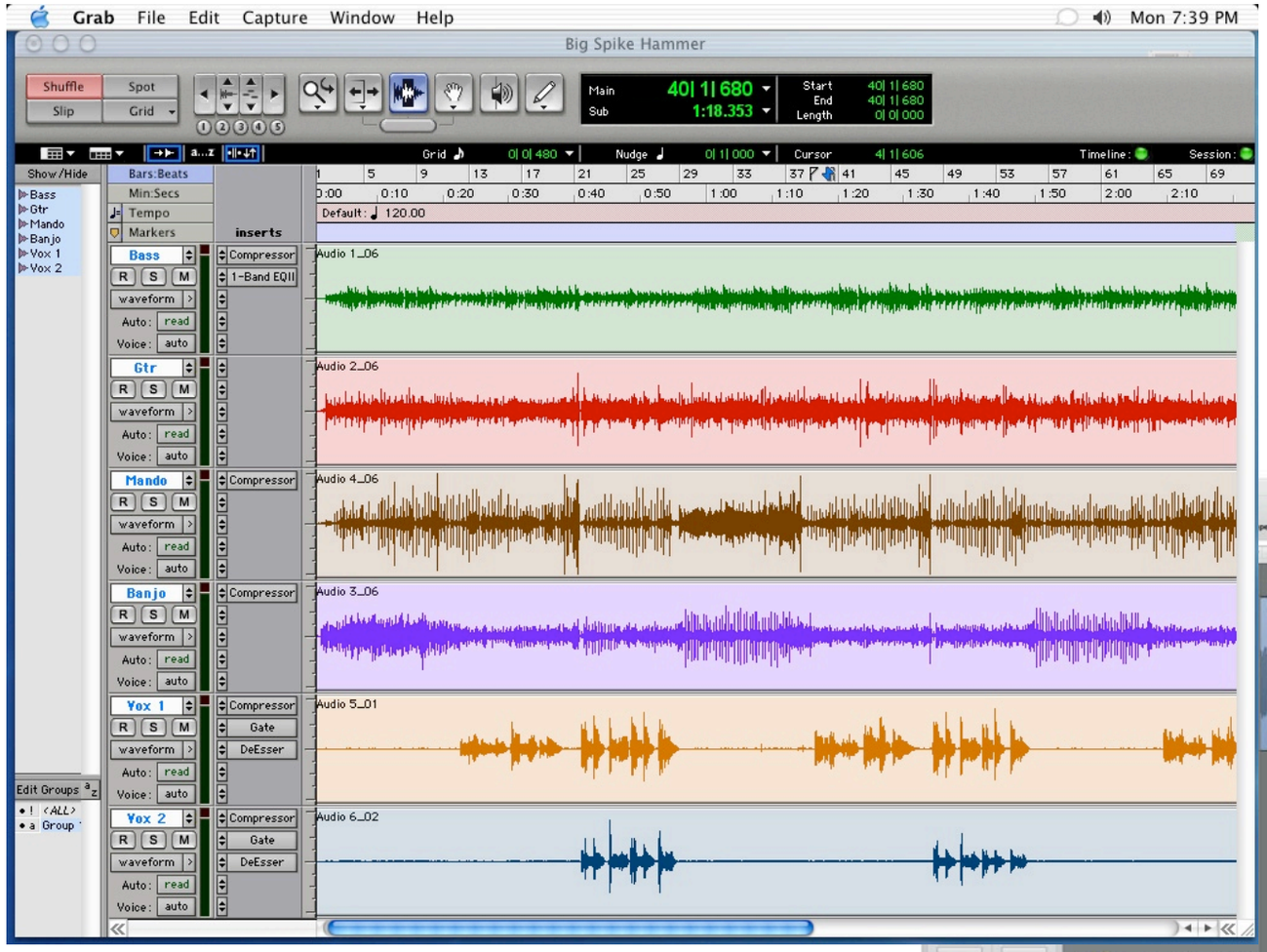
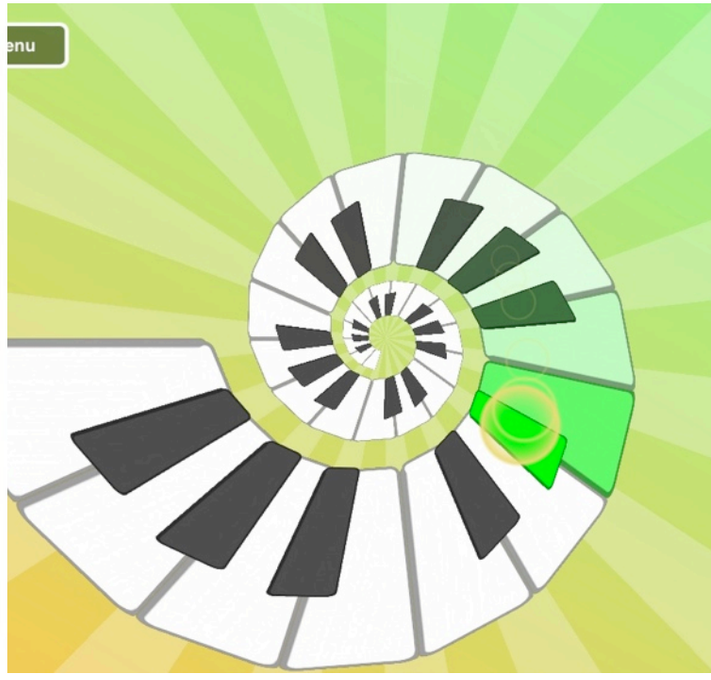
Some thoughts on (digitally-assisted) creativity

Creativity in the big... is too hard a problem
for a mathematician.

So I'll restrict my domain of discourse here to
musical creativity, in the hope that
this generalizes.



Lots of tools for “making music”



Some even provide “exploratory” assistance

But none focus 100% on helping me “be creative”.

- **First step: Define creativity.**
  - "define" in the mathematical sense: make a precise statement describing an object that I want to argue about.
  - I am *in no way* suggesting that this is a universally correct/accepted definition (in the sense of a dictionary definition).

- Creativity is:
  - Pattern seeking
  - Structural model building

- We “distilled”(??) a vast quantity of ideas in the existing literature down to nine design principles.

This process was, necessarily, quite subjective and, consequently, totally unscientific!

Structure Principle

- Content should be:
  - *modelled* with structure
  - *presented* in a way that intuitive reflects the underlying model

Construction Principle

- Tools should:
  - retain a history of transformations applied to the model
  - make it easy for the user to get at (and play with!) that history.

Juxtaposition Principle

- Tools should:
  - expose the artist to multiple artifacts simultaneously
  - facilitate fast comparison of artifacts

Annotation Principle

- Tools should permit the artist to annotate steps and collections of steps with additional semantics beyond the rote specification of a transformation.

Infusion Principle

- Tools should:
  - have vast libraries of "prior art"
  - library artifacts should be modelled in a way consistent with the operation of the tool.

"Lesser artists borrow,
great artists *steal*."

Fluidity Principle

- Artifacts should be represented in a way that facilitates "frequent, *radical*" transformation.

Imprecision Principle

- Artifacts should be presented in a way that "properly conveys their rough and approximate nature."
- viz., you should be able to "get a sense of the whole at a glance".

Responsiveness Principle

- Get the hell out of the artists way.
- As quickly as possible.

