/actions
- Point of presence in improvisation is moving in time.
  - continuosly new contextualisations of ideas require attention
- Memory and anticipation as major factors determine the course of musical events.
  - short-term, mid-term, long-term levels of planning ahead (Lothwesen & Frieler, 2012; Lehmann & Goldhahn, 2009)

MIDLEVEL ANALYSIS (MLA)

- Lothwesen & Frieler (2012) developed a new qualitative analysis method for jazz piano improvisation.
  - MLA led to the Ideational Flow Model (IFM), extending cognitive models.
- System extended and tested on a larger set of jazz piano improvisations by Schütz (2011, 2014).
- Adaptation of the system to monophonic jazz improvisation by Schütz and the Jazzomat team (Frieler et al., 2016), now called Midlevel Analysis (MLA).

MIDLEVEL ANALYSIS (MLA)

- **Strong hypothesis:** Phenomenological midlevel units correspond to cognitive plans (ideas) and are produced by them.
- **Aim of the approach:** Identifying improvisers' ideas on a middle level and describing them phenomenologically.
- **Qualitative method:**
  - Idea categories extracted from the data itself (open and axial coding).
  - Categories successively added and refined until saturated and a codebook could be written.

MIDLEVEL ANALYSIS (MLA)

- Continuous, non-overlapping and gap free annotation of the stream of musical events.
  - Ideas are phrases or subsets of phrases.
  - Ideas can be related (idea chains).
- Hierarchical, unbalanced category system:
  - 9 main categories,
  - 18 sub categories,
  - 39 sub-sub categories.
- Compact annotation syntax.

category	definition	subtypes
Line	series of tones mostly proceeding in small, step-sized intervals with high rhythmical uniformity and a salient trajectory in pitch space	**line, line_tick:** Clear line without turns. **line_wavy:** Wavy lines, many turns. **line_interwoven:** Two or more interwoven lines.
Lick	rather short and concise melodic figure often including rhythmical and intervallic salience	lick_blues, lick_bebop
Melody	not derived from the theme of the song, embodying some kind of "song-like", "lyrical", or "cantabile" character	
Rhythm	units in which the rhythmical expression is the single most prominent feature	**single/multi** and **regular/irregular** combinations: **rhythm_sr:** Single tone, regular rhythm **rhythm_si:** Single tone, varying rhythm **rhythm_mr, oscillation:** Multiple tones, regular rhythm **rhythm_mi:** Multiple tones, varying rhythm
Theme	material taken directly from the theme of the tune, possibly with variations	
Quote	Direct quotes from another piece of music (jazz tune, classical tune etc.)	
Fragment	small set of tones neither forming a clear contour-based succession or motivic/thematic figure nor very expressive	
Expressive	single tones with a sound- or gesture-like character in which aspects of expressivity are clearly focused	
Void	moments of "actively playing nothing"	

Fig.8: Definition of MLA-categories (Frieler et al,. 2016)

MLA: EVALUATION

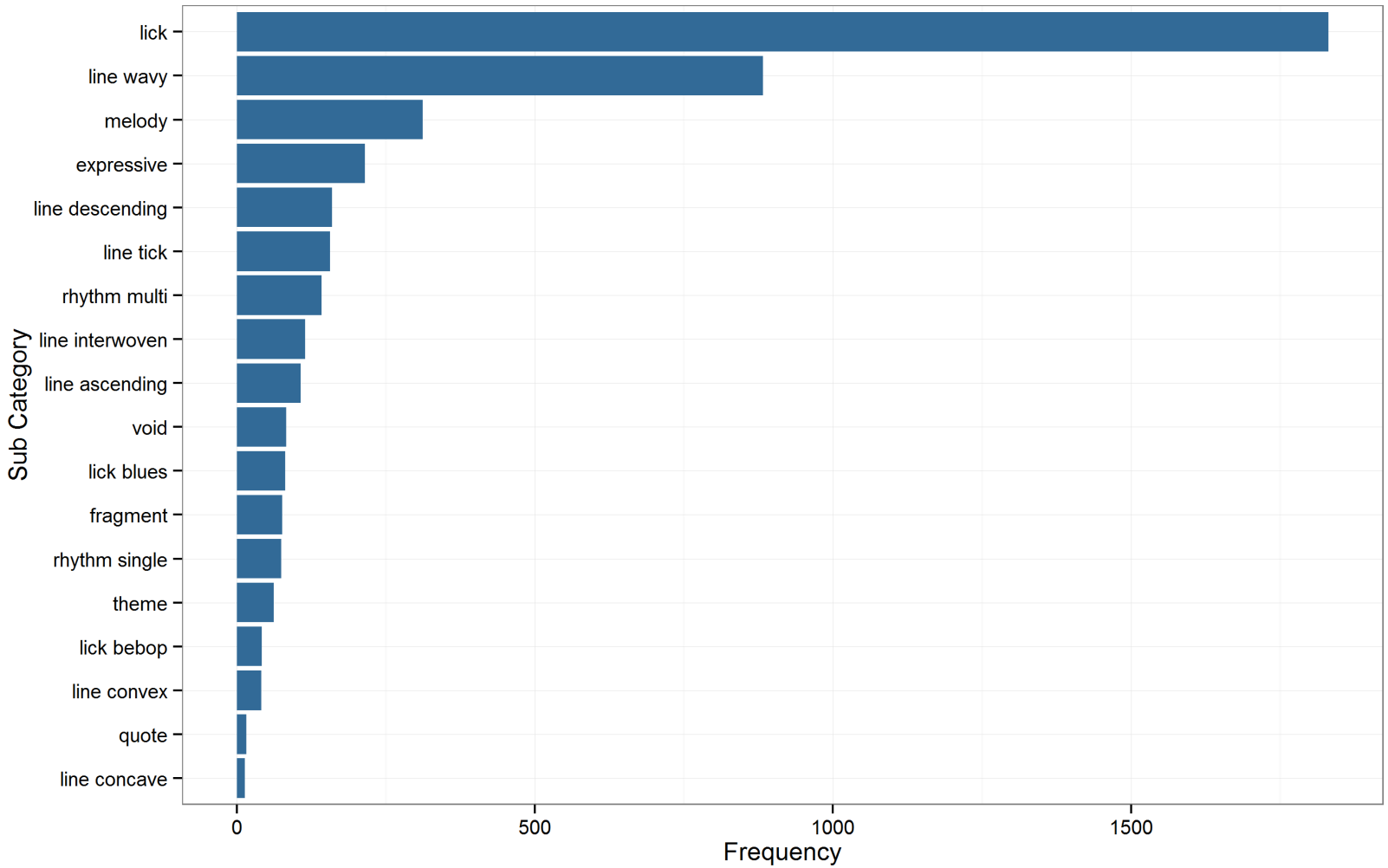
- Schütz (2015): Very high intra-coder reliability for one coder, high external validity according to musician interviews.
  - Evaluation of 10 solos with up to 4 different annotators:
    - Mean F-score for segment borders: .83 (sd: .08, baseline: .16)
    - Mean accuracy for main categories: .60 (sd: .15, baseline: .16)
    - Mean accuracy for full categories: .46 (sd: .15, baseline: .03)
  - Problems:
    - lick vs. line (23% of all confusions)
    - lick vs. melody (7%)
    - lick vs. rhythm (5%)
    - Recognising quotes, themes and long range references
    - Idea splitting

