

STEAMy Theater Roles

A close-up photograph of a human hand with a painted face. The hand is positioned palm-up, with fingers slightly spread. The skin is a light brown color. The fingers are painted with a light green or teal color. The palm and wrist area are painted with a darker, more textured green color, resembling a face or a mask. The background is a blurred, mottled green and brown.

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Why Me?!



What Is the Creative Process and How Can We Harness It for Education? What Can Arts Teach STEM?

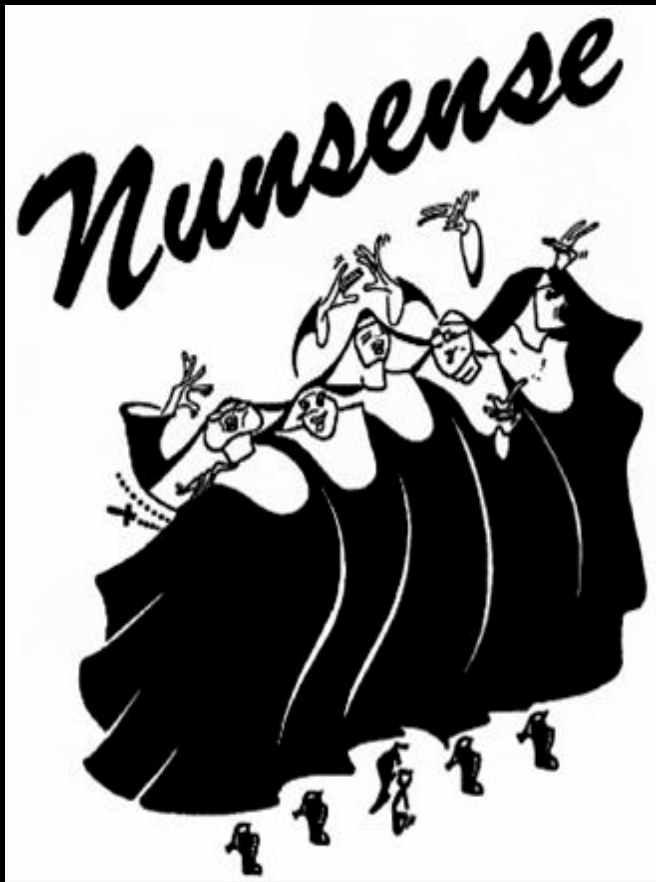


Creativity Riddle

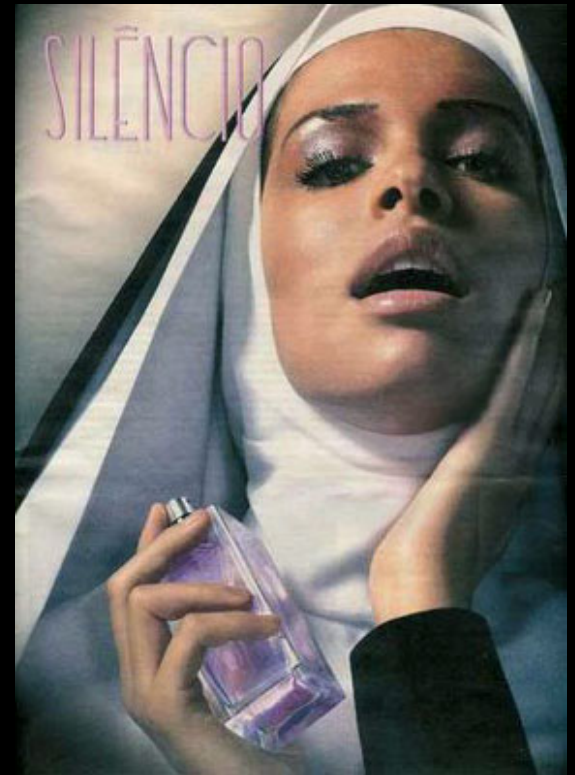
- What do you get when you cross an abbey with a perfume factory?



- Nun scents or
nunsense...

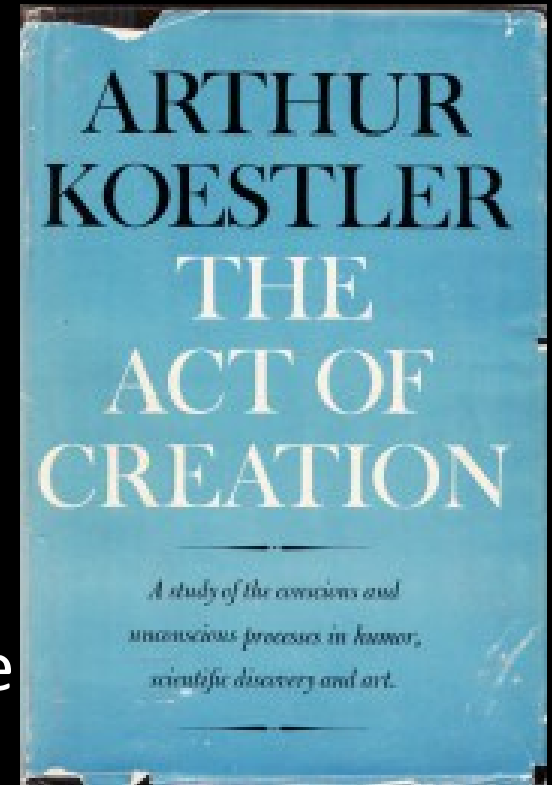


or
just
nonsense?

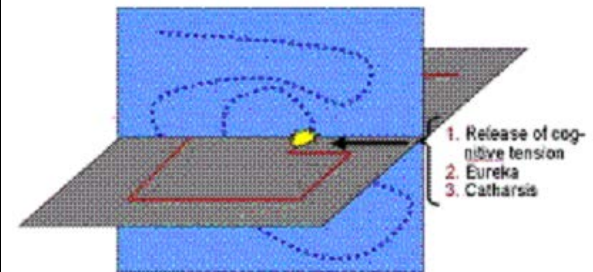


“Bisociation”: The Nature of Creativity

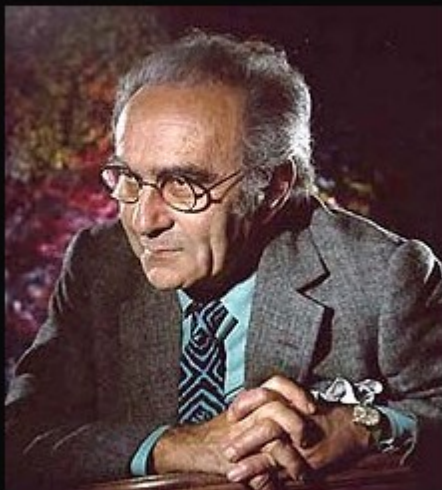
- Arthur Koestler proposed that all creativity shares commonalities with jokes and riddles
- Creativity is often defined as “effective surprise”
- But surprise requires putting together unlike things in unlikely ways to achieve unexpected but fruitful results
- Creativity therefore often involves play & playing
- Creativity always involves risk
- Creativity always causes rethinking and revaluation



E.g. Arthur Koestler's* depiction of "bisociation" in which two conceptual planes or matrices are reversed (joke, humor)¹, fused into a new synthesis (scientific discovery)², or illuminate incompatibles, symmetries, paradoxes, etc. (ritual & arts)³



* from The Act of Creation, 1964



I set out to show that there exists single creative activity, which is displayed alike in the arts and in the sciences. It is wrong to think of science as a mechanical record of facts, and it is wrong to think of the arts as remote and private fancies. What makes each human, what makes them universal, is the stamp of the creative mind.

(Jacob Bronowski)

izquotes.com

“The scientist or the artist takes *two facts or experiences* which were separate; he finds in them *a likeness which had not been seen before*: and he *creates a unity...*”

- Jacob Bronowski, mathematician, playwright, poet and author of *“The Ascent of Man”*

Indeed, One of the Foundations of Theater Is “Bisociation”!

Montague



Lord Montague



Lady Montague



Mercutio



Romeo



Friar Lawrence

Capulet



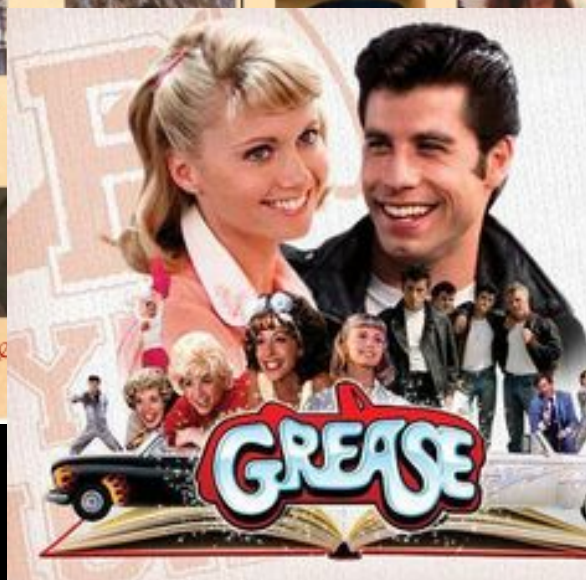
Lord Capulet



Lady Capulet



Tybalt



Riddle

- SO: What do you get when you cross theatre arts with the sciences?



Science**T**echnology**E**ngineering**A**rts**M**ath



Not just hot air, but harnessed to do work!