Serendipity Principle

- Close no doors
- Make accidents happy
- *Actively encourage* accidents

Wheelsong

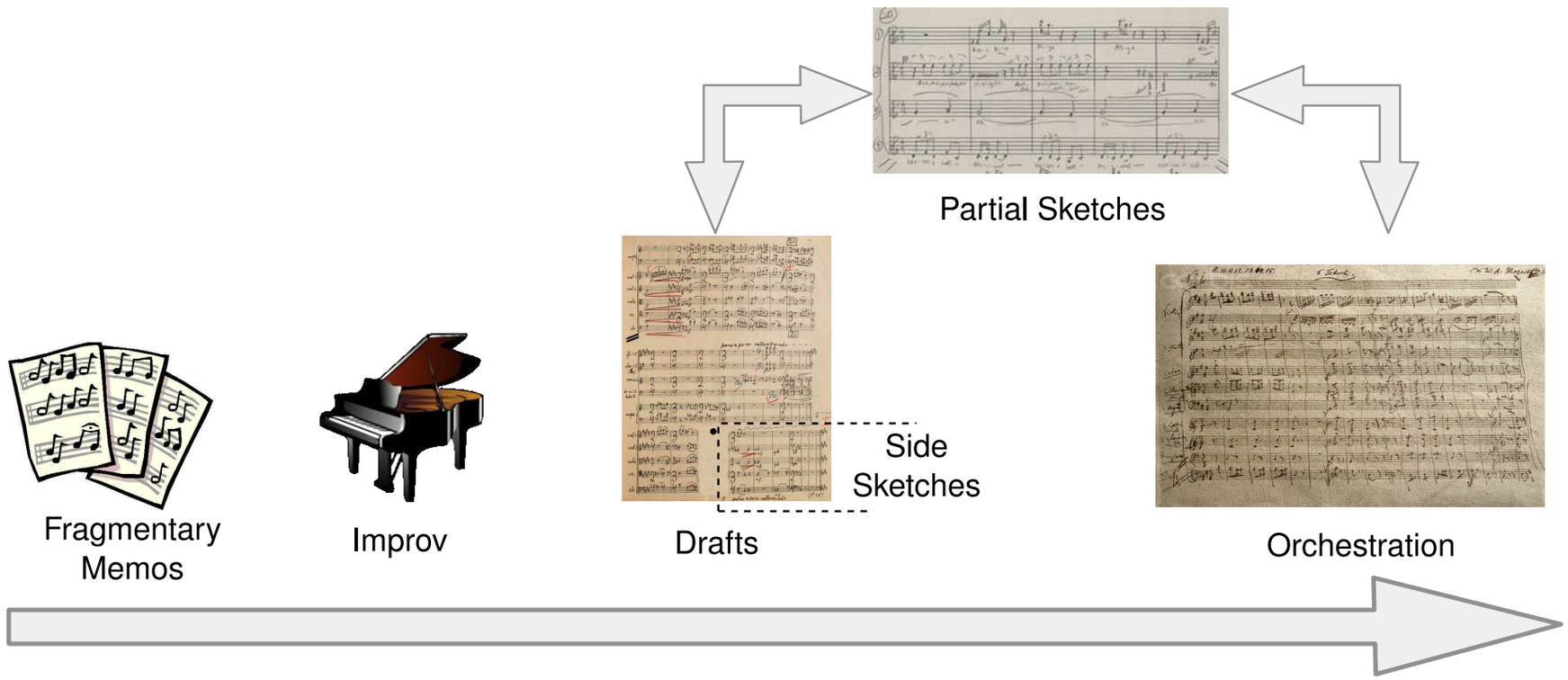
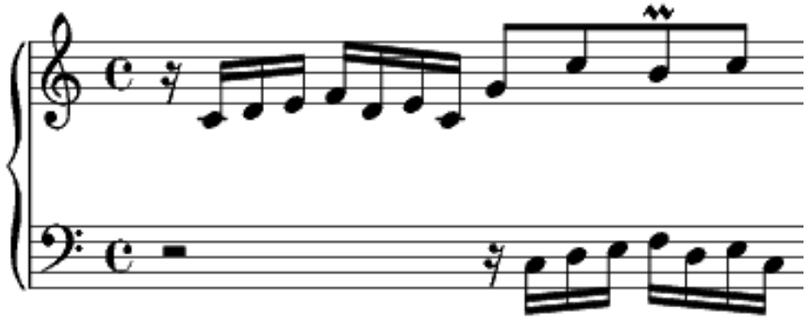


Figure 2.6: Bartók's primary creative workflow [107, adapted from p. 34]

The goal



(a) Common Notation

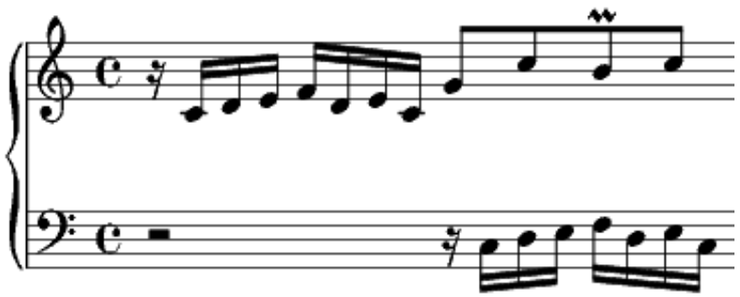
```
% Treble clef
P60S60T01D1V000C255X0Y0 P60S60T02D1V200C200X0Y0
P62S62T03D1V200C200X0Y0 P64S64T04D1V200C200X0Y0
P65S65T05D1V200C200X0Y0 P62S62T06D1V200C200X0Y0
P64S64T07D1V200C200X0Y0 P60S60T08D1V200C200X0Y0
P67S67T09D2V200C200X0Y0 P72S72T11D2V200C200X0Y0
P71S71T13D2V200C200X0Y0 P72S72T15D2V200C200X0Y0

% Bass clef
P48S48T01D8V000C200X0Y0 P48S48T09D1V000C200X0Y0
P48S48T10D1V200C200X0Y0 P50S50T11D1V200C200X0Y0
P52S52T12D1V200C200X0Y0 P53S53T13D1V200C200X0Y0
P50S50T14D1V200C200X0Y0 P52S52T15D1V200C200X0Y0
P48S48T16D1V200C200X0Y0
```

(b) WSNG Notation

Figure 4.2: First measure of Bach's *Invention №1 in C Major*

Typical computer encoding. Structure?



(a) Common Notation

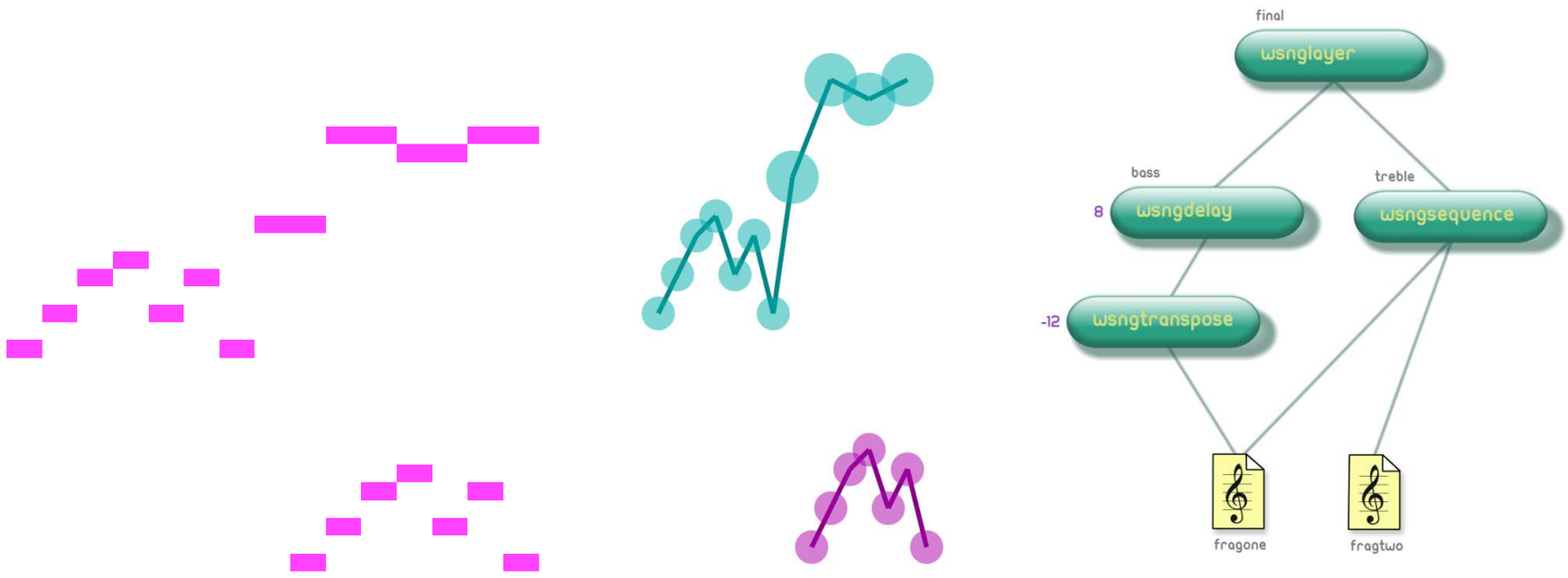
```
FragOne = <P60V0 P60V200 P62 P64 P65 P62 P64 P60>
FragTwo = <P67D2 P72 P71 P72>

wsnglayer [final] {
   -i {
      wsngsequence [treble] {
         -i { FragOne }
         -i { FragTwo }
      }
   }
   -i {
      wsngdelay [bass] {
         -t { 8 }
         -i {
            wsngtranspose {
               -n { -12 }
               -i { FragOne }
} } } } }
```