DATA

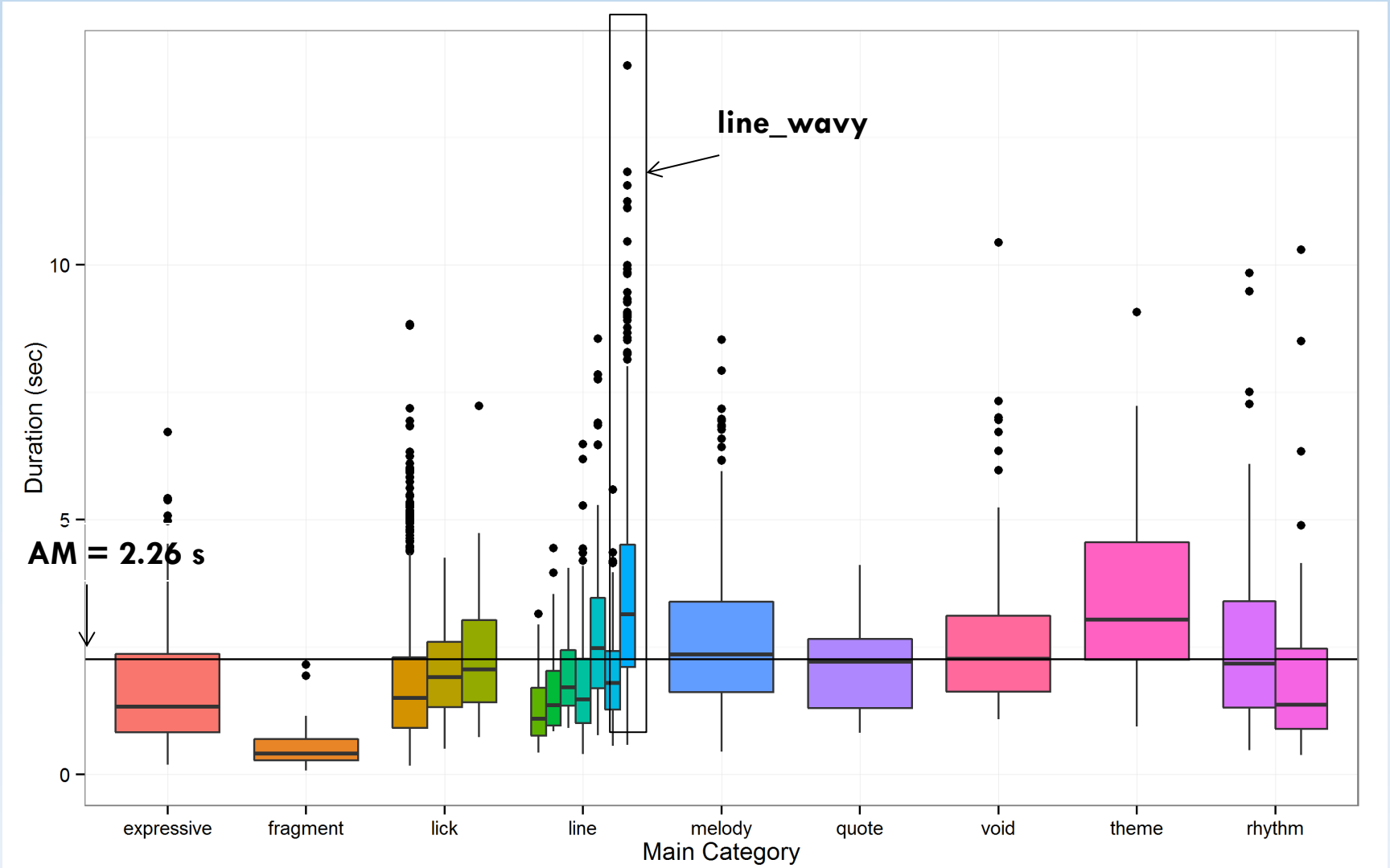
- 116 monophonic solos by 55 performers taken from the *Weimar Jazz Database*, mainly wind instruments, 5 style categories (Swing, Bebop, Cool, Hard Bop, Post-Bop).
- Manually annotated by Benjamin Burkhard, Friederike Bartel, Martin Meusinger and myself. Revised by KF.
- 4412 midlevel units (MLU) in total.

