Thinking with the Body

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UCSD
Topics

Case Study: Dance

What is Marking?

What we found with super-expert dancers

Why is Marking so effective?

A few Claims about thinking

Thinking with artifacts
Case study:
dance making
Timeline – ‘Dyad’ 2009

Total = 6 weeks

UCSD
Jan 26\textsuperscript{th}  Feb 13\textsuperscript{th}

London
Aug 25\textsuperscript{th}  Sept 7\textsuperscript{th}  Oct 13\textsuperscript{th}

Premiere

Wayne McGregor

Random Dance
Timeline – ‘Far’ 2010

Total = 6 weeks

London Premiere

Sept 13th
Nov 13th - Nov 17th
Timeline – ‘Undance’ 2011

Total = 6 weeks

London

Aug 30th

Premiere

Oct 23rd

Nov 30th

Total = 6 weeks
Observation Set-Up - UCSD

- **Mandeville Auditorium**
  - Rear 2
  - W Cam
  - Mandeville
  - Daily 2
  - Daily 1
  - Observers

- **Cal-IT2**
  - Rear 1 (a)
  - Daily 2
  - Rear 1 (b)
  - Rear 1 (c)
  - W Cam (a)
  - Artist Entrance
Dyad UCSD
Field Notes

- Observations for 5 hours/day, for 27 days
  - Online coding of activity in FIELD NOTES
  - Includes: Time of activity, Activity code, and Description of activity
Interviews

Before and after session
2 hours per day, for 23 days
Interviews

After session each day usually in two’s
Data Collected

- 20 TB of video of dancers and choreographer
- Dozens of interviews with choreographer and dancers
- Still images
- Dancer notes
- Associate choreographer’s notes
- Student notes of ongoing
- Music used
Marking and Riffing

TWO PHENOMENA IN DANCE
Thinking with the body

MARKING in dance
Marking - during practice
Marking

A dance phrase is practiced, explored or reviewed in a less energetic manner than doing it ‘full-out’.

Marking for time

Small marking
Marking

- Dancer abstracts from full phrase
- Focuses attention on some specific aspect of the movement
Marking: a universal phenomenon

• Tennis swing – by aspect

• Cello – on the arm

• Staged Plays – an Italian run-through

• Imperfect modeling – aspectual – as a learning/practice technique
Aspects to focus on
Similar Phenomena

- Planning grips and placements in rock climbing
- Planning a downhill in moghul skiing
- Planning turns in a car race
What it is

Represent a full dance phrase by a less energetic, less detailed one

A form of *physical sketching*
Marked aspect anchors projection

Marked aspect in world

Anchors Mental Projection

‘Imagery” in mind
Sketching is a way of exploring designs

• Marking is like sketching with the body
• Dancers can make caricatures
• They can exaggerate
• Focus on specific aspects of a movement
• They may have different sketching styles
• And different objectives when sketching
Antoine: Large marking
Antoine: Small marking
Agnes: Full vs. Marked
Agnes: Large vs. Small marking
Experiment to show the power of marking
Which conditions facilitate learning most?

Full-Out

Mark

Simulate in the head
Experimental Design

<table>
<thead>
<tr>
<th>Trail One 40 mins</th>
<th>Teach Phrase 1</th>
<th>Baseline Measure</th>
<th>Practice Phrase</th>
<th>Final Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 mins</td>
<td>10 mins</td>
<td>10 mins</td>
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<tr>
<td>BREAK 5 mins</td>
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<table>
<thead>
<tr>
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<th>Teach Phrase 2</th>
<th>Baseline Measure</th>
<th>Practice Phrase</th>
<th>Final Measure</th>
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<tr>
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<td>10 mins</td>
<td>10 mins</td>
<td>10 mins</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td>BREAK 5 mins</td>
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</table>

<table>
<thead>
<tr>
<th>Trail Three 40 mins</th>
<th>Teach Phrase 3</th>
<th>Baseline Measure</th>
<th>Practice Phrase</th>
<th>Final Measure</th>
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<tr>
<td></td>
<td>10 mins</td>
<td>10 mins</td>
<td>10 mins</td>
<td>10 mins</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>BREAK 5 mins</td>
<td></td>
<td></td>
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</tbody>
</table>
Performance Measures

1. Technicality
   - Precision of positions

2. Memory
   - Completeness of detail

3. Dynamics
   - Speed, Force, Acceleration

4. Timing
   - Tempo, duration
Mean Improvement From Practice

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean(raw delta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full</td>
<td>-0.5</td>
</tr>
<tr>
<td>Marking</td>
<td>0.0</td>
</tr>
<tr>
<td>Simulation</td>
<td>0.5</td>
</tr>
<tr>
<td>Simulation</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Higher is better