TechnologyEngineeringArtsMathScience



SciencesEngineeringArtsDesign



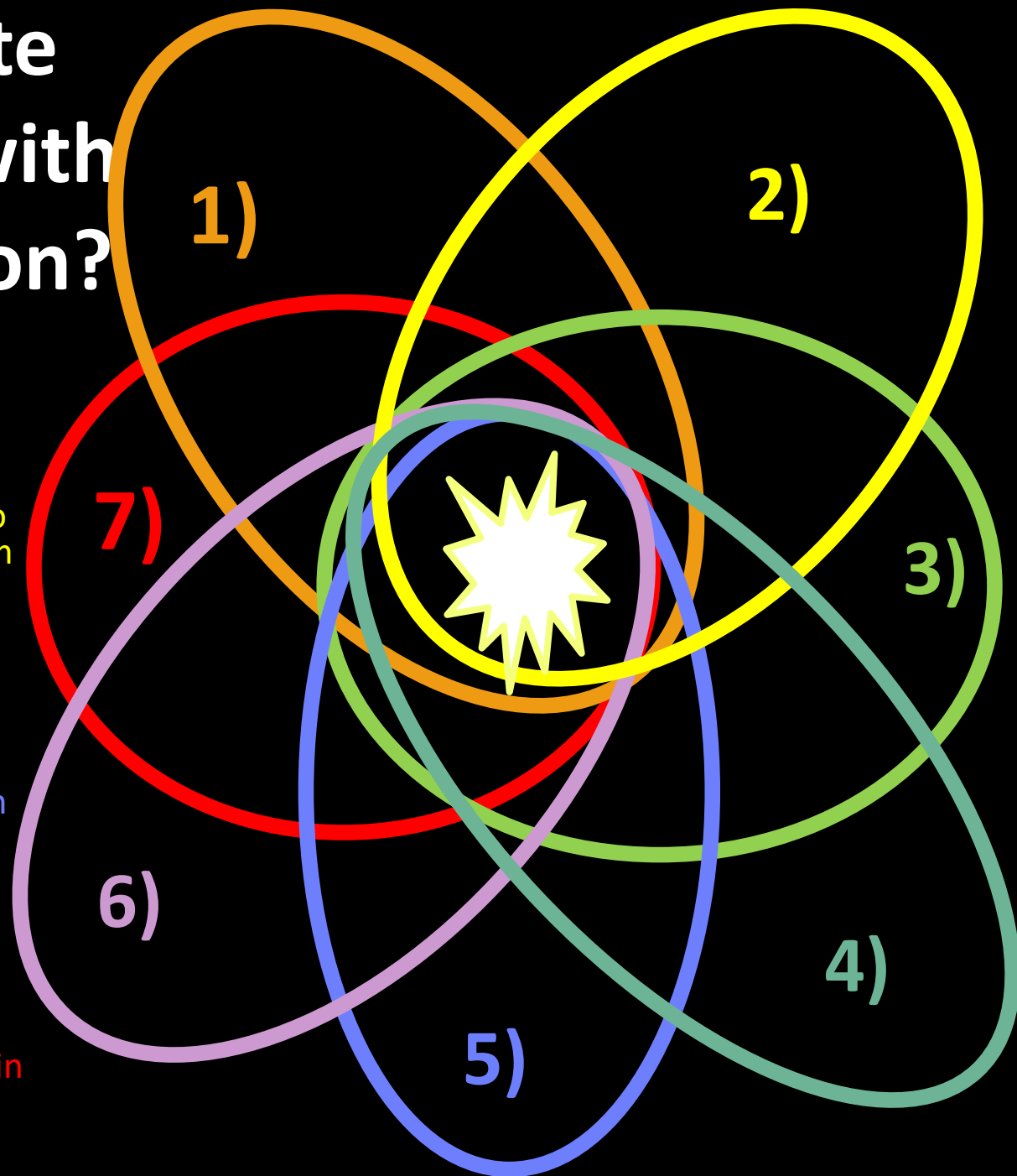


**A National Science Foundation-
Funded Project for Bridging and
Networking Arts and Sciences**

<http://sead.viz.tamu.edu>

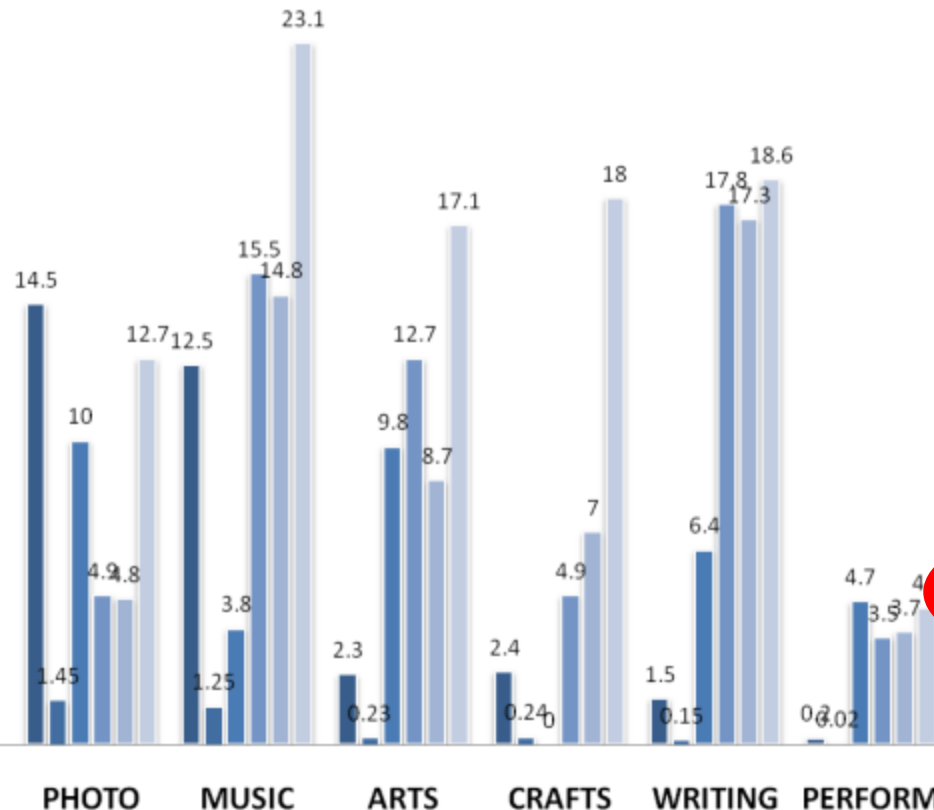
Why Integrate Theater Arts with STEM Education?

- 1) Large-scale statistical studies demonstrate correlations between ACD and STEMM success
- 2) Case studies provide insights into what STEMM professionals get from ACD
- 3) 13 empirically-derived types of connections or “bridges”
- 4) Cognitive identities
- 5) Many of these bridges have been harnessed successfully by ACD-STEMM integrated pedagogies
- 6) Inverse case: ACD practitioners contribute to STEMM
- 7) ACD proffer new approaches to training student traditionally weak in STEMM subjects



Adult Avocations Correlate with Scientific Success

■ SIGMA XI MAX n = 4406
■ US PUBLIC n = 4250
■ NAS, USA n = 1266
■ SIGMA XI MIN n = 42,525
■ ROYAL SOC n = 1634
■ NOBELS, TOT n = 510



Compared with typical scientist, Nobel laureates are at least:

- 2X photographers
- 4X musicians
- 17X artists
- 15X craftsmen
- 25X writers
- 22X performers

Root-Bernstein, et al.,
2008

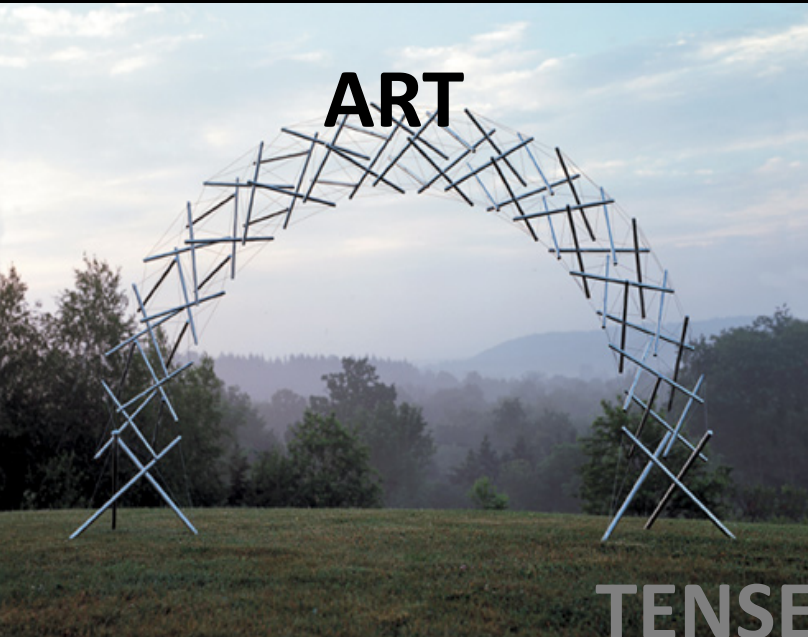
Summary of Study Outcomes

- Musical scientists duet (and do it) better
- Artistic scientists have more image to their imagination
- Crafty scientists are more handy
- Literary scientists have the making of pundits
- And performing scientists perform better

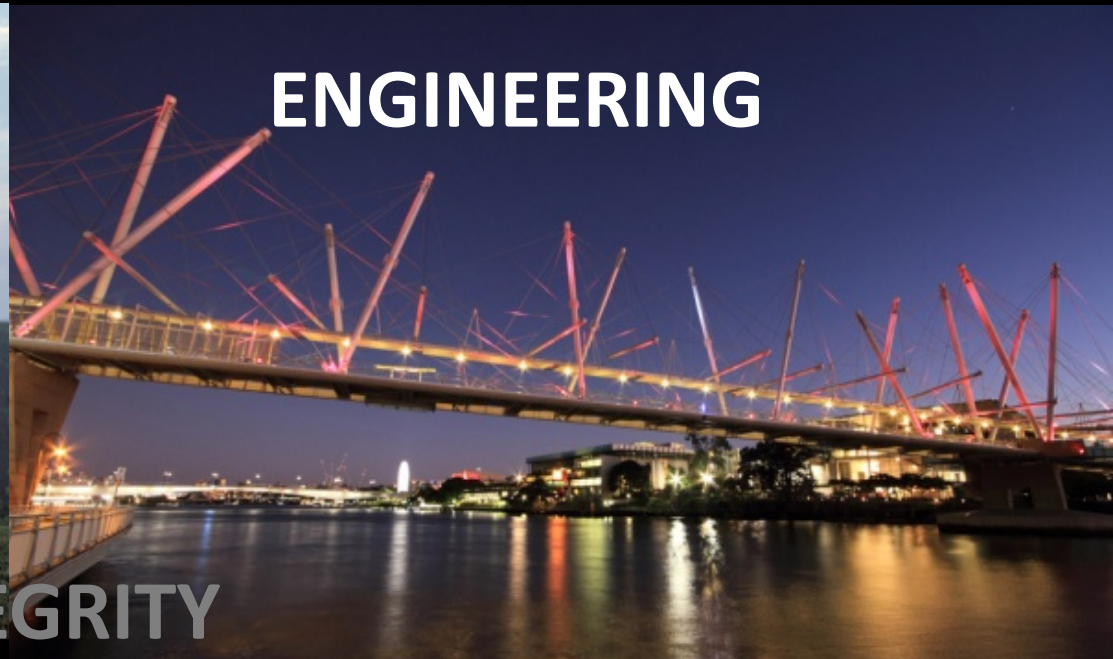
How to Integrate Arts with STEM

- Root-Bernstein RS, Pathak A, Root-Bernstein MM. A Review of Studies Demonstrating the Effectiveness of Integrating Arts, Music, Performing, Crafts and Design into Science, Technology, Engineering, Mathematics and Medical Education.
- Part 1: Summary of Evidence that Integration Is Professionally Useful and Effective. LEONARDO (in press)
- Part 2: Statistically-Validated and Controlled Pedagogical Studies of the Root-Bernsteins' "Tools for Thinking". LEONARDO (in press)
- Part 3: Statistically-Validated and Controlled Pedagogical Studies of Eleven ACD-Integration Strategies Utilized by STEMM Professionals and General Conclusions. LEONARDO (in press)
- All 3 parts available in draft at <http://sead.viz.tamu.edu>

KEY SEAD STUDY LESSON: Must BRIDGE Transdisciplinary Learning!



Kenneth Snelson
“Rainbow Arch”



Cox Architecture
Kurilpa Bridge, Brisbane

Every Good Play “Bridges” Its Characters! You Have to Connect!