Art Pepper	1	David Murray	1	John Abercrombie	1	Rex Stewart	1
Ben Webster	1	Dexter Gordon	3	John Coltrane	6	Roy Eldridge	1
Benny Carter	1	Dickie Wells	2	Joshua Redman	2	Sonny Rollins	4
Benny Goodman	2	Dizzy Gillespie	2	Kenny Dorham	3	Sonny Stitt	2
Bob Berg	2	Don Byas	4	Kenny Garrett	1	Stan Getz	2
Buck Clayton	1	Don Ellis	2	Lee Konitz	3	Steve Coleman	2
Cannonball Adderley	4	Eric Dolphy	1	Lee Morgan	1	Steve Lacy	3
Charlie Parker	3	Fats Navarro	2	Lester Young	3	Steve Turre	2
Chet Baker	3	Freddie Hubbard	3	Lionel Hampton	1	Warne Marsh	1
Chu Berry	1	Gerry Mulligan	1	Michael Brecker	2	Wayne Shorter	3
Clifford Brown	4	Hank Mobley	1	Miles Davis	4	Woody Shaw	2
Coleman Hawkins	2	J.J. Johnson	1	Milt Jackson	1	Wynton Marsalis	1
Curtis Fuller	1	Joe Henderson	4	Pat Martino	1	Zoot Sims	1
David Liebman	3	Joe Lovano	1	Paul Desmond	4		