P = .018

Condition

- Full
- Marking
- Simulation
Learning broken down by dimension

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mark &gt; Full</th>
<th>Full &gt; Mark</th>
<th>Mark &gt; Sim</th>
<th>Full &gt; Sim</th>
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</thead>
<tbody>
<tr>
<td>Memory</td>
<td>.7334</td>
<td></td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
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<tr>
<td>Technicality</td>
<td>.0029</td>
<td>&lt;.0001</td>
<td>.0005</td>
<td></td>
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<tr>
<td>Timing</td>
<td>.0194</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
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<tr>
<td>Dynamics</td>
<td>-</td>
<td>.145</td>
<td>.0003</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Mem, Tech, Timing</td>
<td>.0189</td>
<td>-</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

P Values

Higher is better
Why this is interesting

• Three ways of practicing

- Regular Practice
- Repeat real thing
- Marking
  - Small scale model
- Mental Simulation
  - Imagination

Realistic movements

- Real skiing, tennis games and shots, practice music on violin, dance the real phrase ...
• Three ways of practicing

- Regular Practice
- Repeat real thing
- Mental Simulation

**Marking**

**Small scale model**

**Partial model of real thing**

- Italian run-through, Cello on arm, marking in dance, slow practice, aspectival practice, vocalize tabla rhythm
• Three ways of practicing

- Repeat real thing
- Small scale model
- Cyber skiing, mental run-throughs, imaginary dancing ...
Body thinking in dance

‘Marking’ shows that dancers use their body as simulation engines.

They use them representationally.

They think with their body.
Upshot of marking study

• Marking confers cognitive benefits during the rehearsal process

  • Sometimes people learn faster by producing simplified or distorted models of the real thing

    – E.g. practice getting the notes right at slow speed, or just the rhythm with wrong notes – or saying the rhythm (bols in tabla)

• Marking is a movement reduction system

• Other movement reductions might also facilitate:

  – whispering or subvocalizing
  – Gesturing
CLAIMS ABOUT THINKING
PROJECTION
What is Mental Projection?

Move the colored balls, one at a time in a minimum number of moves, from the start state to the goal state.
Projection vs. Imagination

**Perception**
- Reality oriented
- See what is present

**Projection**
- Augment reality
- Anchored

**Imagination**
- Virtual Reality
- No size or location
Mental Projection is more powerful than mental imagery alone.

We can project beyond what we can readily imagine.

External structure helps us.
Experiment to explore projection
Tic tac toe experiment – 3 by 3

Experimental Conditions

Imagination Condition
- Blank Sheet
  - Blank

Projection conditions
- Table
- Table + X O
Blank page is unanchored imagination

*Imagination Condition*

- Blank Sheet
- No external structure to help Projection
- Many people closed their eyes: no projection at all.
Projection ≠ Memory Offload of State

No state change in the environment

Board remains the same over time
Within Subject, practice first

<table>
<thead>
<tr>
<th>practice</th>
<th>Imagination Condition</th>
<th>Projection conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3</td>
<td>Blank Sheet</td>
<td>X O</td>
</tr>
<tr>
<td>4 5 6</td>
<td>Blank</td>
<td>Table</td>
</tr>
<tr>
<td>7 8 9</td>
<td>Blank</td>
<td>Table + X O</td>
</tr>
</tbody>
</table>
Results 3 by 3

Overall Means

Secs

4.8
4.9
4.6

Blank    Table    Table + XO

Not significant  N = 25

Surprise!

4.8 ≈ 4.9

Table is no better than blank
Results 3 by 3

More than half were better using imagination alone

Significant $p = .002$
You must factor in Anchoring Costs

- Cost of anchoring process must be factored in. Cost of coupling with the world.
- The tighter the coupling the lower the mediating cost of ‘anchoring’
- Gestures, registration and other processes are often involved as we situate ourselves – help us couple.

Anchoring processes
Can we find cases where benefits always overcome anchoring costs?
Conjecture:

if the imagery task is hard enough everyone will benefit.
4 by 4 Experiment: harder imagery task

<table>
<thead>
<tr>
<th>Practice</th>
<th>Imagination</th>
<th>Projection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4</td>
<td>Blank Page</td>
<td>X O</td>
</tr>
<tr>
<td>5 6 7 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 10 11 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 14 15 16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3 Conditions

- Blank Page
- Table
- Table + X O
Results 4 by 4

N = 25

Implication:

Once task is hard enough

Table is worth the cost of coordination

Table faster than Blank mean difference 1.6s, p = .002

Table faster than XO p=.01
Is it better for everyone

Bad visualizers are helped much more!

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Mean Time Per Move in seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 by 3</td>
<td>4.7 4.6 4.8</td>
</tr>
<tr>
<td>4 by 4</td>
<td>10.7 9.5 9.1 10.4 11.6 10.1 9.4 9.3</td>
</tr>
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</table>

Weak grid > blank
p = .014

Strong > weak
p = .05
Projection is a real process distinct from perception and imagination.

As problems get harder we cannot easily imagine the answer so we rely on projection more.

- Imagination has memory limitations that are partly overcome by external supports.

Projection and imagination are driven by the actions you are familiar with.

- Different people will be able to project different outcomes.
Thinking with the body

RIFFING in dance
WHAT EXTRA DOES MOVING ADD?