Montague



Lord Montague



Lady Montague



Mercutio



Romeo



Friar Lawrence

Capulet



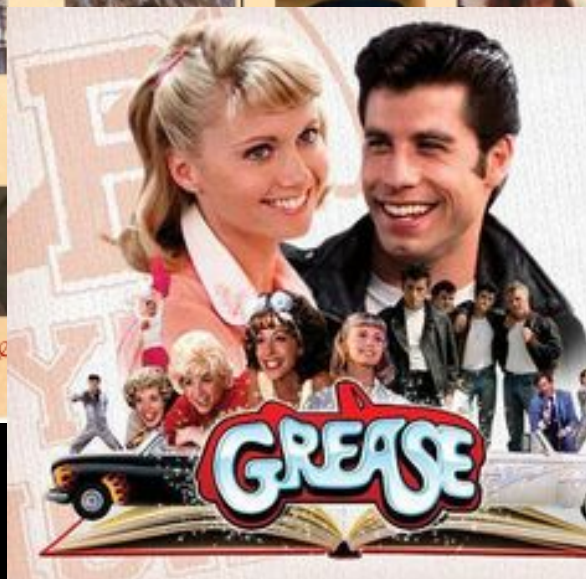
Lord Capulet



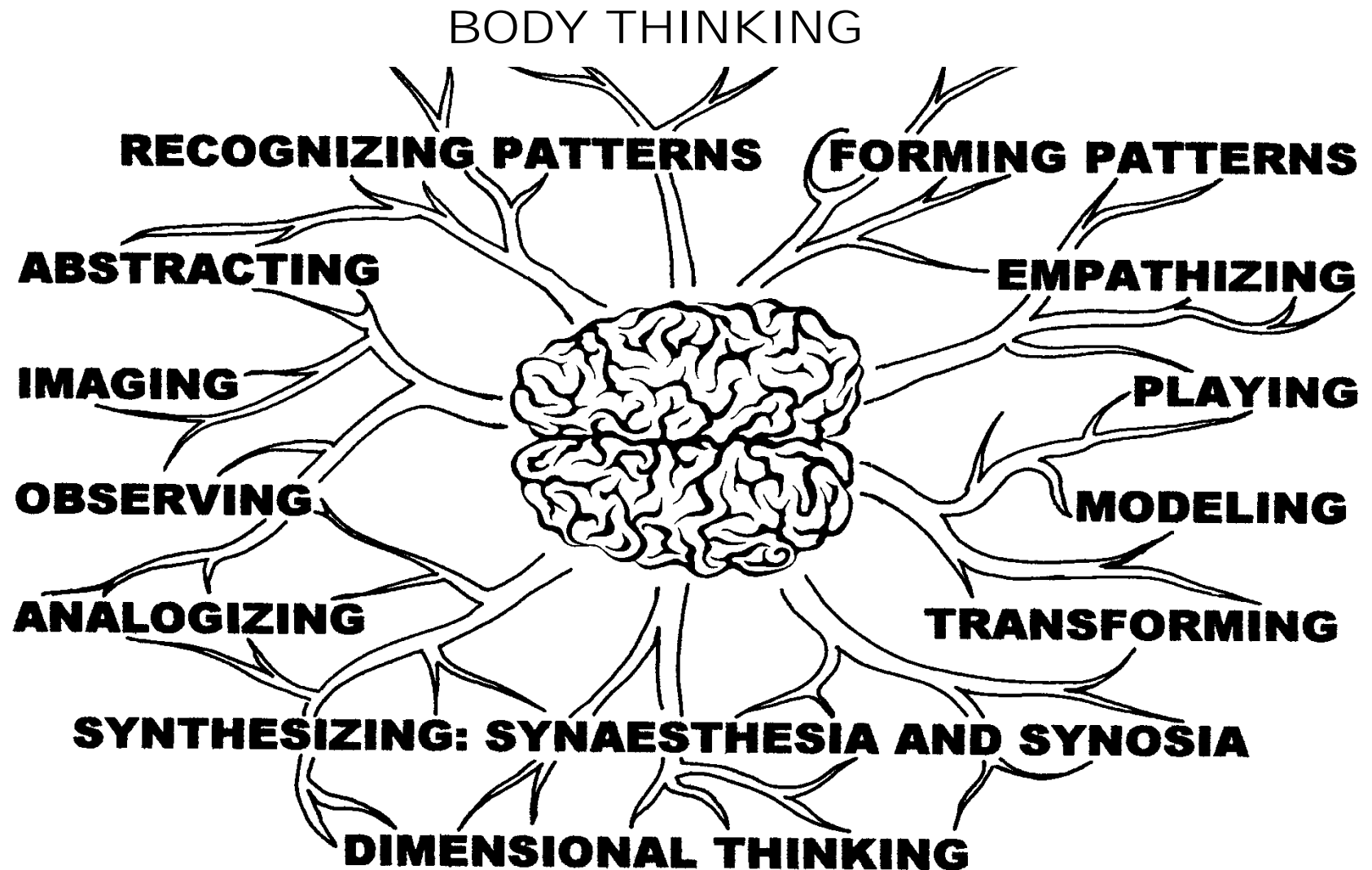
Lady Capulet

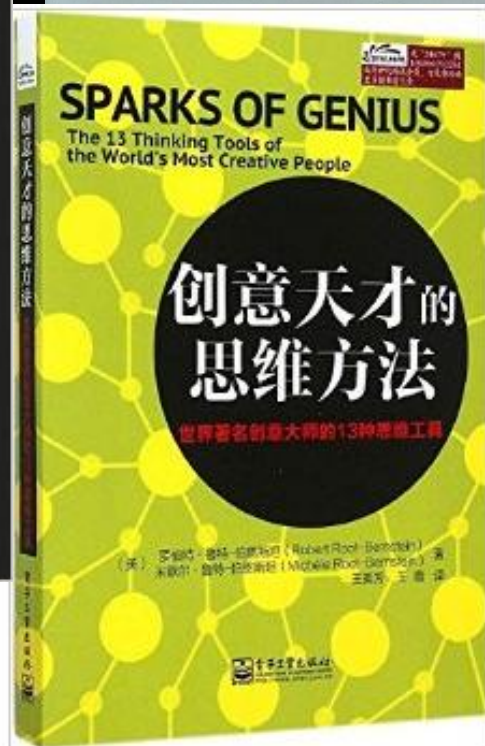
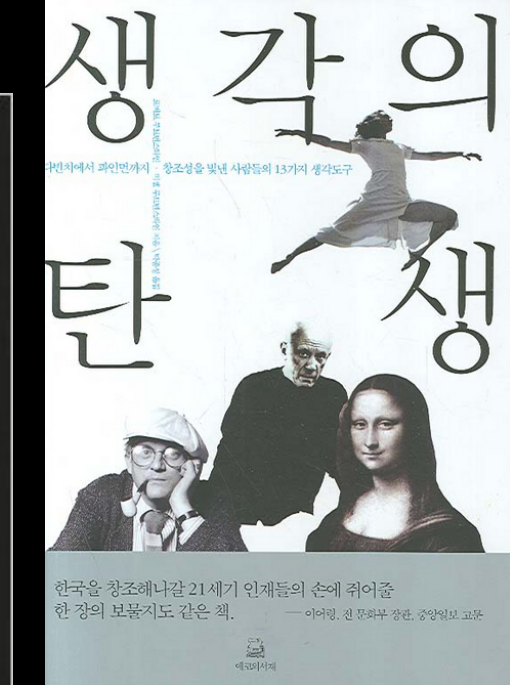
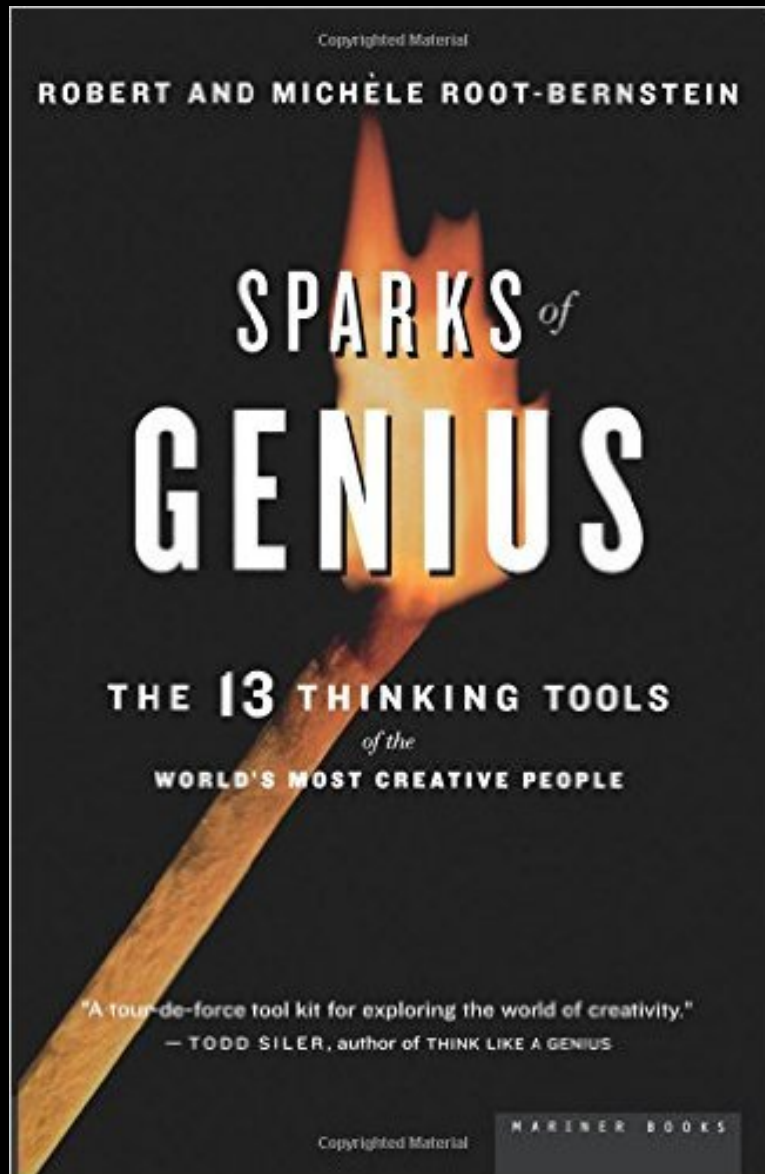
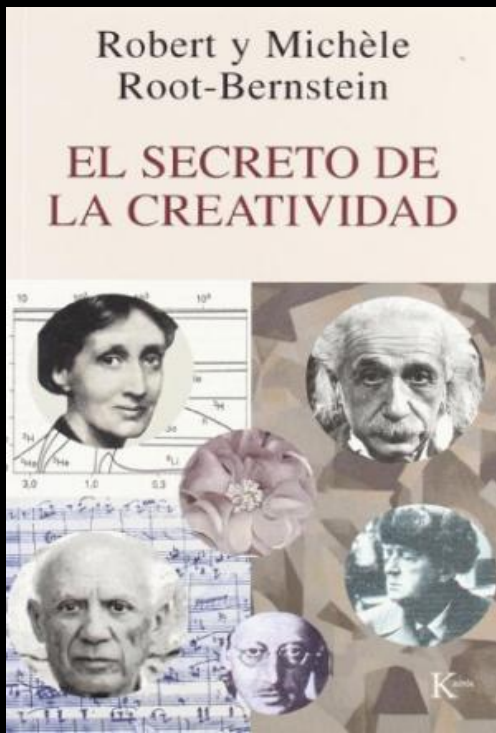
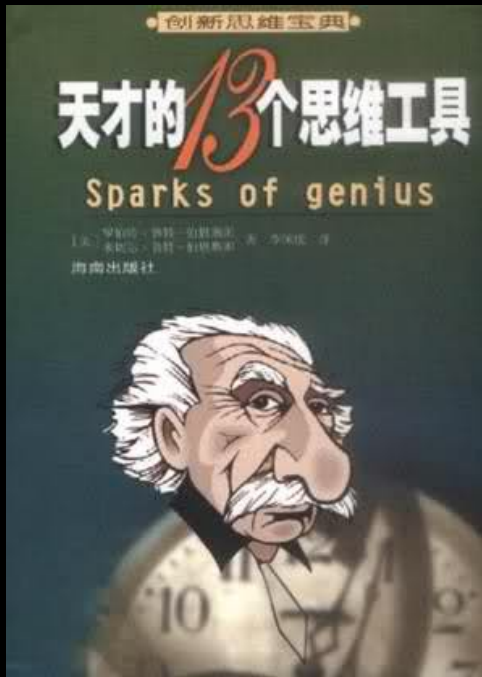


Tybalt



Main Bridge: The 13 Thinking Tools





OBSERVING



...means honing ALL the senses
to perceive acutely &
accurately...

Observing applies to ALL senses:

Sight



Hearing



Touch

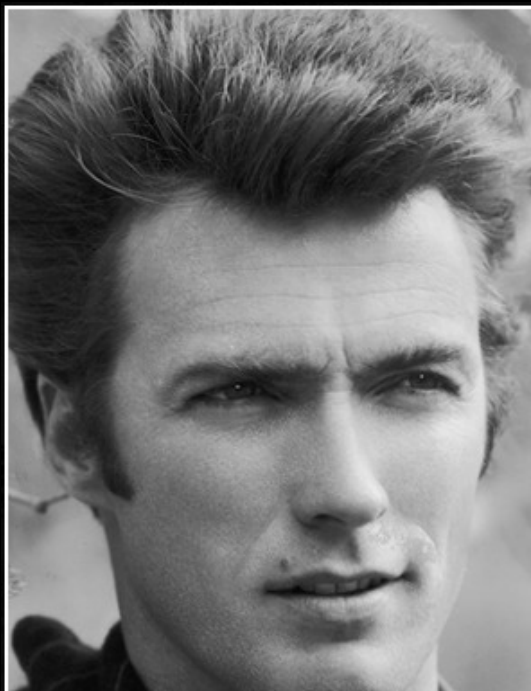


Smell



Taste





You spend your life training to be an actor, observing people's characteristics so that you can design characters around what you've seen.

— *Clint Eastwood* —

AZ QUOTES



The best preparation for acting is life - observing life and people and observing yourself. All that becomes your library. So when you have to research a part, a scene or an emotion, you go into the library and get what you need.

(Kate Capshaw)

izquotes.com

Beyond Observing to Perception:

Would You Like Your Audience To REALLY Perceive a Ghost?