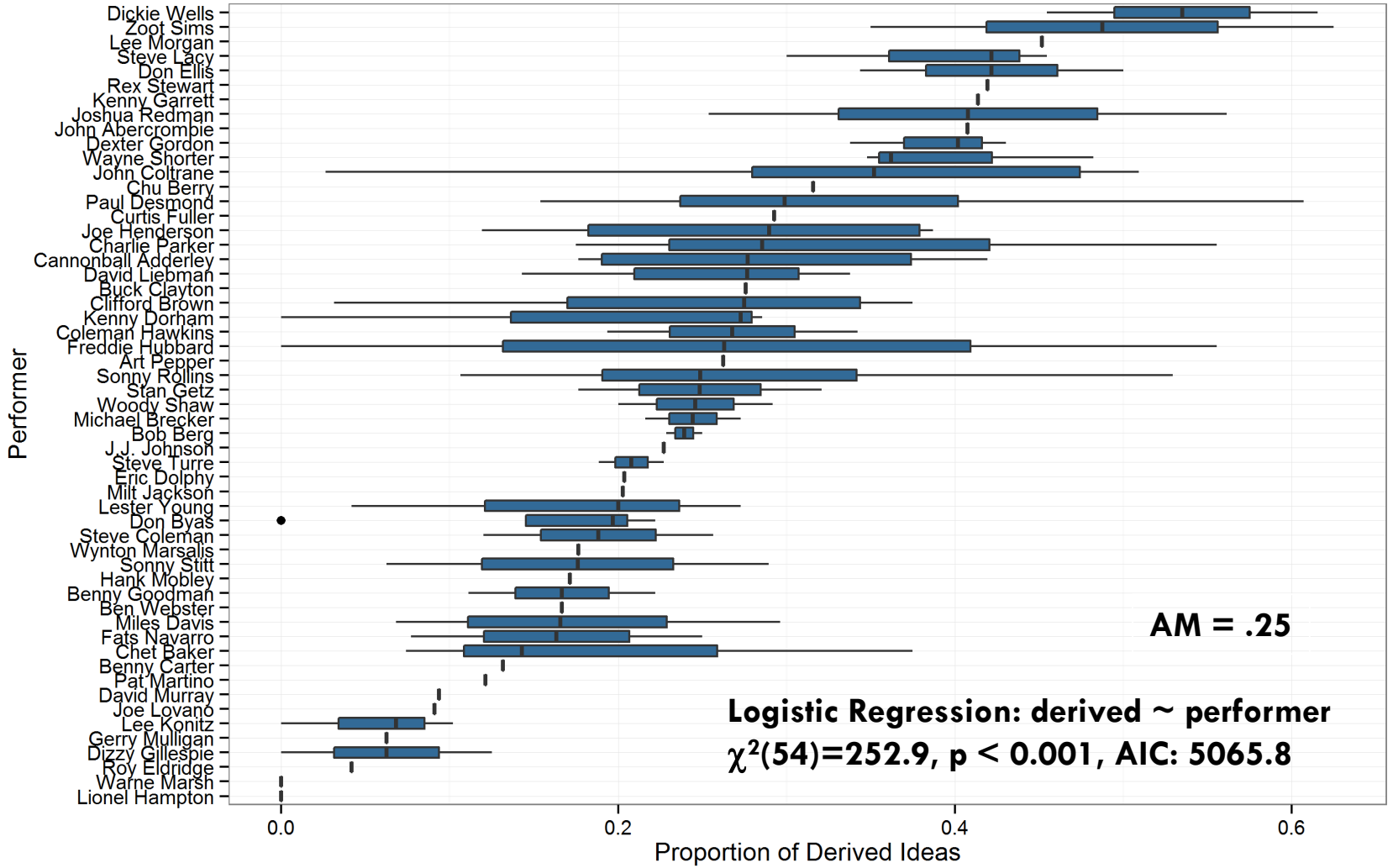
DISTRIBUTION OF SUBTYPES



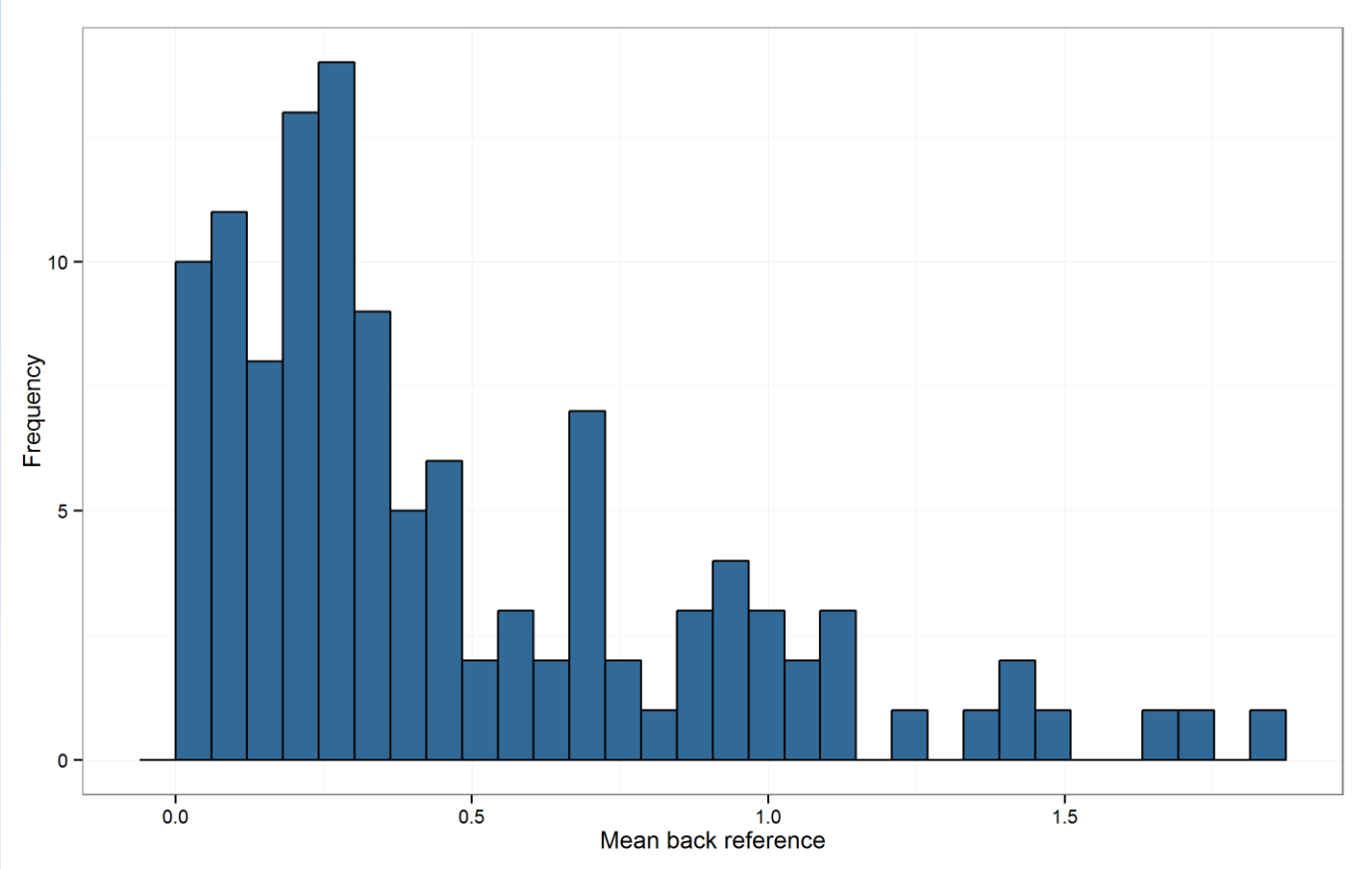