(b) WSNT Notation

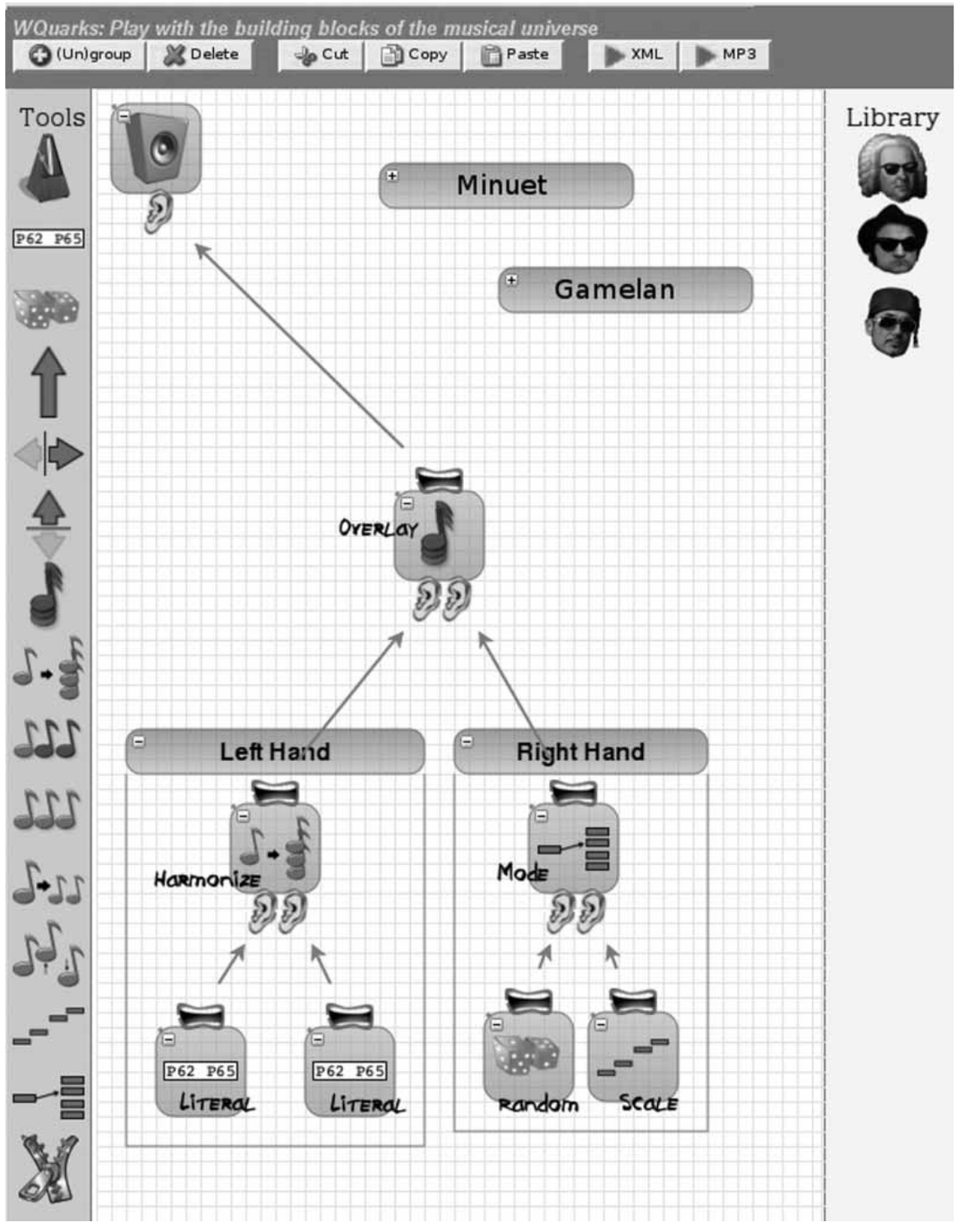
Figure 4.9: First measure of *Invention №1 in C Major*, expressed structurally

Hierarchical Structure



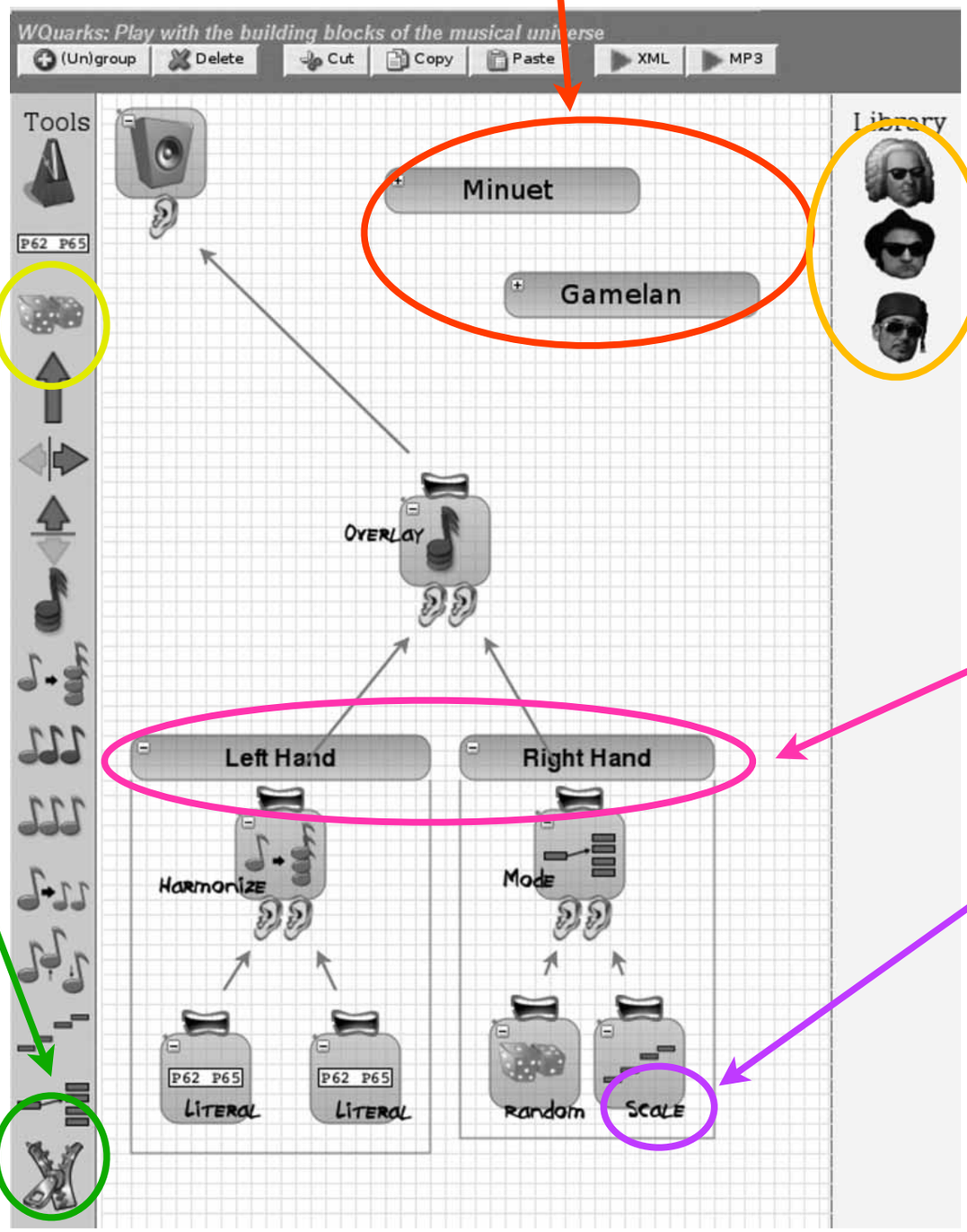
(a) Piano Roll (b) Voice flow (c) GraphViz