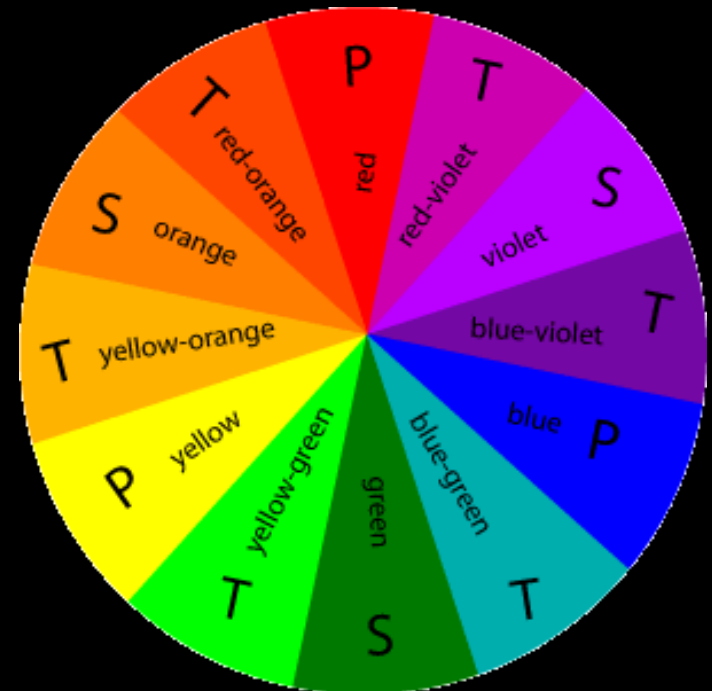
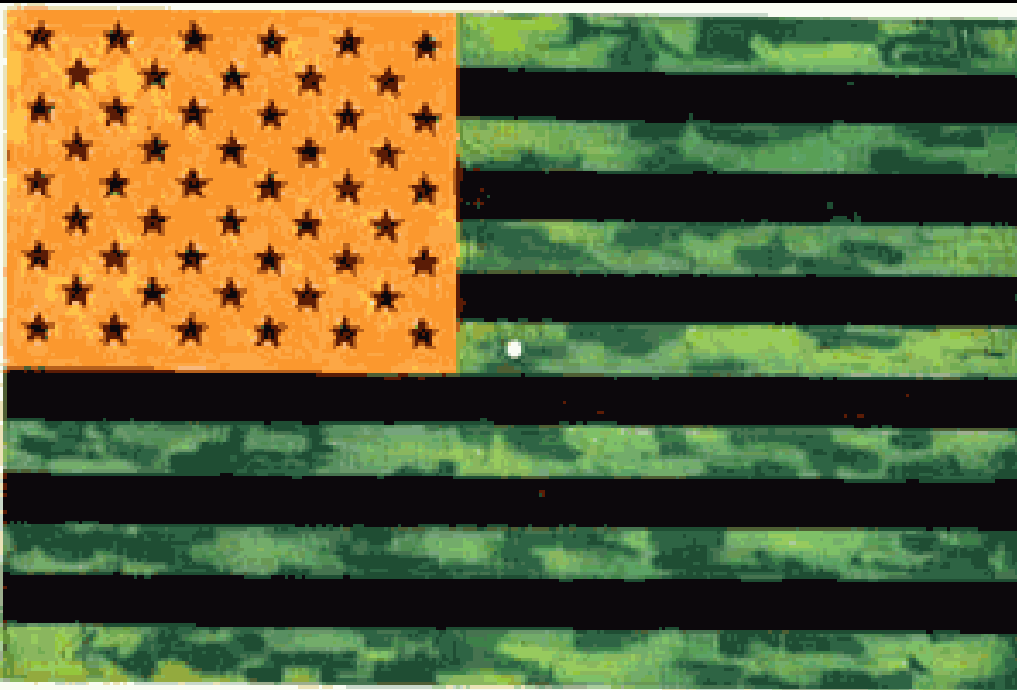
- Then you need to understand perception!

Jasper Johns on OBSERVING



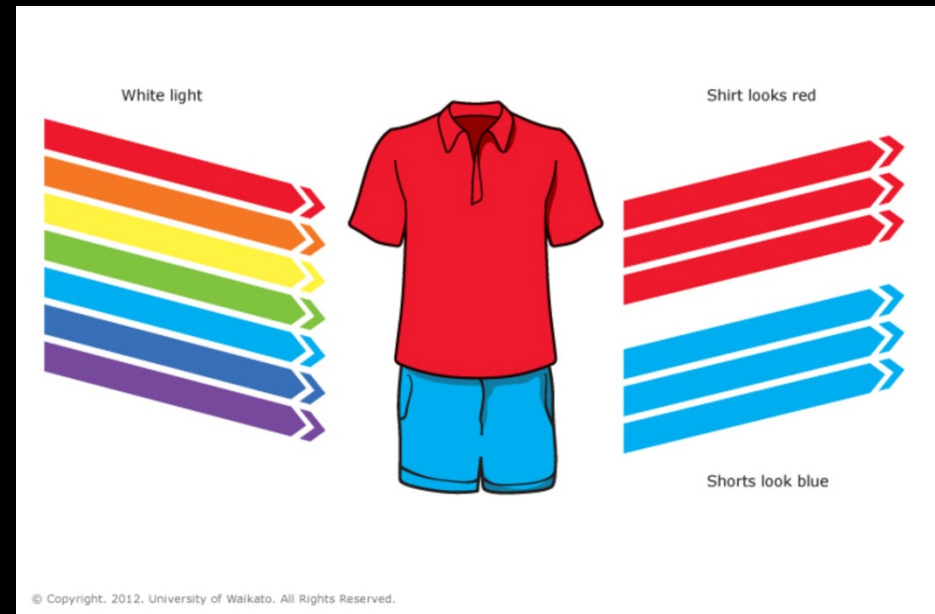
“I wanted to paint a flag so that you don’t just look at it, but you SEE it....”

Afterimage Is In Complementary Colors!



Using Color Perception to Play Games with Your Audience!

- If only blue **light** is shone onto a **red** shirt, the shirt would appear black, because the blue would be absorbed and there would be no **red light** to be reflected.
- Under blue light, the blue pants would look white, because they reflect all the light. Similarly, the red shirt would appear white under red light.
- <https://www.sciencelearn.org.nz/resources/47-colours-of-light>



IMAGING



.... creating
mental images
of things
observed or
imagined,
using any or
all of the
senses...

L.A. Times Wednesday, December 7, 1983 / Part V 25

Dennis The Menace

By Hank Ketcham



Ketcham
12-7

"Okay, now close your eyes and if you can see anything . . . you're THINKING!"

Actors Use their Imaginations

Imagination

- ⦿ As an actor, you must use your imagination to make what happens onstage look real.
- ⦿ Your imagination is essential in acting.
- ⦿ The process of **visualizing**, or imagining and seeing pictures in the mind, is important if your theatre experience is to have the greatest possible impact on an audience.



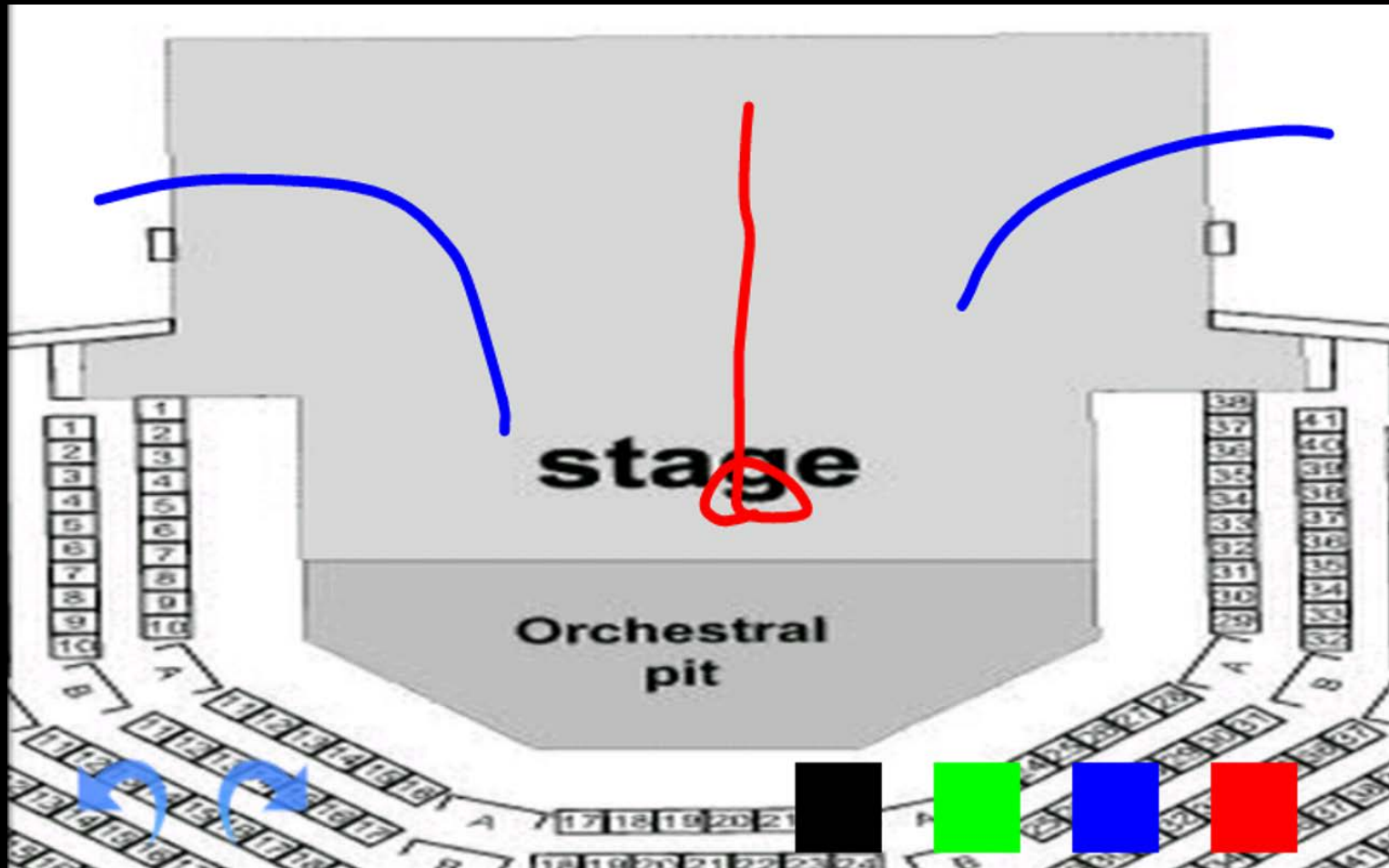
To be an actor or actress, you have to feel on a deep level and tap into emotions that you've never felt before. You're imagining how something would feel. You have to use your imagination so much.