IDEA DURATIONS



FREE & DERIVED IDEAS: PERFORMER

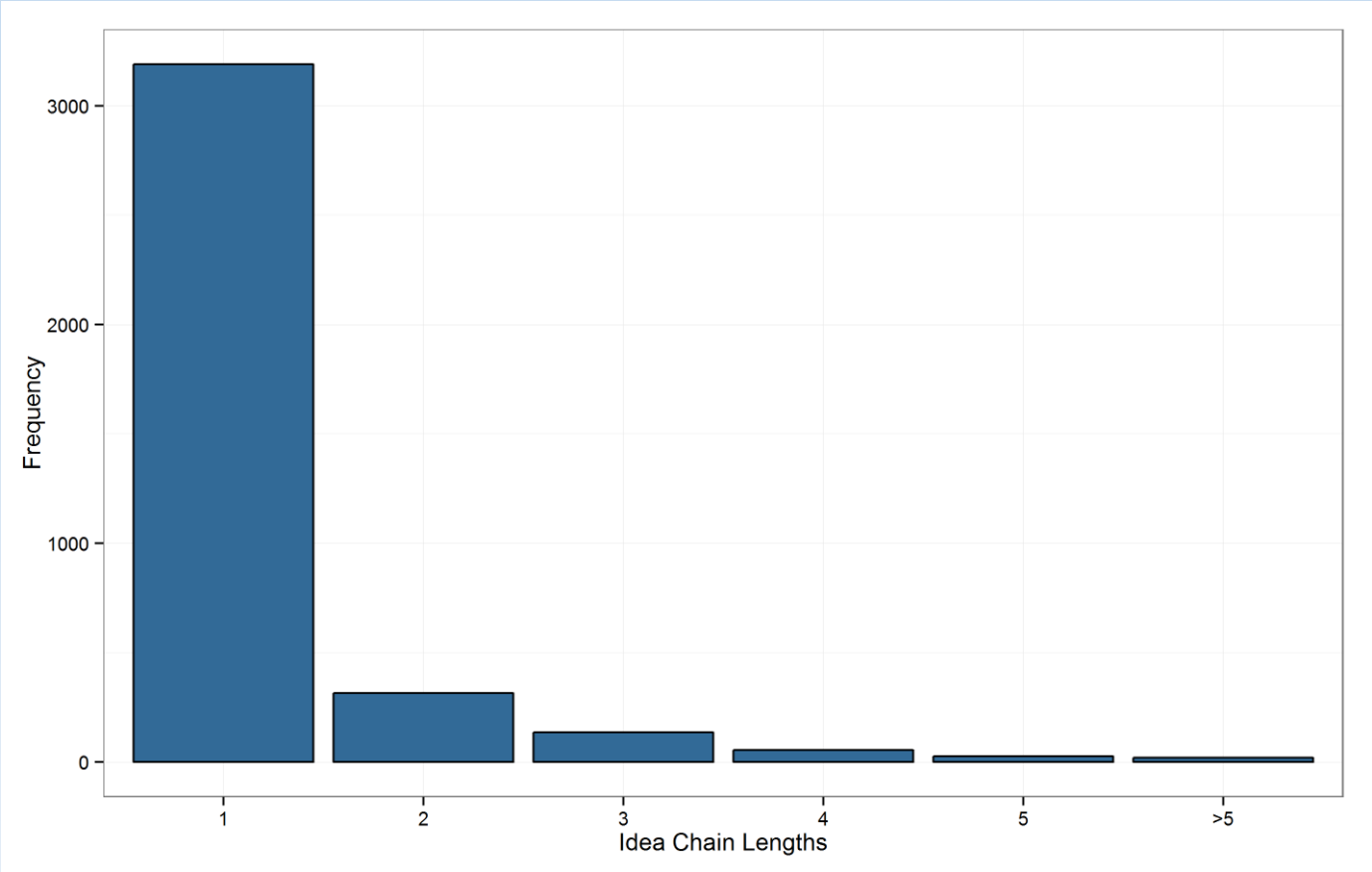


FREE & DERIVED IDEAS: BACK REFERENCE