Figure 4.11: Visualizing the first bar of Bach's *Invention №1 in C Major*



The interface: facilitating creation

Juxtaposition



Fluidity

Infusion

History

Structure

Imprecision

Annotation

Responsiveness

Serendipity

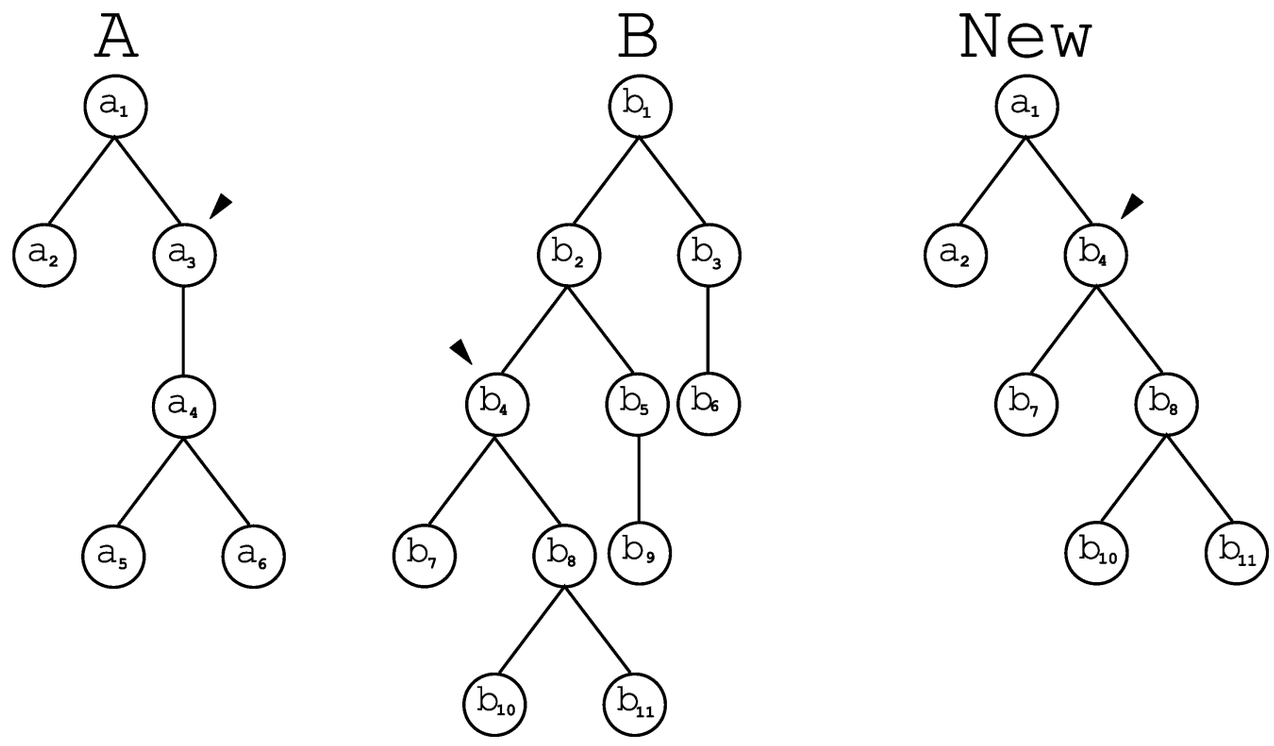


Figure 6.7: Tree crossover

An example of 'Fluid recombination'

(a) April 2010

Submission	Overall
24	8.75
36	8.69
31	8.38
21	8.26
17	8.01
25	8.00
29	7.91
37	7.84
7	7.73
9	7.69
6	7.67
22	7.64
3	7.55
5	7.50
20	7.45
26	7.45
23	7.41
33	7.35
39	7.35
27	7.30
16	7.27
19	7.20
8	7.17
28	7.13
32	7.00
35	7.00
40	6.98
Clockhouse	6.98
15	6.95
2	6.87
34	6.80
4	6.73
38	6.60
30	6.59
10	6.48
18	6.41
14	6.32
13	6.27
1	6.25
11	6.16
12	6.13

28/41

Submission	Creativity
39	9.00
Clockhouse	8.50
24	8.49
25	8.29
26	8.02
36	7.99
37	7.85
31	7.83
21	7.78
17	7.74
3	7.70
5	7.65
9	7.64
6	7.62
16	7.54
15	7.52
32	7.44
22	7.41
19	7.40
35	7.39
4	7.30
27	7.30
7	7.22
23	7.15
2	7.02
8	7.01
13	7.01
14	7.01
20	6.93
28	6.92
12	6.88
33	6.82
29	6.81
34	6.71
40	6.61
38	6.55
10	6.47
11	6.34
18	6.21
30	6.17
1	5.77

2/41

(b) July 2010

Submission	Overall
24	8.52
11	8.46
15	8.13
13	8.07
23	8.00
7	7.78
29	7.75
6	7.71
9	7.71
28	7.68
1	7.58
26	7.58
18	7.53
10	7.52
20	7.44
34	7.41
25	7.33
31	7.28
4	7.26
32	7.25
22	7.20
36	7.17
27	7.16
35	7.16
12	7.02
30	6.99
5	6.95
Lament	6.74
19	6.74
16	6.69
3	6.64
14	6.54
2	6.26
33	6.04
37	4.76
17	4.25
21	3.90

28/37

Submission	Creativity
24	8.24
15	8.00
11	7.74
28	7.56
32	7.49
9	7.43
27	7.42
18	7.36
5	7.35
29	7.32
36	7.32
13	7.26
7	7.25
1	7.22
6	7.17
34	7.17
26	7.15
10	7.14
31	7.13
35	7.13
20	7.12
25	7.12
19	7.11
4	6.97
23	6.96
14	6.78
12	6.75
16	6.75
Lament	6.72
22	6.71
30	6.71
3	6.60
2	6.20
17	5.96
33	5.95
37	5.37
21	4.26