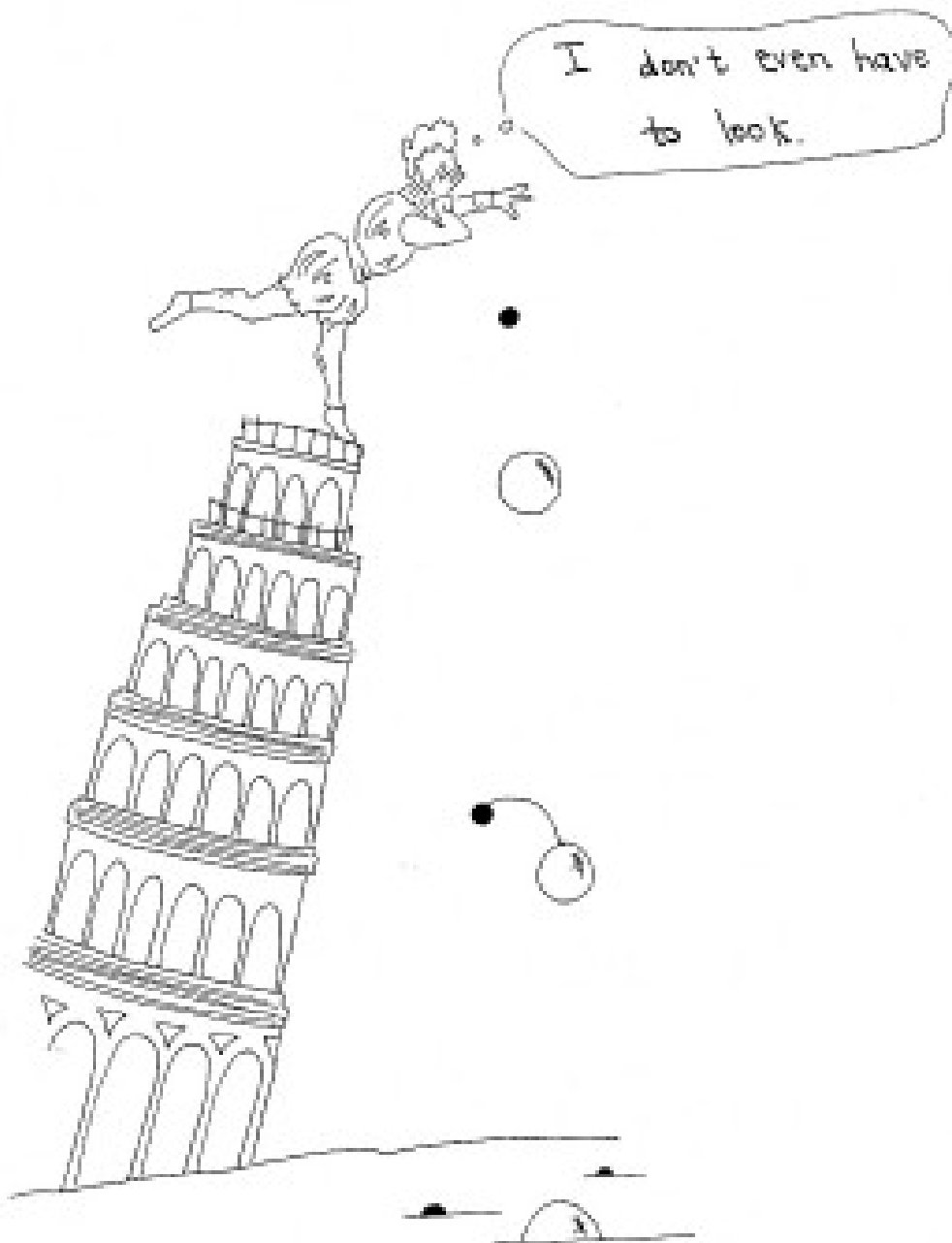
Elle Fanning

PICTUREQUOTES.COM

PICTUREQUOTES

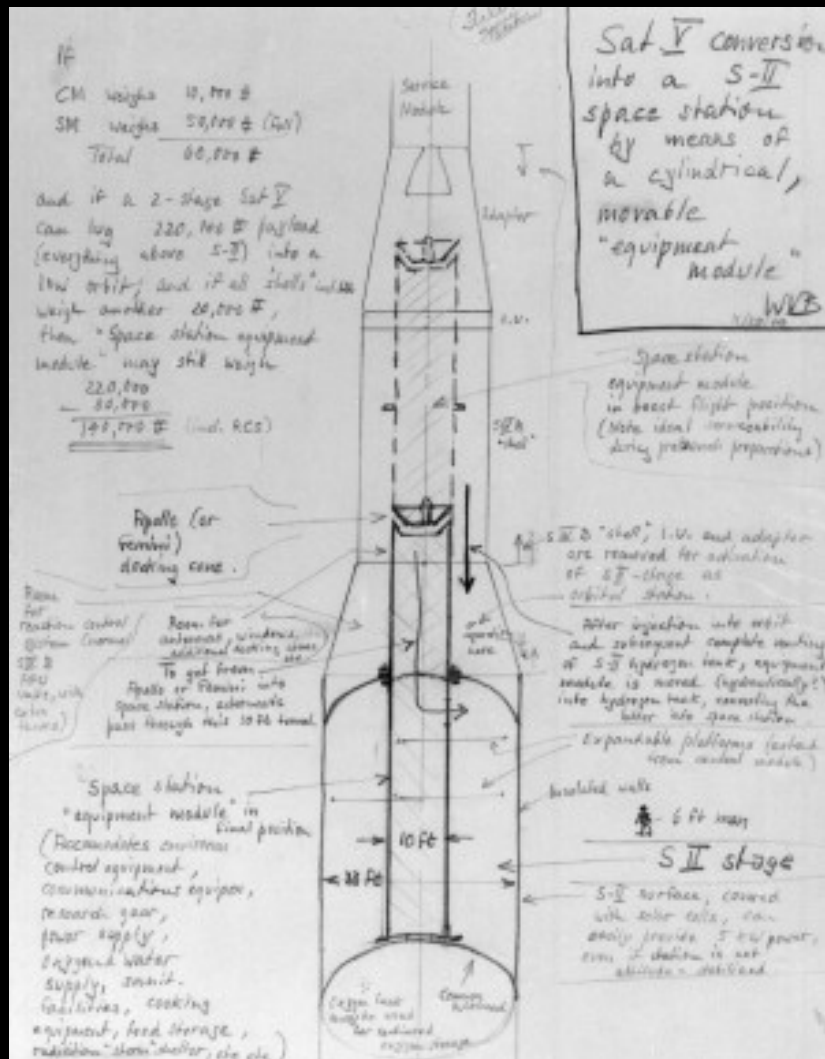
Blocking Out a Scene Involves Imaging





**Scientists Use
“Thought
Experiments”
that They
Imagine in
Their Minds!**

Visual Thinking Training Improves Science and Engineering Ability



. R. Lord, *J. Res. Sci. Teach.* 22, 395 (1985).

J. A. Deno, *Eng. Design Graphics J.*, 5 (autumn, 1995).

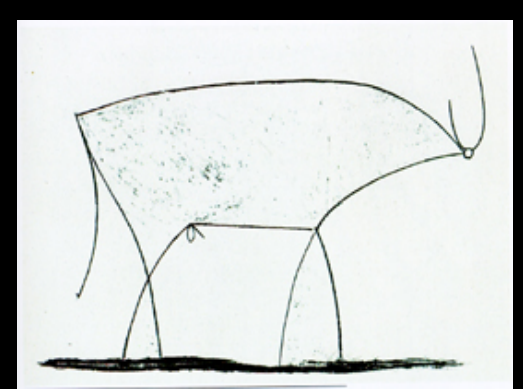
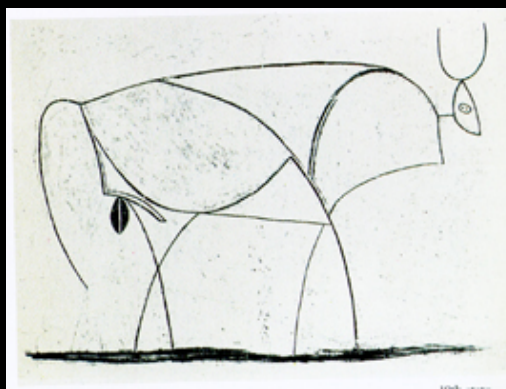
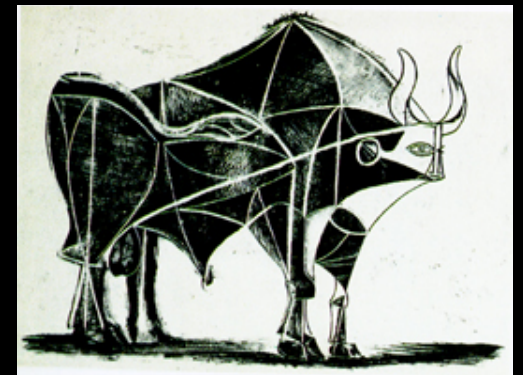
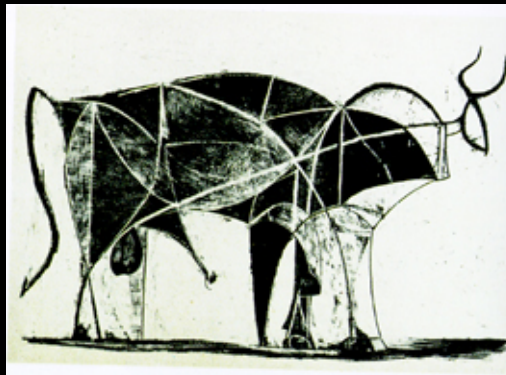
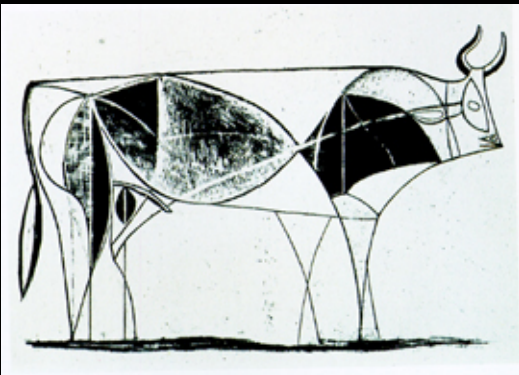
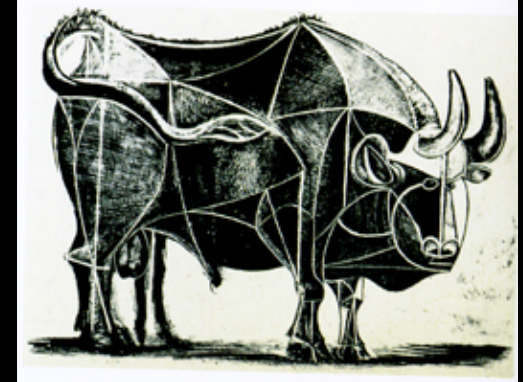
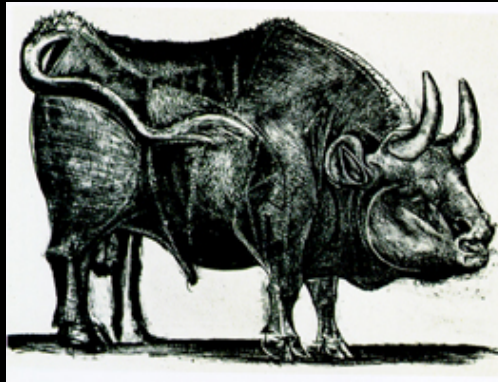
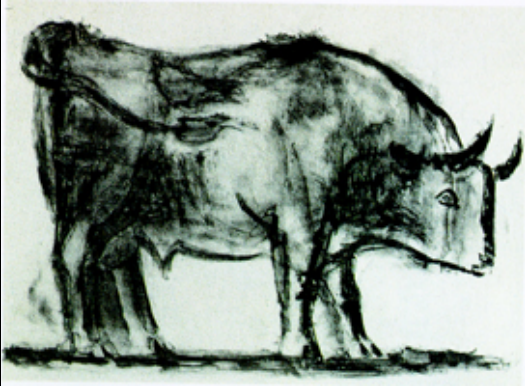
S. A. Sorby, B. G. Baartmans, *Eng. Design Graphics J.* 60, 13 (1996).

M. Alias, T. R. Black, D. E. Grey, *Inter. Ed. J.* 3, 1 (2002).

S. Sorby, *Cogn. Proc.* 10 (suppl. 2), S312,

10.1007/s10339-009-0310-y (2009).

Abstracting: Process of Eliminating All but the Essence of a Thing



Actors Strip Bare!

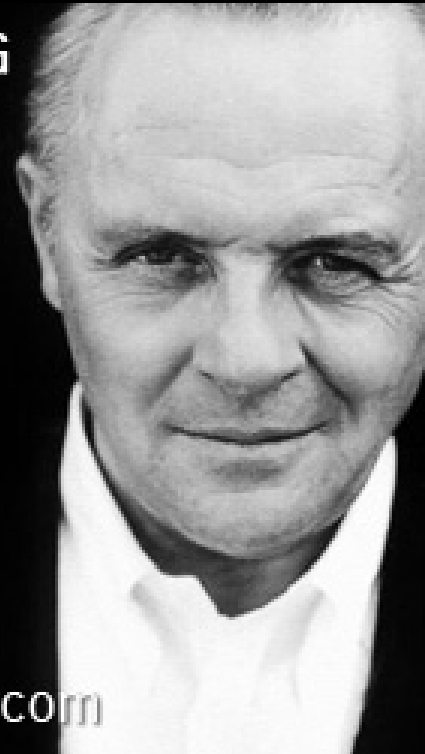
“ Acting is not about dressing up. Acting is about stripping bare. The whole essence of learning lines is to forget them so you can make them sound like you thought of them that instant.

Glenda Jackson



THE ART OF ACTING IS NOT TO ACT. ONCE YOU SHOW THEM MORE, WHAT YOU SHOW THEM, IN FACT IS BAD ACTING.

Anthony Hopkins
www.quote-coyote.com



Changing Character By Changing Hats Is a Form of Abstracting



Simple Can Be Effective!