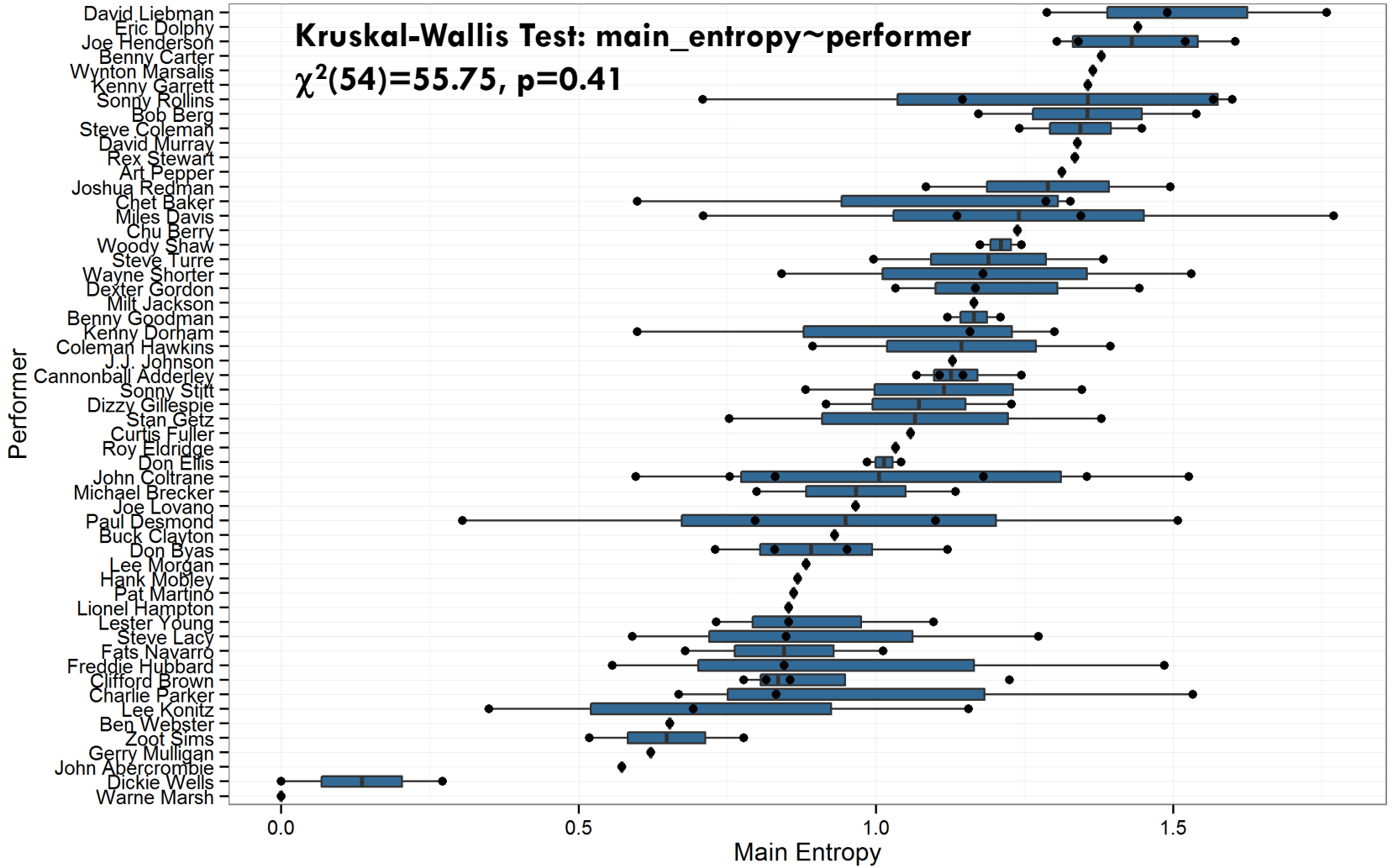
AM=0.47, SD=0.42

IDEA CHAIN LENGTH



AM=1.5 (2.8), SD=0.85 (1.44)