Why not just mentally simulate?
Self Authored Riffing
Coding by Richard Caballero, David Mazur, Gina Bello three college seniors. Intercoder reliability was measured on 10% of the material done in common yielding .77 using Krippendorf’s alpha measure.
Data

Fidelity was graded along the dimensions of technicality, memory, timing and dynamics.

<table>
<thead>
<tr>
<th>Riffing</th>
<th>Off-of-Others</th>
<th>(measurements in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Referent Move by dancer</td>
<td>Gap 1</td>
</tr>
<tr>
<td>Mean Sketch Duration</td>
<td>2.7 s</td>
<td>2.8 s</td>
</tr>
<tr>
<td>Mean Gap</td>
<td>0.7 s</td>
<td>20.2 s</td>
</tr>
<tr>
<td>Mean Fidelity</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>Mean WM- added Content</td>
<td>4.1 s</td>
<td>3.1 s</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>6.9 s</td>
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<td></td>
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Pattern:

Riff 1: observe → wait 1s → copy imperfectly + riff more than dancer content
Riff 2: wait 20s → use less of dancer’s movement (modify it more) + reduce riff elements
Riff 3: wait 28s → use more of dancer’s movement (about same fidelity as before) + reduce riff elements
Usually Riffs three times

Pattern:

**Adds his own**

Riff 1:  observe → wait 1s → copy imperfectly + riff more than dancer content

**Substracts his own and theirs**

Riff 2:  wait 20s → use less of dancer’s movement (modify it more) + reduce riff elements

**Puts back theirs**

Riff 3:  wait 28s → use more of dancer’s movement (about same fidelity as before) + reduce riff elements
Why?
Why do you riff?

In interview WM said he riffs:

“to feel the moves”

“to redo them with my own signature”

“to ensure that they are authentic”

“to test if they are “consistent with my artistic style and the integrity of the piece as a whole”

Executing the movement also lets him see its possibilities, its ability to “support invention”, its potential fertility.
OUR CONJECTURE
Conjecture

- Creativity is enhanced by modality switching
  - Switching between different types of imagination is useful
  - Imagine visually vs. imagine kinesthetically
  - What is easy to notice in one modality may be hard in another
Different Sensory Codes

- **Poetry**: why speak it instead of just reading it or writing it?

- **Music composition**: why play it instead of just notate it?

- Encounter with music is different when mediated by *playing* an instrument vs. *listening* alone.
Sensory codes differ in dance

• Motor code:
  – ‘resistance’, ‘about to fall’, ‘feel gravity’, ‘stretching till it hurts’ … terms intrinsically meaningful kinesthetically
  – ‘Start a movement more deeply’ trivial to understand kinesthetically but harder to understand and recognize visually

• Activity Code
Motor vs. Visual Code

- Visual code:
  - Imagine liberty bell
  - You see its structure, you ‘see’ that it is heavy
  - But motor feeling is different than visualization
Visually invisible elements of dance

• During a movement a dancer is sensitive to:
  – Weight
  – Balance
  – Force
  – Resistance

• These are kinesthetically meaningful but almost impossible to discern visually
END OF WHAT WAS SHOWN IN CLASS
HOW DOES IT WORK?
Explicitness of information

43,610
Is this divisible by 10?
43,610

The attribute divisible-by-10 is *explicitly encoded* in the base 10.
34,776

Divisible by 7 ?
34,776

Divisible-by-7 is NOT explicitly encoded in the base 10
34,776_{10} = 63,620_{7}
63,620_7

Divisible by 7 ?
Explicitness of information

- Inferential distance in geometry vs. algebra determines how easy or hard to prove something to discover new theorems.
- Changing representation space increases the probability of generating new candidates.
- Connections are visible in one representation and not in another.
By analogy

Encoding in each modality make different things visible – each has its own metric of goodness.

Changing encoding increases the probability of generating new candidates.
Attributes have different computational distances in different modalities
Aesthetic Judgements

Seems right in Sense$_1$ ≠ seems right in Sense$_2$
Upshot of Riffing Study

- Dancers and choreographer use their bodies as a thing to think with
  - By using their sensory systems as engines to simulate ideas non-propositionally

- There are sensory specific codes that encode dance relevant attributes differently -

- This increased expressive range enlarges the candidate space of dance ideas – therefore, translate between modalities

- Metrics of goodness may also be sensory specific
Conclusions

- Our study of dance revealed two highly general methods of physical thinking:
  - Marking – imperfect simulation
  - Riffing – appropriation in a multiple modalities
Conclusions

• Marking shows that an external simulation can be used as constituent in thinking as well as an internal simulation
  – Externalizing provides a physical understructure that supports projection
  – Simplifying the simulation focuses attention on aspectival elements enabling better practice

• Riffing shows that translation between modalities such as kinesthesia and vision can be used for creative thought
Conclusions

• The principles at play are:

1. Thinking can be pushed forward by physical movement

2. Projection onto external structures or processes is a method of visual thinking

3. Projection is part of an extendable interactive method of thinking – Project◊ Create ◊ Project

4. Projection needs to be anchored and gestures are sometimes used to foster anchoring

5. Modality translation is powerful when the explicitness landscape of modalities differs
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