Stage Design Ideas

Corrugated Boxes



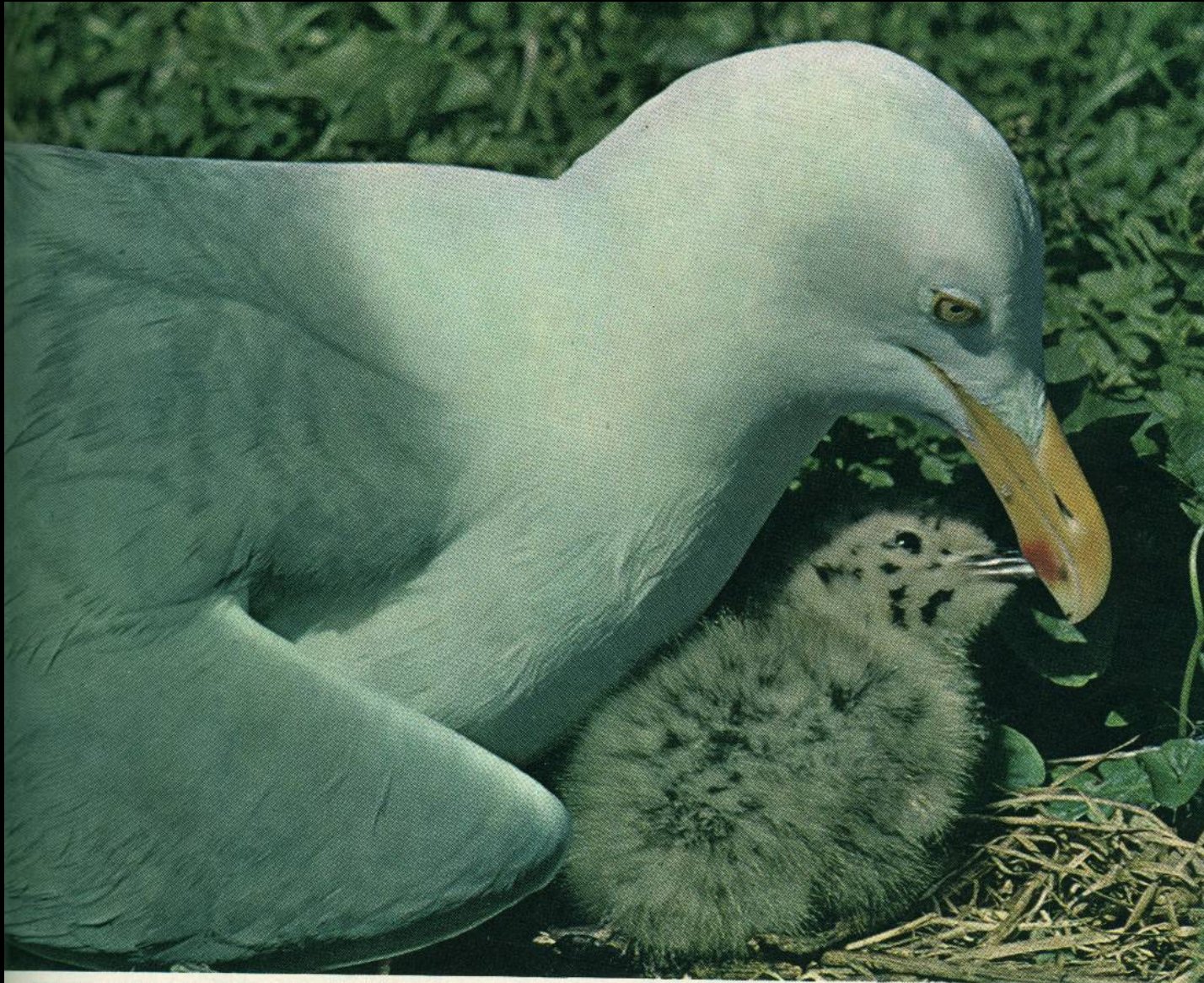
Mitchell Feigenbaum: Inventor of Mathematics of Chaos Theory



“It’s abundantly obvious that one doesn’t know the world around us in detail. What artists have accomplished is realizing that there’s only a small amount of stuff that’s important and then seeing what it was. So they can do some of my research for me.”

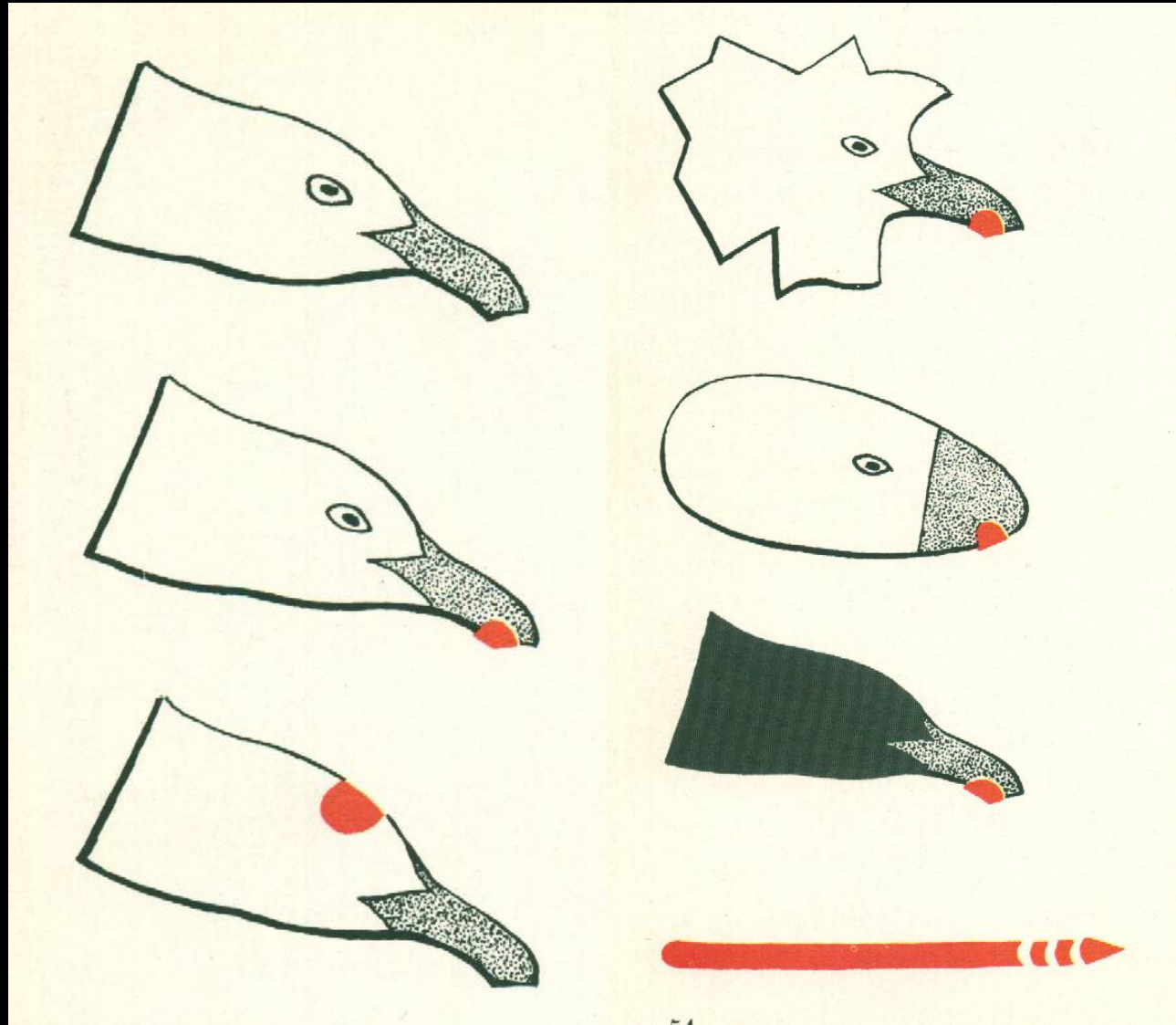
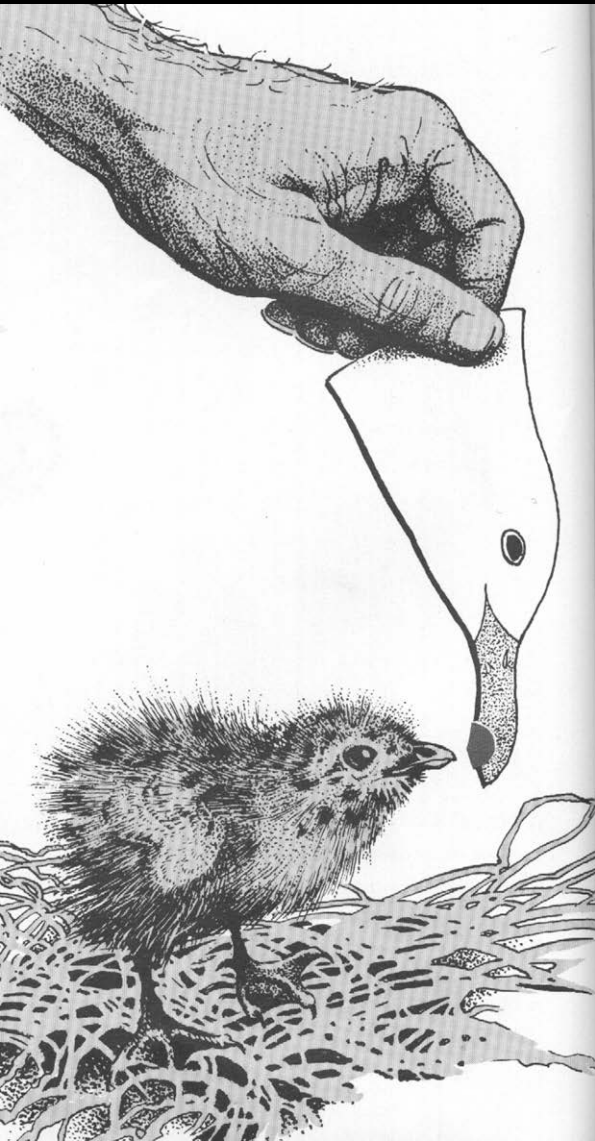
Gleick, James. 1984. “Solving the mathematical riddle of chaos”, NY Times Magazine, 10 June 1984, p. 71

Niko Tinbergen As Abstractor



PECKING INSTINCTIVELY AT A RED SPOT ON ITS PARENT'S BILL, A HUNGRY BABY HERRING GULL INDUCES THE PARENT TO REGURGITATE FOOD

Experimenting As Abstracting

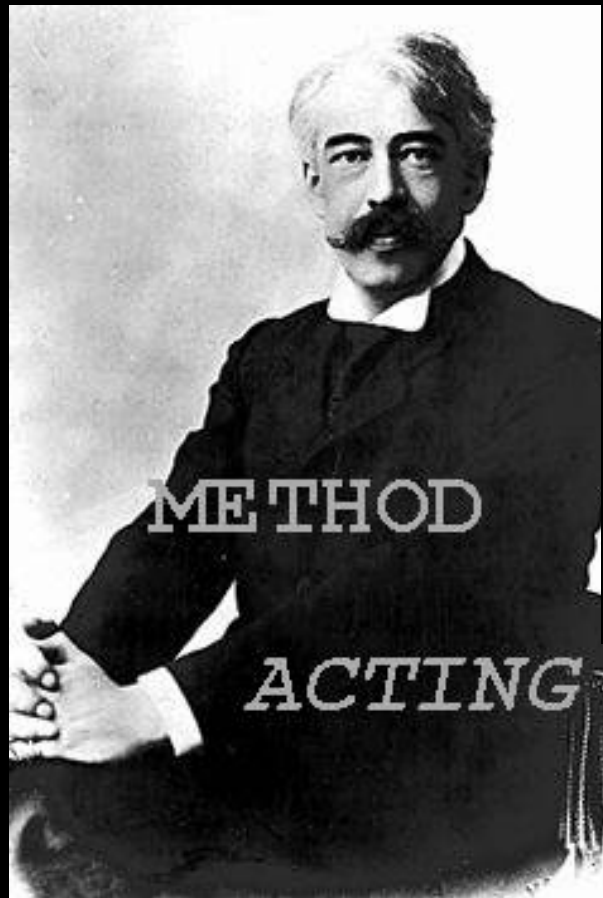


EMPATHIZING/ PLAYACTING



...becoming
the thing that
you want to
understand or
recreate,
be it animate
or
inanimate...