ENTROPY OF MAIN TYPES: PERFORMER



IDEATIONAL FLOW MODEL

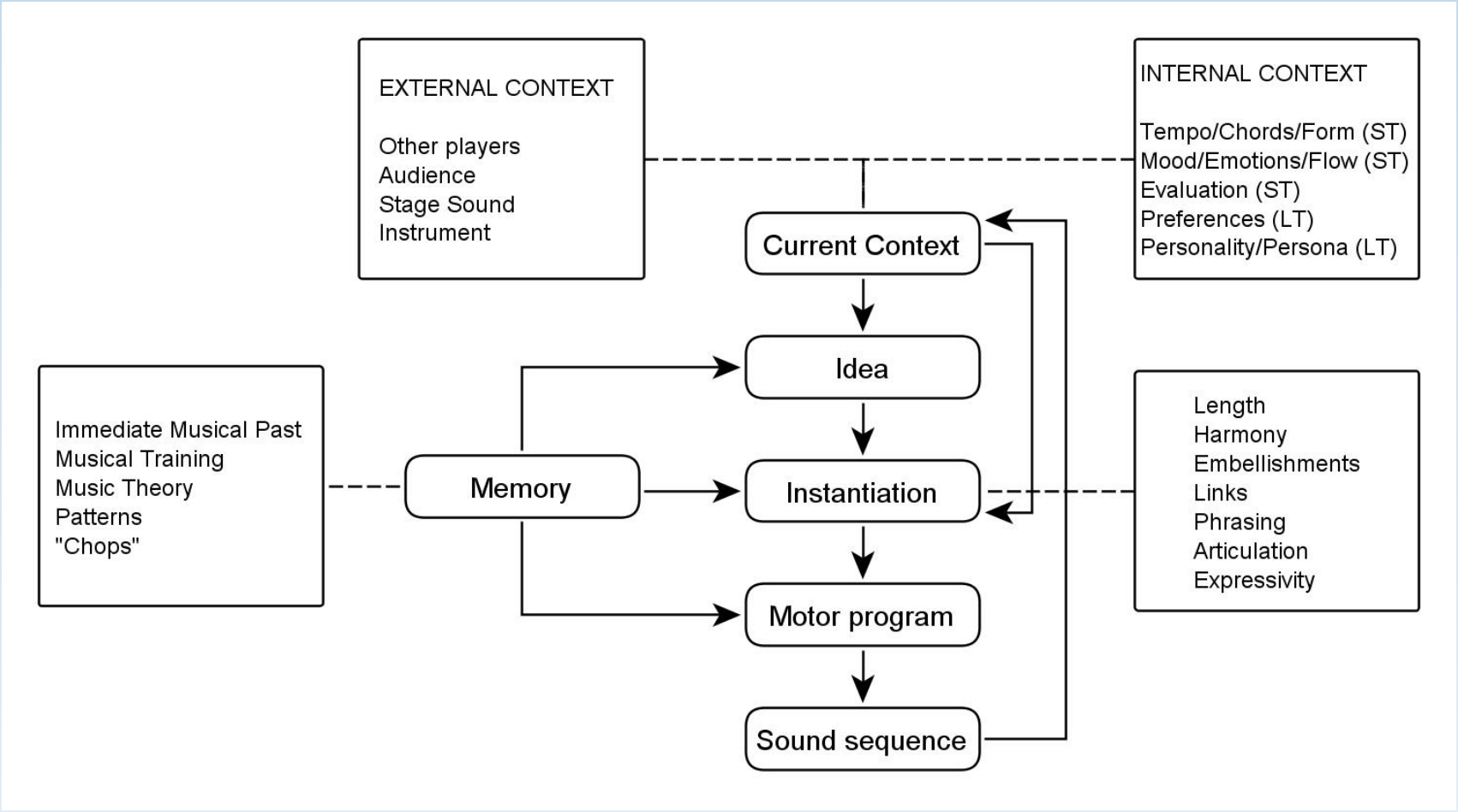


Fig.9: Flow diagram of the Ideational Flow Model (Frieler, Lothwesen & Schütz, in prep).

IDEATIONAL FLOW MODEL

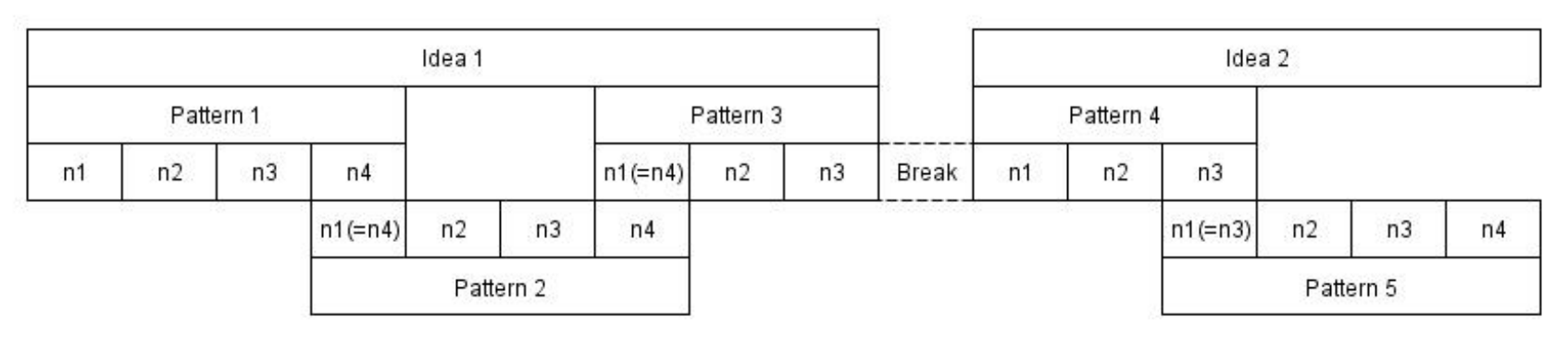


Fig.10: Schematic time sequence of the IFM (Frieler, Lothwesen & Schütz, in prep).

IDEATIONAL FLOW MODEL

General assumptions of the IFM:

1. Conscious decision making on a note to note level is not to be performed sufficiently during performance due to high demands of information processing.
2. Improvisers naturally seek to reduce the cognitive load of incoming information during performance in order to remain capable of acting.
3. The generation of ideas in musical improvisation is located at a mid-level providing gesture-like musical forms that allow to focus on particular parameters in spontaneous actions.
4. Idea generation is majorly influenced by internalised motor programmes that help to overcome the 'time to think' needed for idea generation.

- The IFM is an explanatory strategy for continuous idea generation during musical improvisation: 'ideas' are representations of musical gesture-like forms that provide frames for actual note-to-note-events.

IDEATIONAL FLOW MODEL

Open questions:

1. How do ideas come about?
2. How are ideas actually instantiated?
3. How can the Ideational Flow Model be validated?

Thank you for your attention!