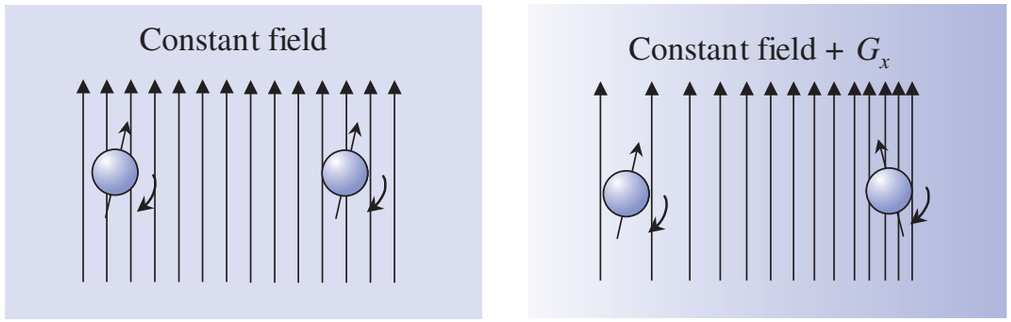
29/37

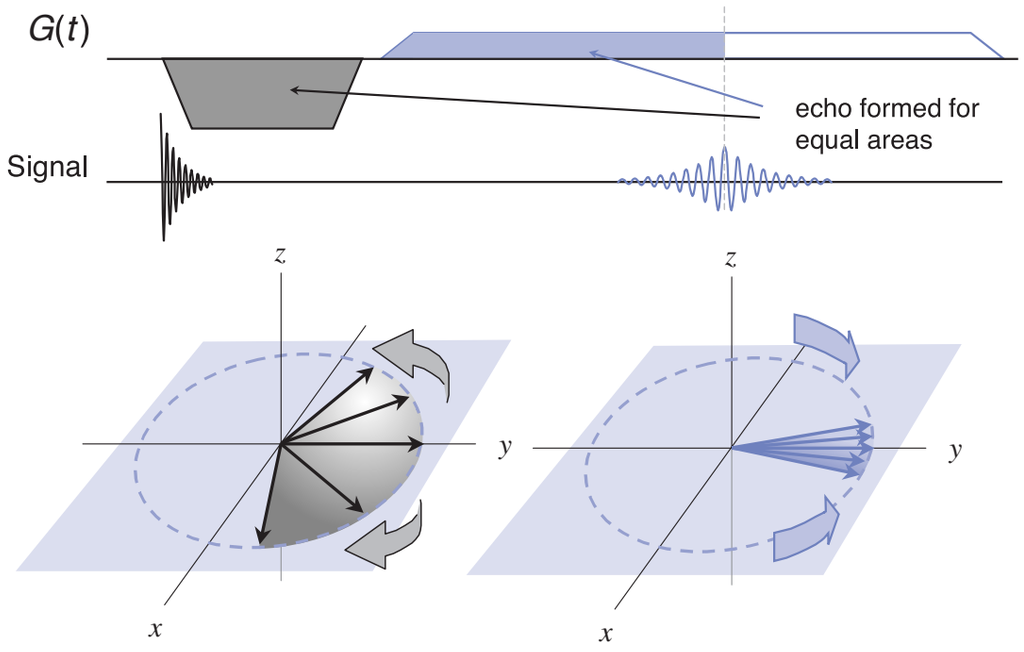
Table 6.14: Composition contest results

Neuroscience of musical creativity

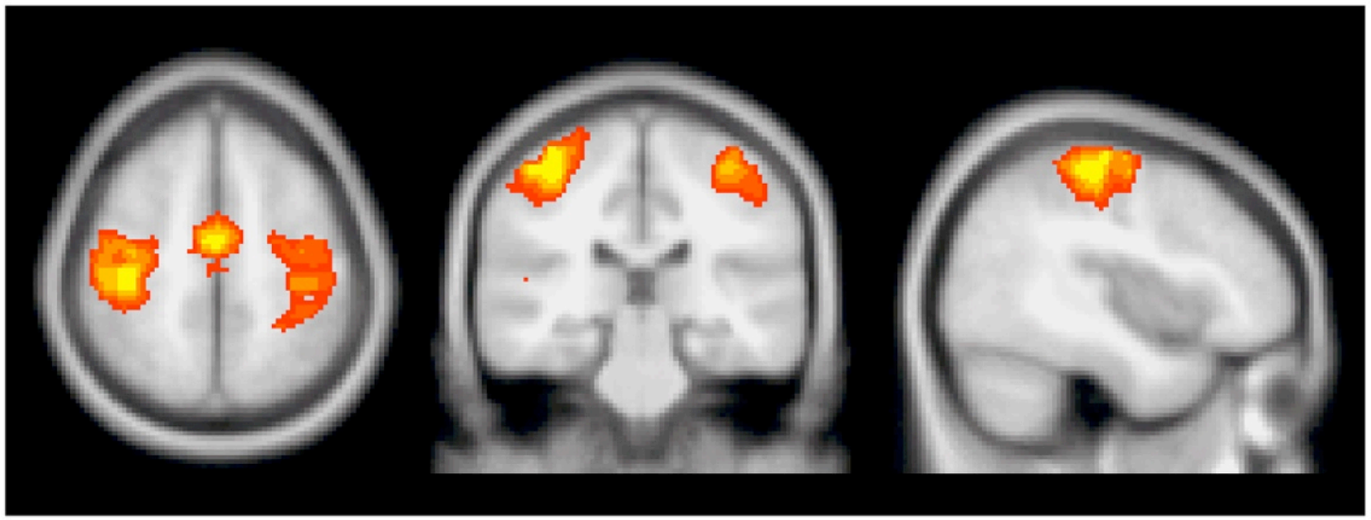

SIEMENS

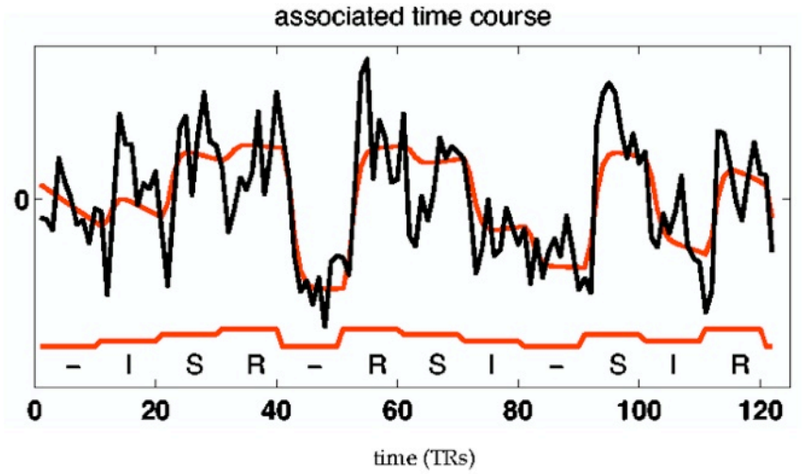
MRI

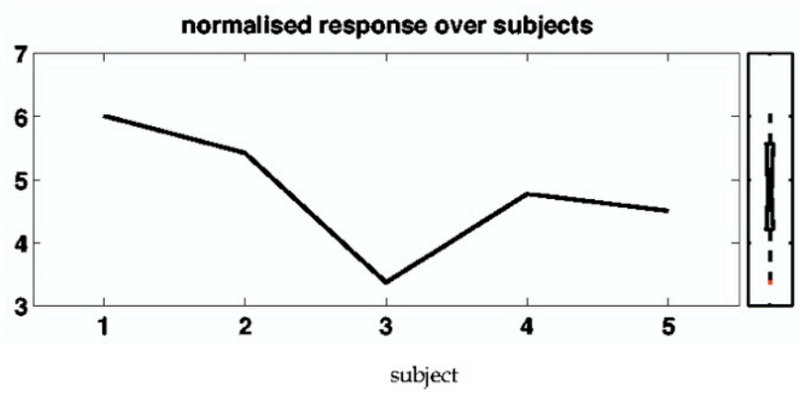

Constant field
Constant field + G_x

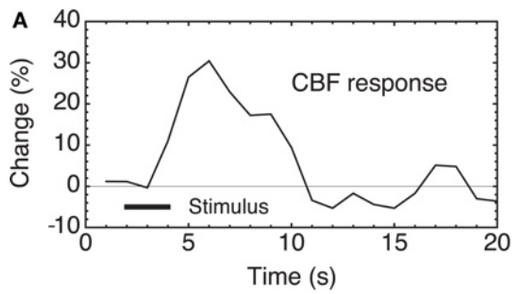

$G(t)$
Signal
echo formed for
equal areas
z
y
x
z
y
x

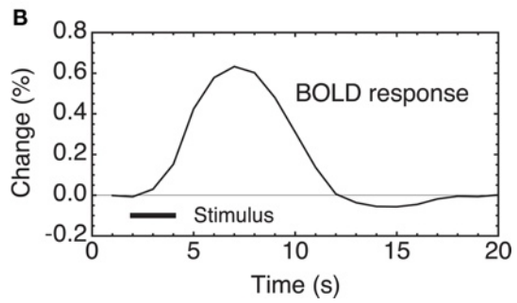
fMRI











Interpreting oxygenation-based neuroimaging signals: the importance and the challenge of understanding brain oxygen metabolism