E.g.,
Stanislavsky



Empathizing as Connecting



Stony Brook University's Alan Alda Center for Communicating Science



Scientists Empathize to Gain Understanding of Other Species



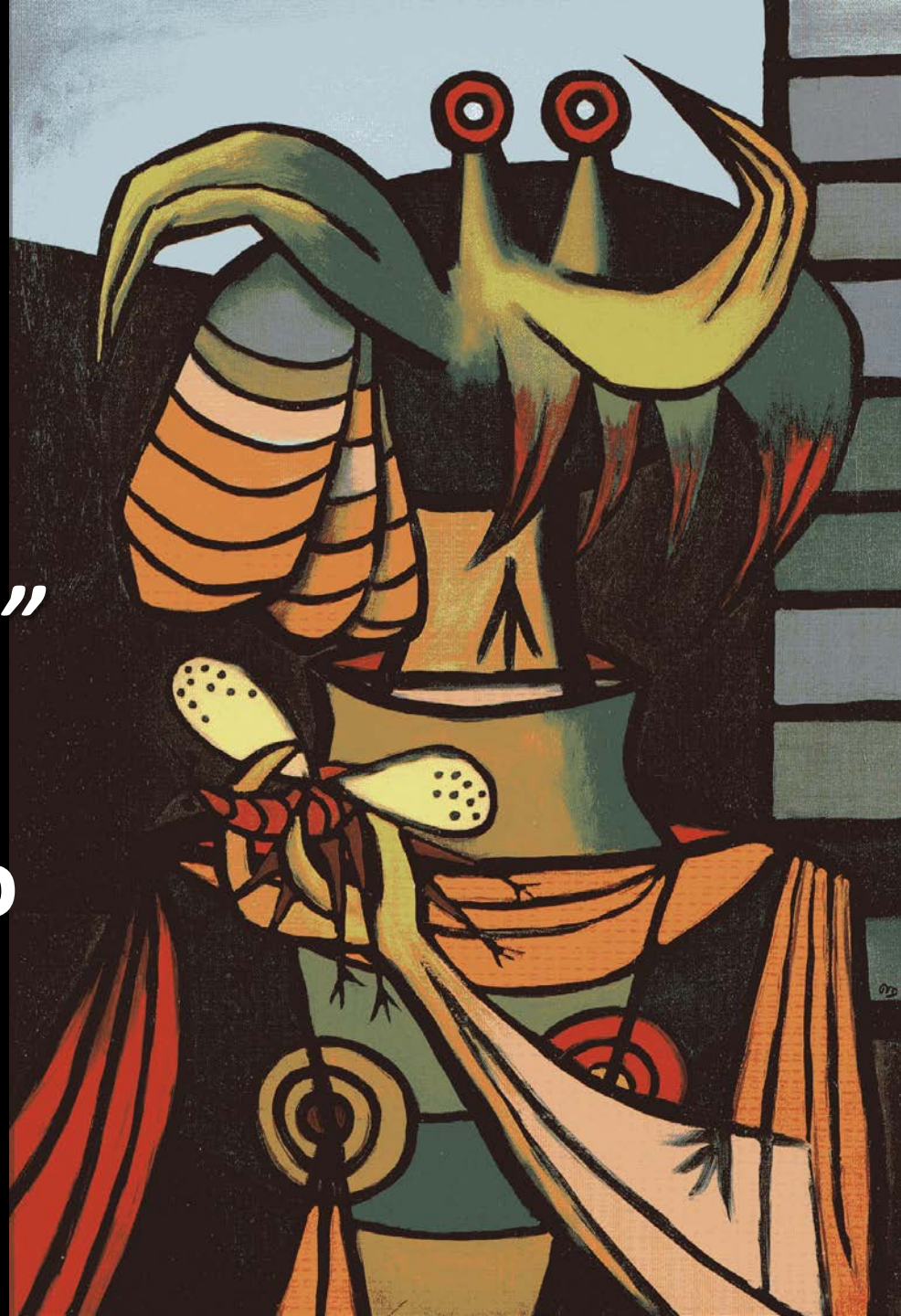
Jane Goodall



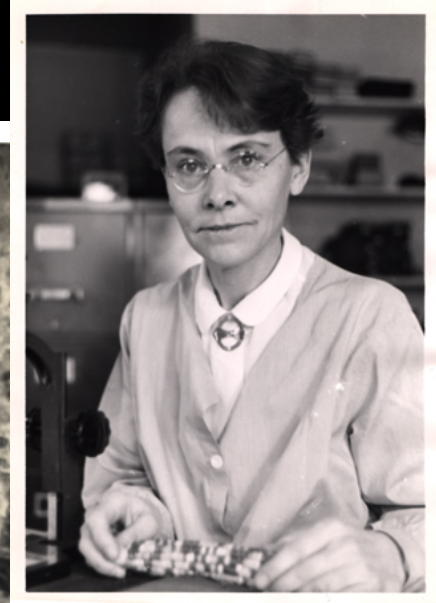
• **Diane Fossey**

Oxford zoologist
Desmond Morris
"The Entomologist"

Becoming a bug to
understand it



Nobel Laureate Barbara McClintock spoke of “A Feeling for the Organism” & “Becoming their Friend”

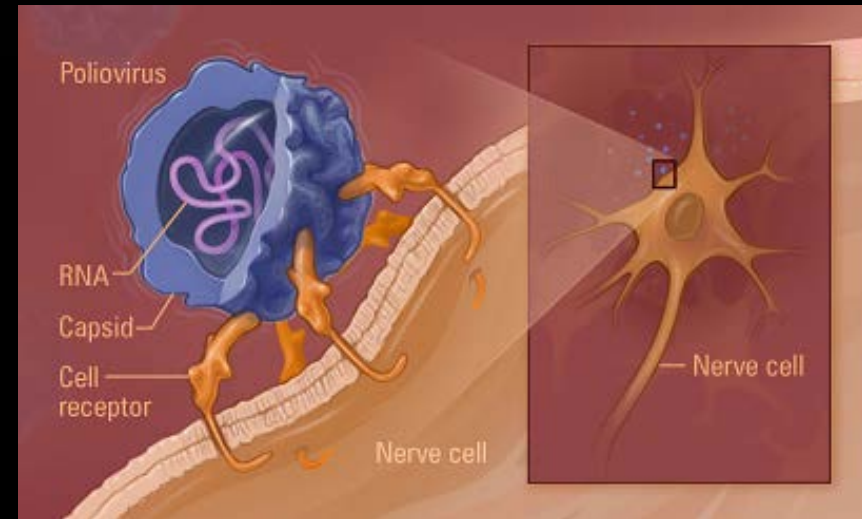


Jonas Salk, MD “Became a Virus” to Understand Polio



"I pictured myself
as a virus or a
cancer cell and
tried to sense what
it would be like."

Jonas Salk



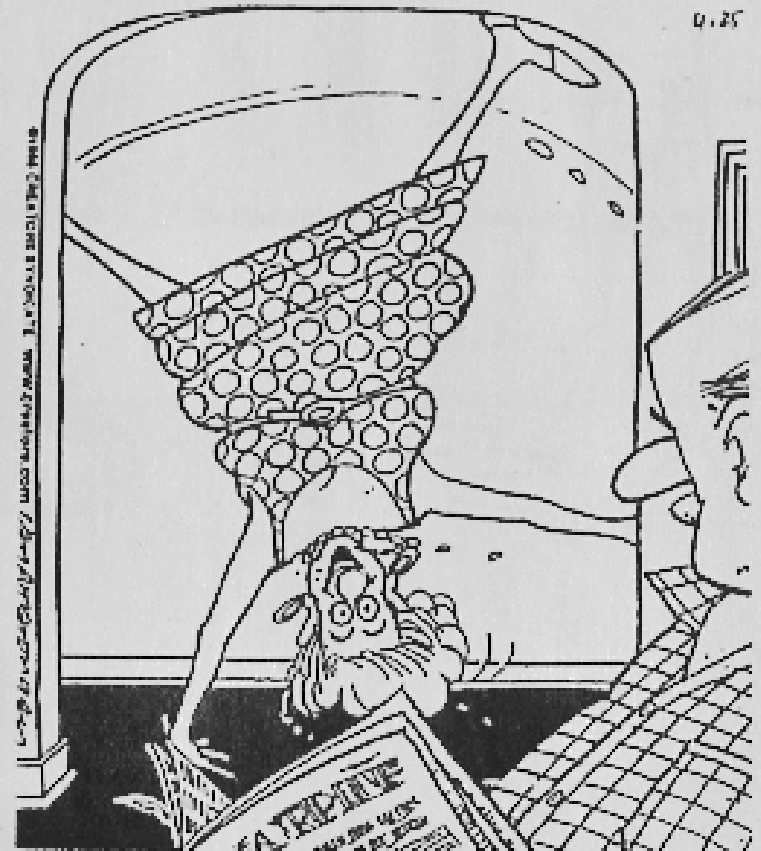
BODY THINKING



**...using muscle memory,
physical feelings, gut
reactions and emotional
states to recognize,
organize, and address
problems:**

**“Vivian just read how
different ways of moving
can produce different
ways of thinking!” ...**

BALLARD STREET By Jerry Van Amerongen



Vivian just read how different ways of moving can produce different ways of thinking.

Turn It Upside-down



BALLARD STREET By Jerry Van Amerongen



Vivian just read how different ways of moving can produce different ways of thinking.

Choreographing the Body in Space Is Literally Applied Physics



Theatre Lab: Body and Space

An in-depth exploration of
physical acting



Event Subhead

19 - 30 June
2 - 5pm

Tvak Studios

tvakstudios.blogspot.in/

In Theatre Lab: Body and Space, we experiment with the different physical elements of acting.

During this workshop we will focus on the body and its' limitations, proprioception and other senses, and the body in relation to space and other objects.

Proximity, speed, direction and (a)symmetry are just a few of the elements we explore within the context of theatre as a performing art.

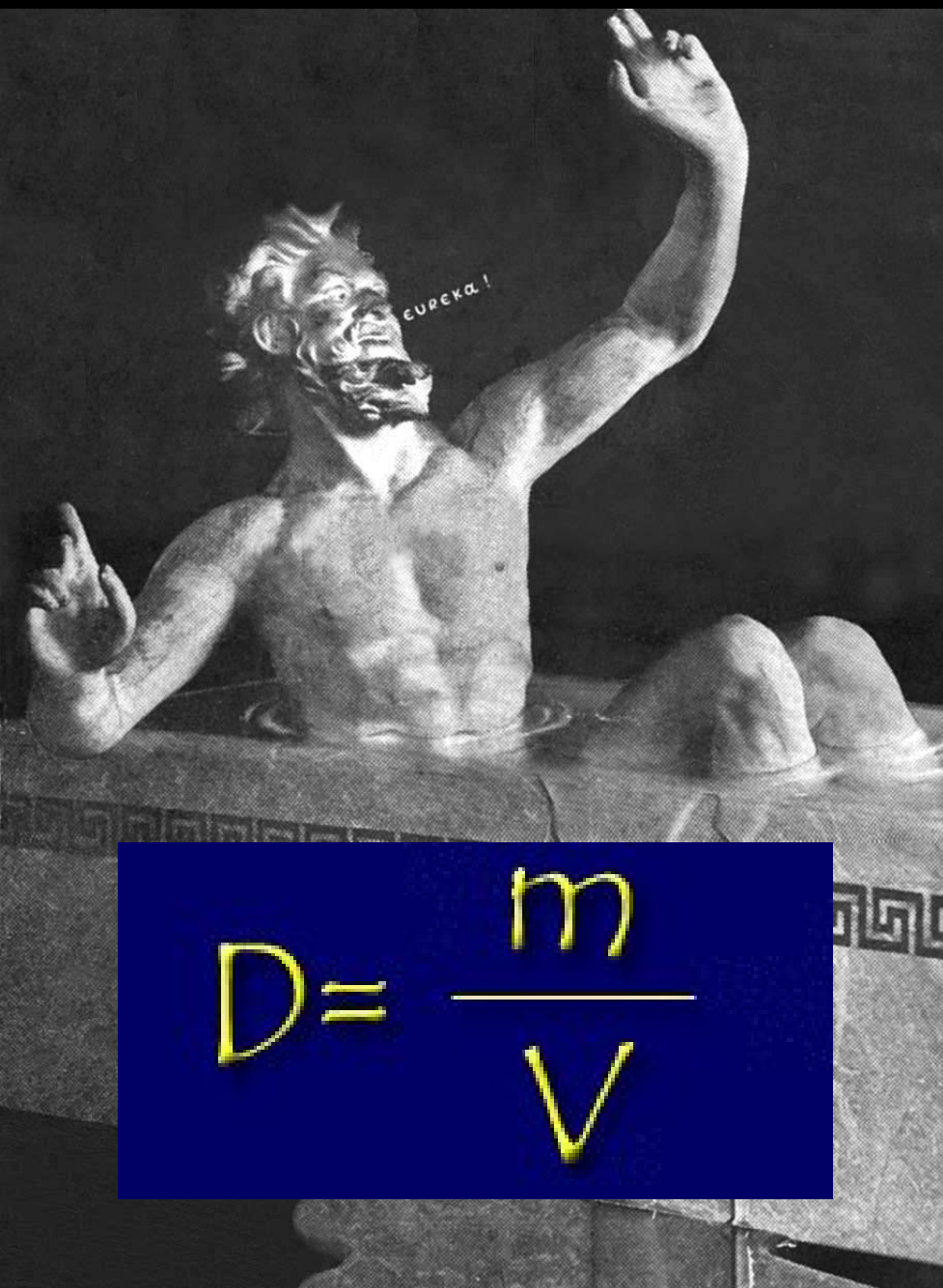
Where guitarists use a guitar, actors use their whole body. That is why, during our sessions we will start by "tuning" our instrument with an intense physical warm up, followed by an exercise which aims to train our equilibrium and proprioception. Thereafter we explore some of the many ways of using our instrument via different theatre exercises.