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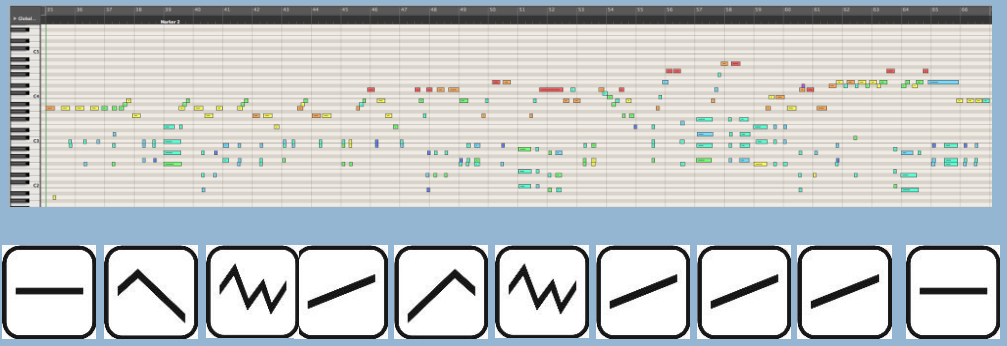

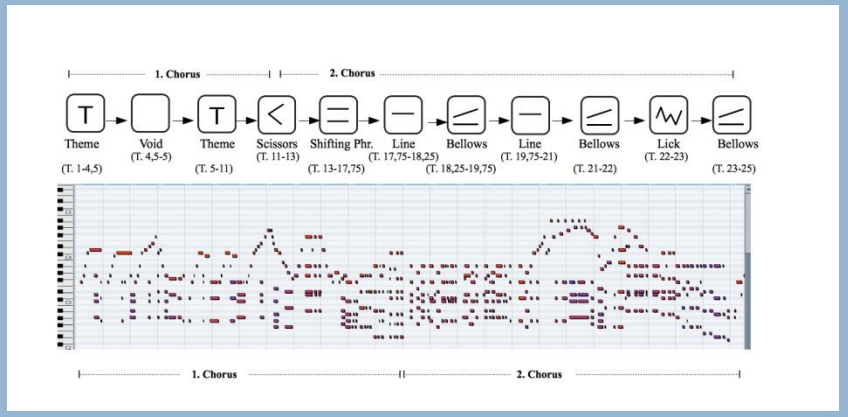

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HOW DO IDEAS COME ABOUT?

Attention: Speculations ahead!

- Underlying mechanisms must be based on neuronal networks.
- NN are hierarchical & recurrent.
- NN are deterministic → can only produce sequences already seen.
- NNs are embedded in much bigger networks, which serve as modulators to low level behaviour.

HOW DO IDEAS COME ABOUT?

- Modulators are dependent on internal and external states, which cannot be completely known.
- Incomplete knowledge is best to be modelled using probabilistic tools.
- There are no real random processes (except in the quantum world), there is only incomplete knowledge.
- Which is basically the same.
- And this is the source of creativity.

HOW DO IDEAS COME ABOUT?

- But randomness does not mean lawlessness.
- Idea generating networks could be modelled as associative networks.
- The probability to observe an idea is conditional on internal states, which are in turn conditioned on external states via sensorial, cognitive, motoric and affective processing.

$$\mathbf{p(idea) = \Sigma_{all\ states}\ p\ (idea \mid internal)\ p(internal \mid external)\ p(external)}$$

HOW ARE IDEAS REALIZED?

- The probability of chunk is given by an a-priori value (due to practice) and an **associative value** of the chunk in the current context.
- The **associative value** of a chunk is given by
  - The harmonic context (an mostly internal state, Pressing's "referent").
  - Current motor trajectory and other body states (breathing).
  - Technical difficulty.
  - Semantic associations (e.g. quotes, theme reference)
  - Communicative intentions (e.g. displaying chops).
  - Input from other players (imitation, call-and-response.)

HOW ARE IDEAS REALIZED?

- Instantiation processes with concrete motor actions are governed by similar mechanisms.

$$p(\text{action}) = \sum_{\text{past, external}} p(\text{action} \mid \text{idea, prev. action}) \times p(\text{idea} \mid \text{prev. idea, internal}) \times p(\text{internal} \mid \text{external})$$

- Simple model:
  - Tones are produced as rather fixed chunks.
  - Chunks can change, depending on the context (internal &external states, e.g. idea, harmonic referent, co-player input).
  - Ideas can also change, depending on the context.

HOW CAN THE MODEL BE TESTED?

- Two approaches:
  1. Introspection of performers
  2. Generative models
- First approach already carried out:
  - Schütz (2015) did extensive interview studies with jazz piano players, teaching them the method. Participants mostly agreed with the mid-level approach
  - Second study under way with saxophone players (cf. today afternoon).

HOW CAN THE MODEL BE TESTED?

- Generative models are still to be developed.
  - Indirect evidence by studying pattern distributions (Owens, 1974; Norgaard, 2012; Frieler, 2014)
  - Markov and N-gram models are not the correct approach:
    - Produce either to less (small order) or too many patterns (large order).
    - Problems of multidimensionality and constraint satisfaction.
    - Cannot account for **theme, quote, oscillation,** and **expressive** ideas as well as motivic work (about 25% of all ideas are derived!).
    - Markov probabilities clearly depend on context, e.g. harmonic referent.

DISCUSSION AND OUTLOOK

- IFM advances Pressing's and Behne's models.
- Midlevel analysis provides operationalization of the model.
- IFM offers new approaches for generative models.
- Future:
  - Test MLA under controlled lab conditions.
  - More interview studies with performers.
  - Build actually generative models based on the IFM.