Richard B. Buxton*

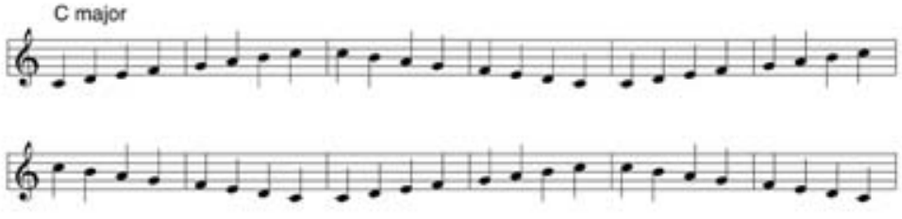
Neural Substrates of Spontaneous Musical Performance: An fMRI Study of Jazz Improvisation

Charles J. Limb[1,2]*, Allen R. Braun[1]

over-learned

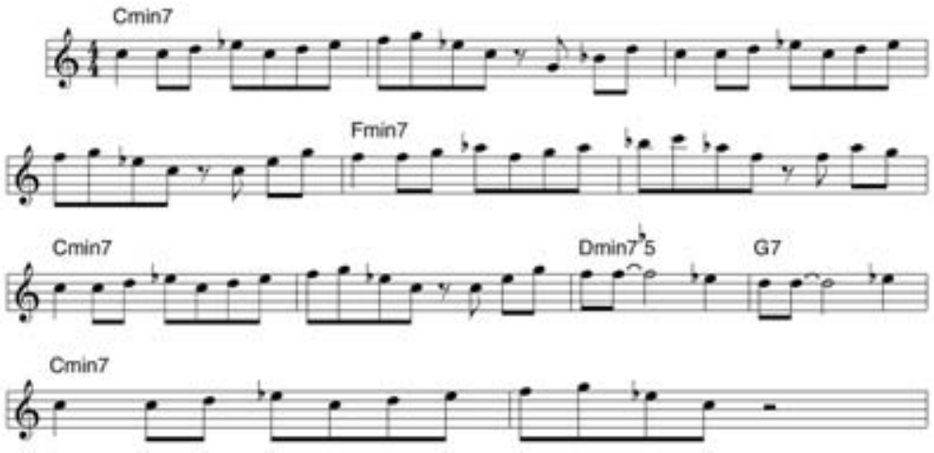
improvised

ScaleCtrl

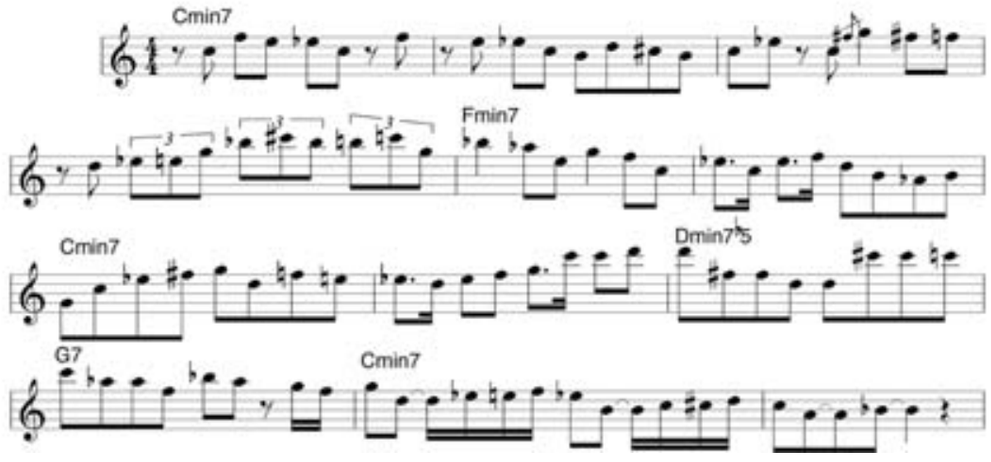


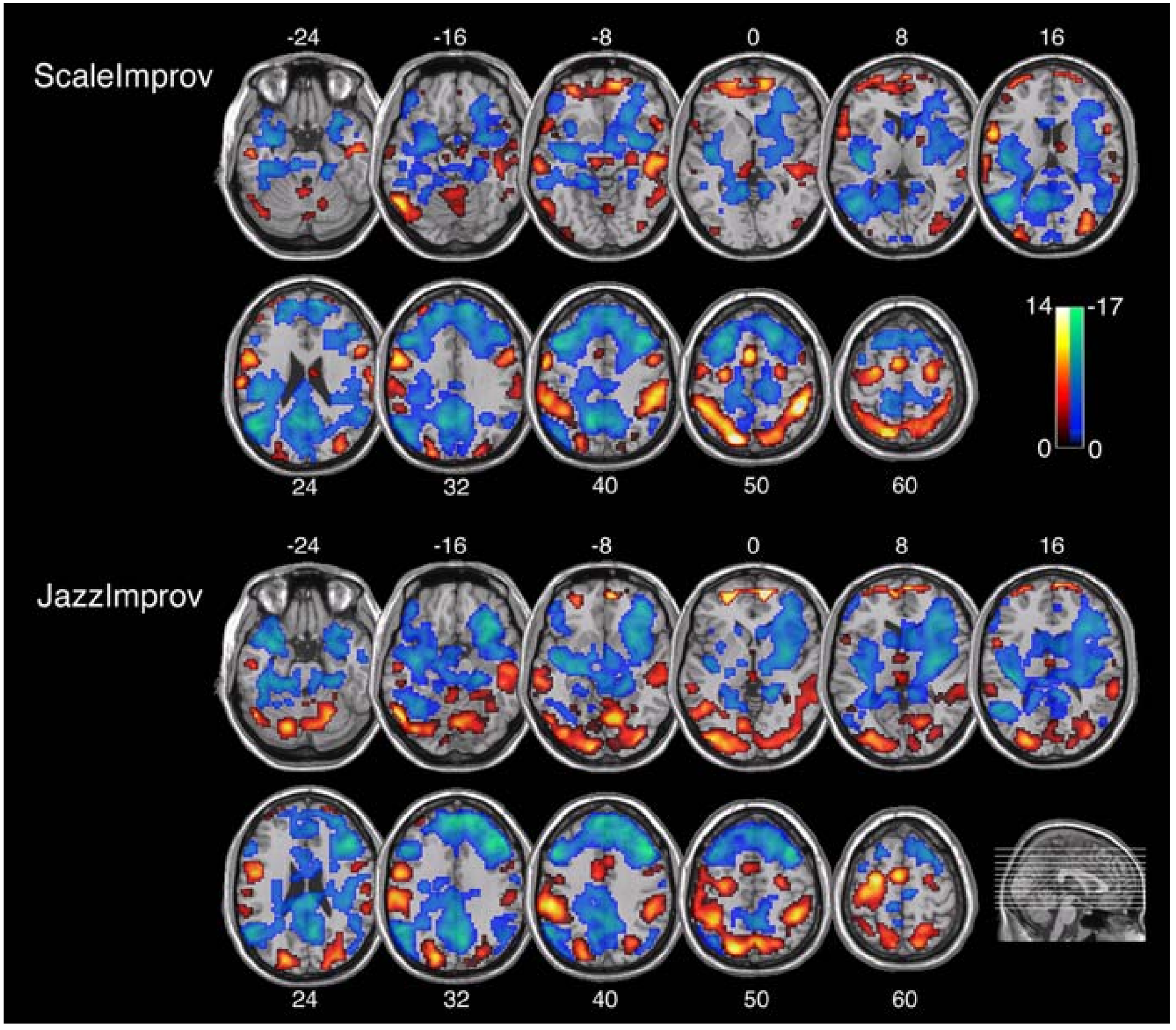
ScaleImprov *(example)*

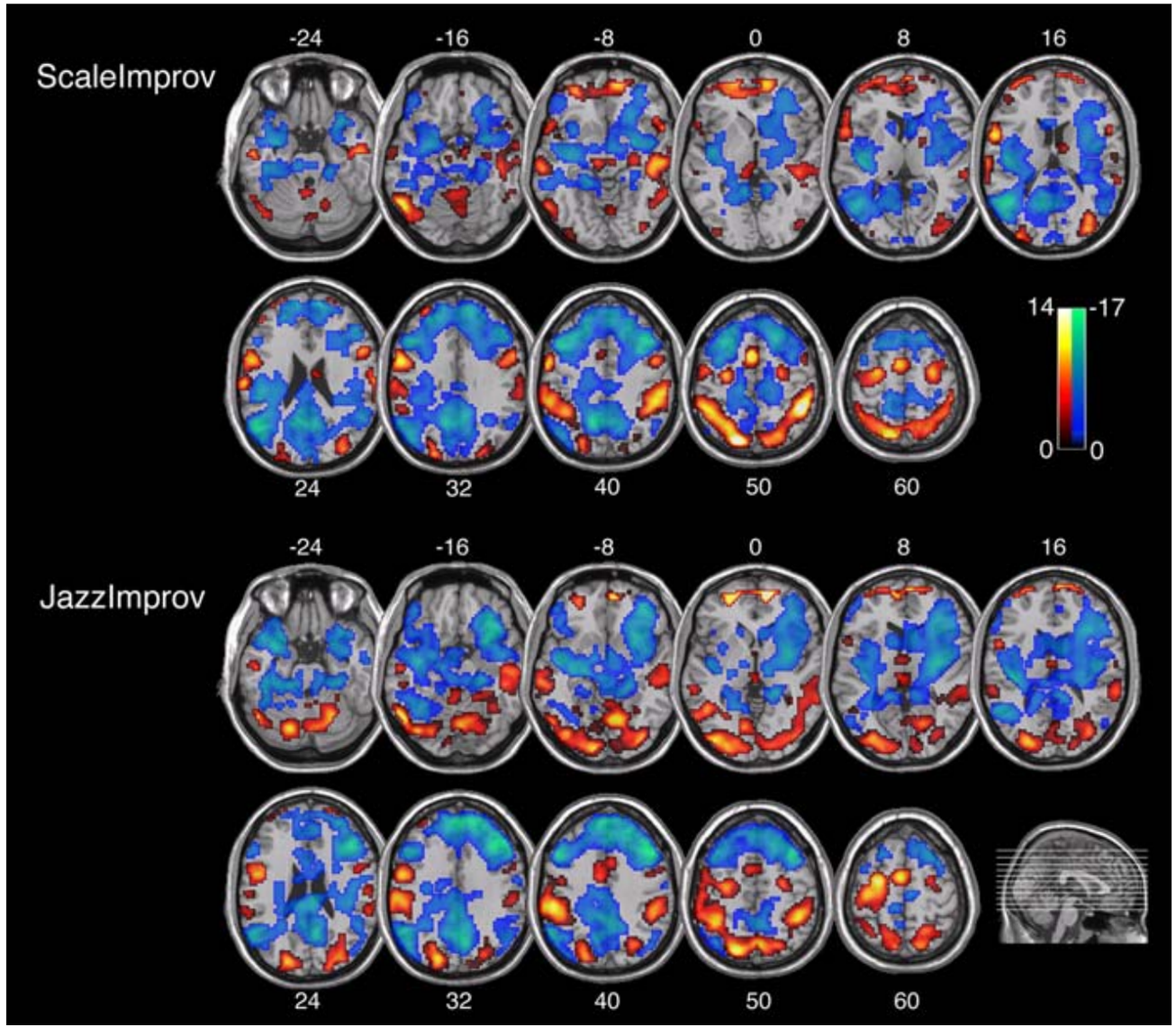
JazzCtrl



JazzImprov *(example)*




ScaleImprov
-24
-16
-8
0
8
16
14
-17
0
0
24
32
40
50
60
JazzImprov
-24
-16
-8
0
8
16
24
32
40
50
60



Wow.. that's a lot of blue!

Creativity (at least improv) is apparently about... *inhibition.*

"creative intuition may operate when an attenuated DLPFC no longer regulates the contents of consciousness, allowing unfiltered, unconscious, or random thoughts and sensations to emerge."

Neural Correlates of Lyrical Improvisation: An fMRI Study of Freestyle Rap

Siyuan Liu[1], Ho Ming Chow[1], Yisheng Xu[1], Michael G. Erkkinen[1], Katherine E. Swett[1], Michael W. Eagle[2], Daniel A. Rizik-Baer[2] & Allen R. Braun[1]

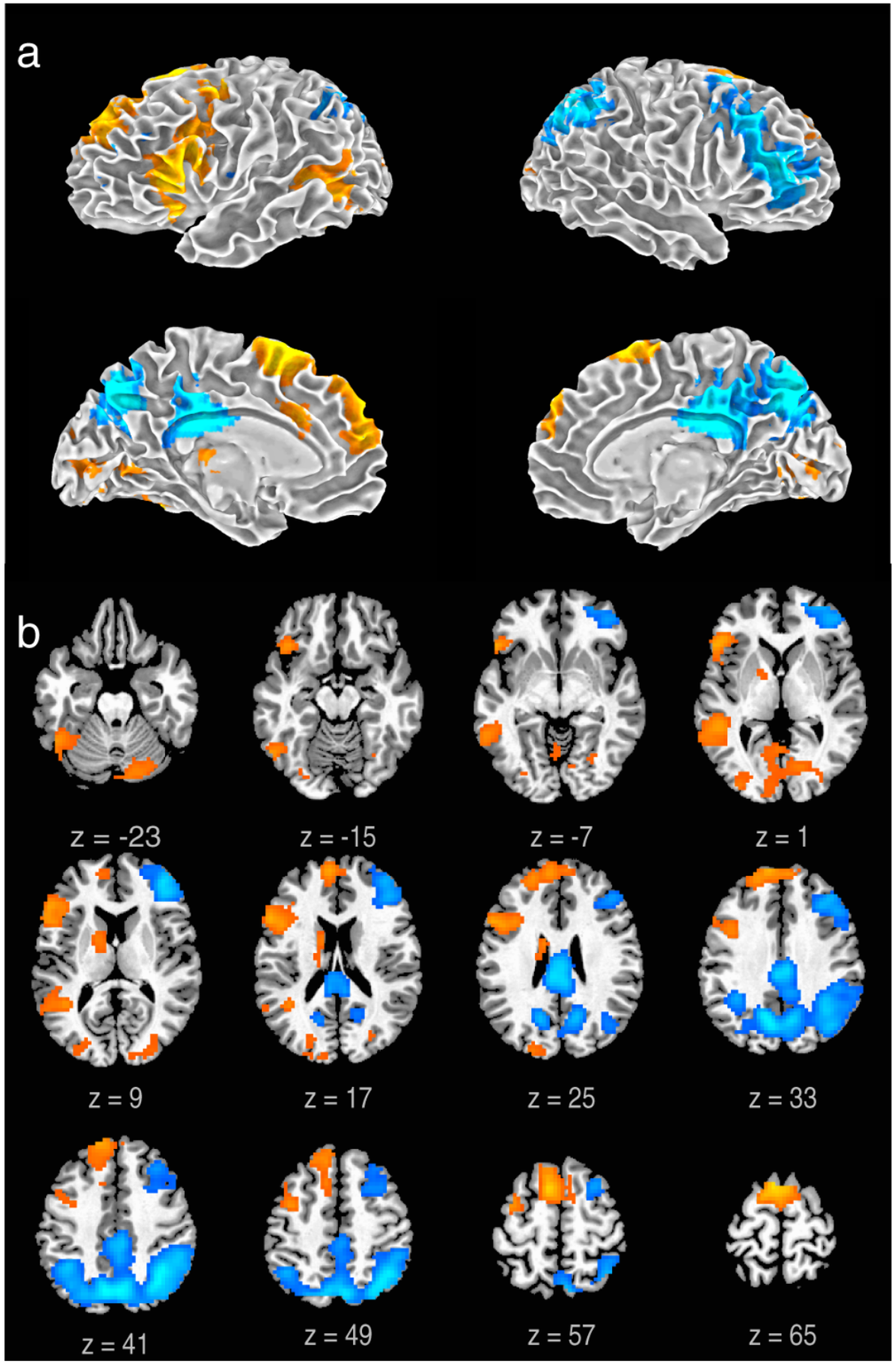
Same experimental design as Limb's.

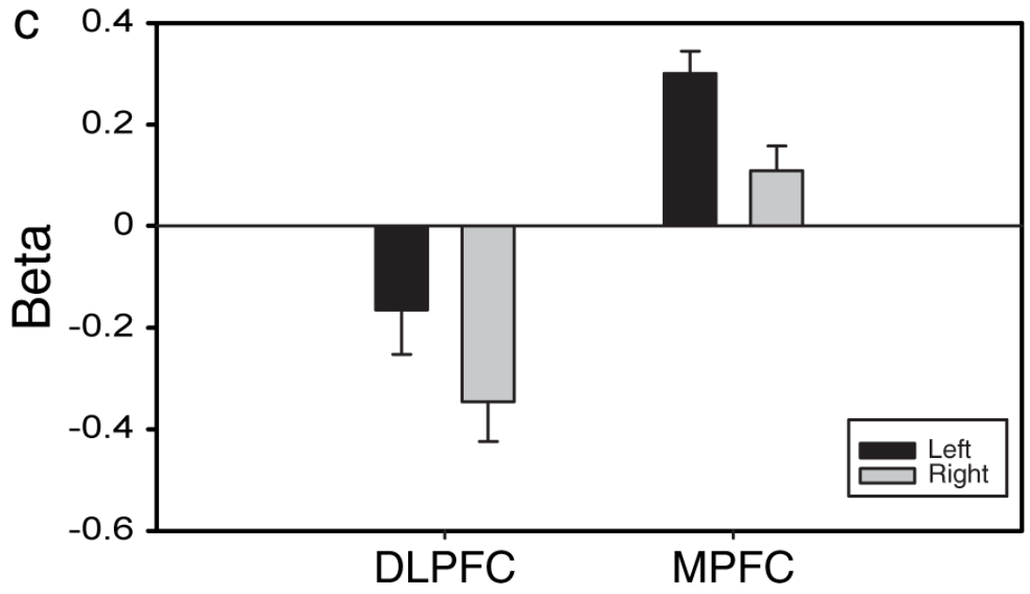
Subjects cued to either:

- repeat a memorized, rehearsed, performance

or

- Freestyle


a
b
z = -23
z = -15
z = -7
z = 1
z = 9
z = 17
z = 25
z = 33
z = 41
z = 49
z = 57
z = 65

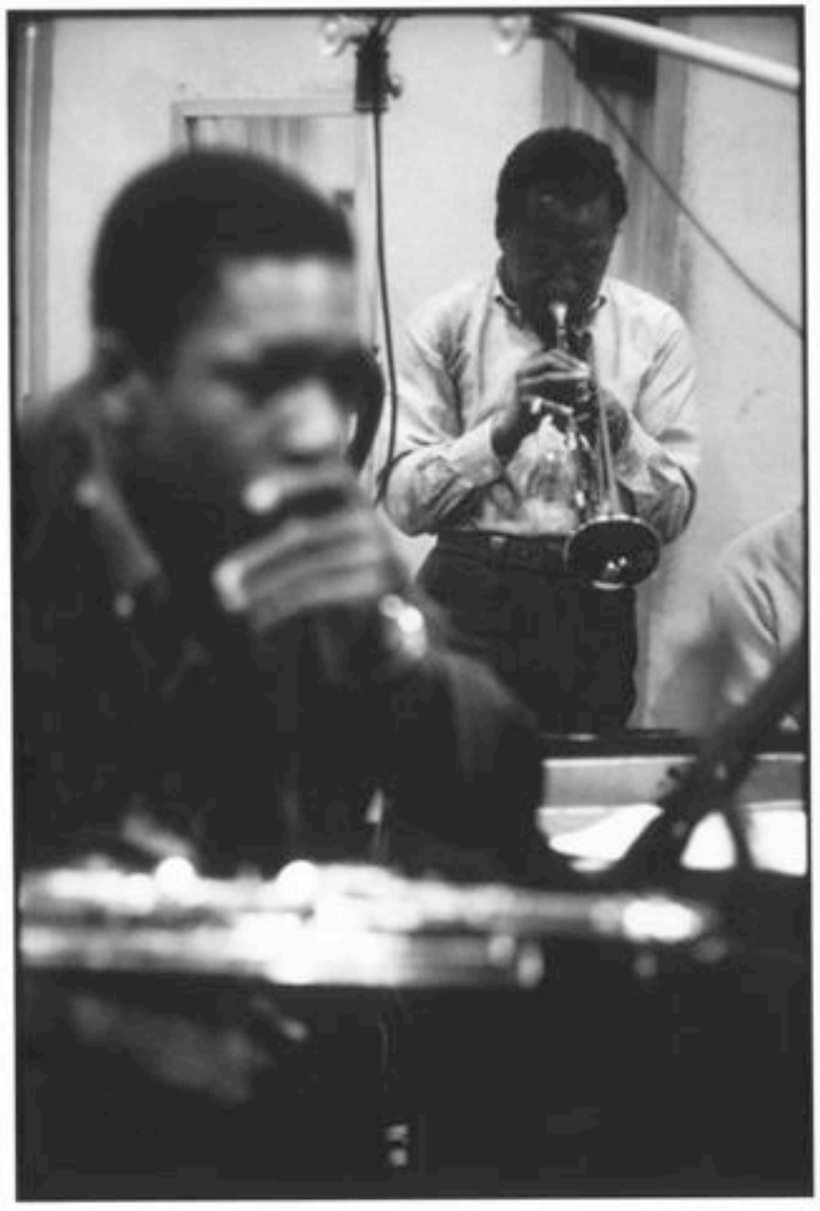

c
0.4
0.2
0
-0.2
-0.4
-0.6
Beta
Left
Right
DLPFC
MPFC

Mostly consistent with Jazz improv

Some additional lateralization effects due to the presence of spoken language.

It is interesting in this context that self-generated, stimulus independent behaviors appear to be initiated ... well before subjects consciously experience the intention to act.

In the absence of processing by lateral prefrontal regions – where a sense of agency could be constructed post-hoc – ongoing actions, moment to moment decisions and adjustments in performance may be experienced as having occurred outside of conscious awareness.



This is not inconsistent with the experience of many artists who describe the creative process as seemingly guided by an outside agency.

"This suggests that the conscious, deliberate, top-down attentional processes mediated by this network may be attenuated during improvisation, consistent with the notion that a state of defocused attention enables the generation of novel, unexpected associations that underlie spontaneous creative activity"

The next generation of digital creativity enhancers should focus on creating states of *flow*.

Neuroscientific investigations will give us both objective direction and the ability to quantify what was previously nebelous.

That can’t be the whole story though, can it?

What do *you* think?