We end each session with short performances which we analyse.

The last 3 sessions of the workshop will consist of creating a small play where we apply everything we've learnt thus far.

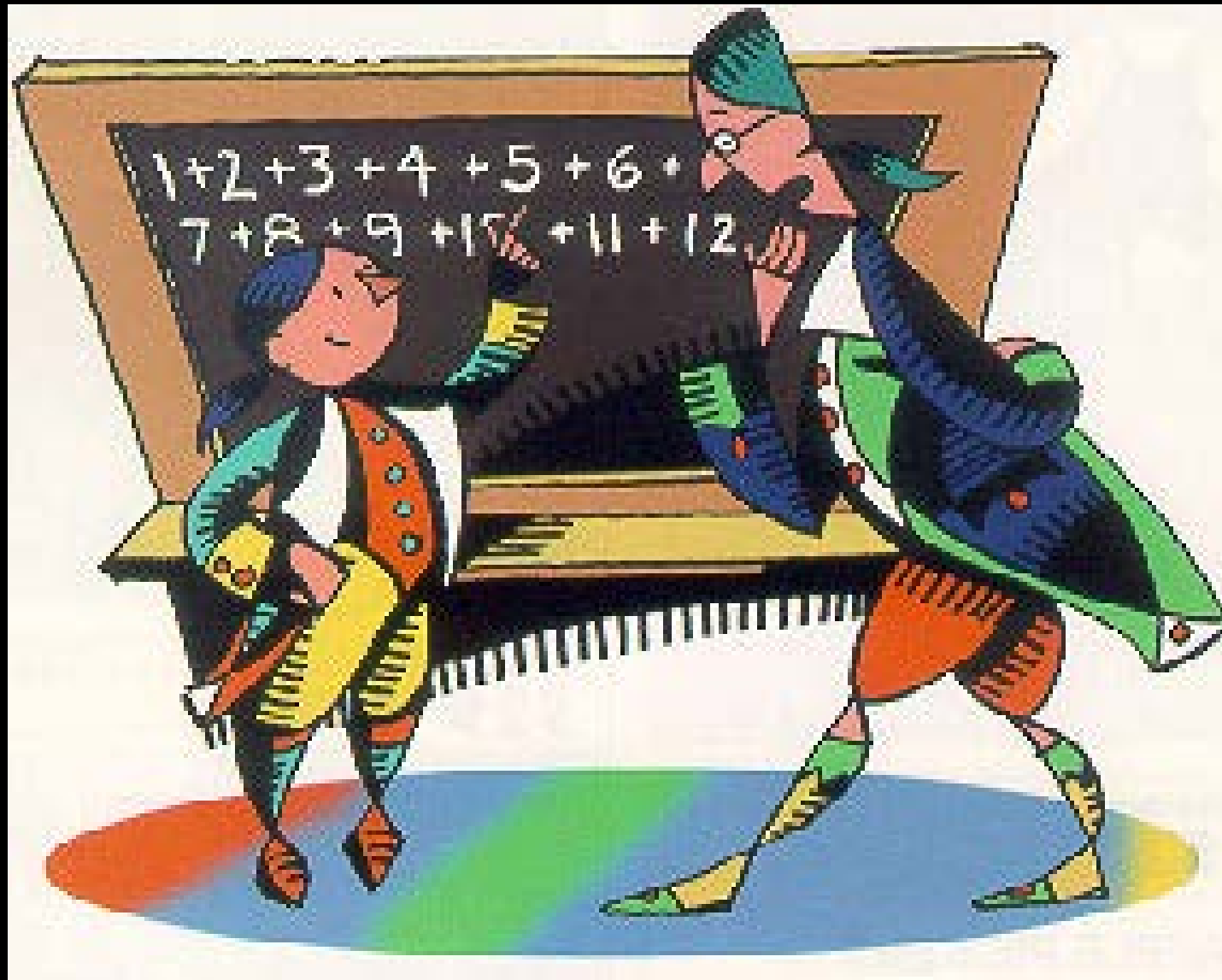
Mirza studies Theatre in Education at the HKU University in Utrecht. For his third year he came to India to explore and experiment with theatre in Indian culture.





**Archimedes's
Discovery of
Density Was a Case
of Embodied
Thinking**

Friedrich Gauss

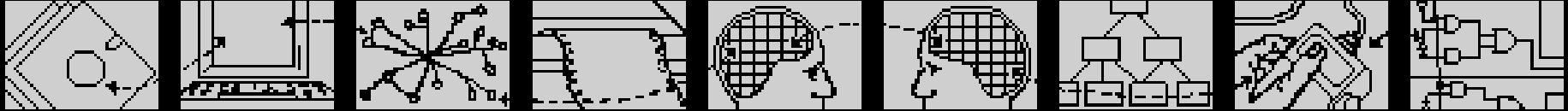


$$\begin{array}{ccccccccccc}
 \sum_{i=1}^n i & = & 1 & + & 2 & + & 3 & + & \dots & + & (n-2) & + & (n-1) & + & n \\
 & & \downarrow & & \downarrow & & \downarrow & & & & \downarrow & & \downarrow & & \downarrow \\
 \sum_{i=1}^n i & = & n & + & (n-1) & + & (n-2) & + & \dots & + & 3 & + & 2 & + & 1
 \end{array}$$

$$\begin{aligned}
 2 * \sum_{i=1}^n i &= (n+1) + (n+1) + (n+1) + \dots + (n+1) + (n+1) + (n+1) \\
 &= n(n+1)
 \end{aligned}$$

$$\sum_{i=1}^n i = \frac{n(n+1)}{2}$$

Transformational Thinking



- Using several or all of the “tools” in an integrated manner to raise and solve problems

Transforming Script and Score from Notations to Performances

***My Fair Lady* Script / 剧本**

Freddy, go and find a cab.

Do you want me to catch pneumonia?

Don't just stand there, Freddy. Go and find a cab.

All right, I'll get one.

Look where you're goin', dear. Look where you're goin'!

I'm so sorry.

Two bunches o' violets trod in the mud. A full day's wages.

-Freddy, go and find a cab. -Yes, Mother.

He's your son, is he?

If you'd done your duty as a mother should...

...you wouldn't let 'im spoil a poor girl's flow'rs and run away without payin'.

Go about your business, my girl.

And you wouldn't go off without payin', either.

Two bunches o' violets trod in the mud.

Sir, is there any sign of it stopping?

I'm afraid not. It's worse than before.

If it's worse, it's a sign it's nearly over.

Cheer up, Capt'n, buy a flow'r off a poor girl.

I'm sorry, I haven't any change.

I can change 'alf a crown. Take this for tuppence.

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MY FAIR LADY

5

Lyrics by
ALAN JAY LERNER
Presto

No. 1. Overture

Music by
FREDERICK LOEWE

Piano

The musical score for the Overture of My Fair Lady is written for piano. It begins with a piano introduction marked 'Piano' and 'ff (Tutti)'. The score is in 2/4 time and features a variety of instruments including strings, brass, woodwinds, and piano. The score is divided into measures, with some measures marked with 'ff' (fortissimo) and 'p' (piano). The score includes a 'Tutti' section and a 'Prestissimo' section. The score is written for piano and includes a variety of instruments including strings, brass, woodwinds, and piano. The score is divided into measures, with some measures marked with 'ff' (fortissimo) and 'p' (piano). The score includes a 'Tutti' section and a 'Prestissimo' section.

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Infringers are liable under the law.



Physicist Jacob Shaham on Transforming

“Acting taught me how to read equations like a script with characters I had to bring to life...”

Maxwell's Equations (Integral Form)

$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{inside}}{\epsilon_0}$$

$$\oint \vec{B} \cdot d\vec{A} = 0$$

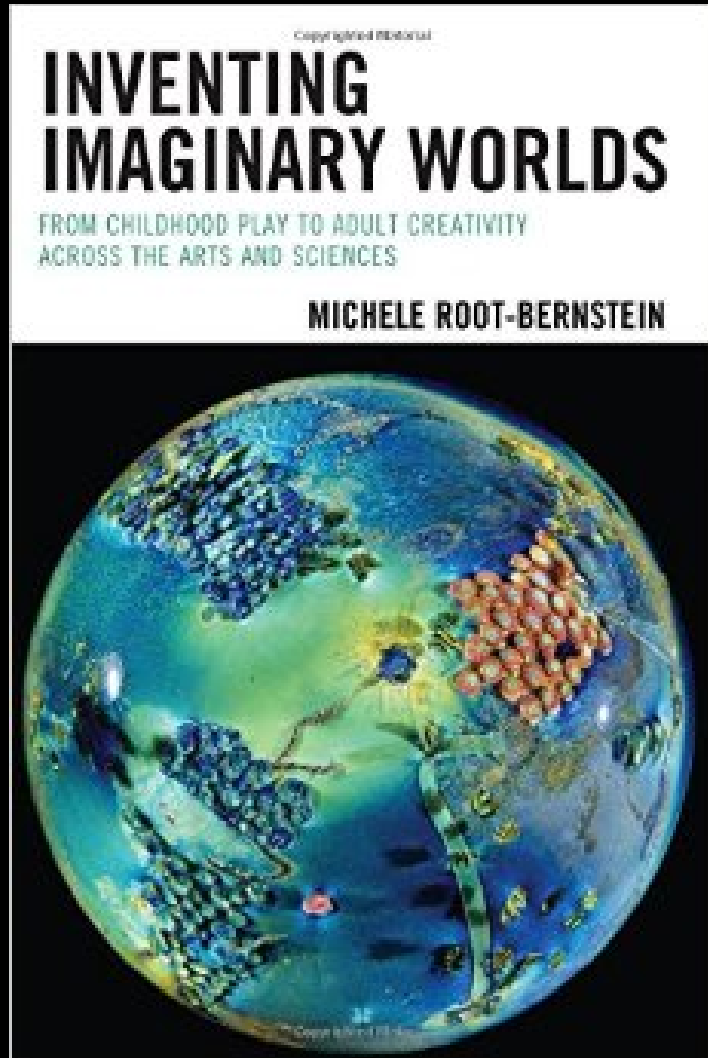
$$\oint \vec{E} \cdot d\vec{s} = -\frac{d\Phi_B}{dt}$$

$$\oint \vec{B} \cdot d\vec{s} = \mu_0 I_{enclosed} + \epsilon_0 \mu_0 \frac{d\Phi_E}{dt}$$

*No magnetic monopoles
and no magnetic “currents”.*

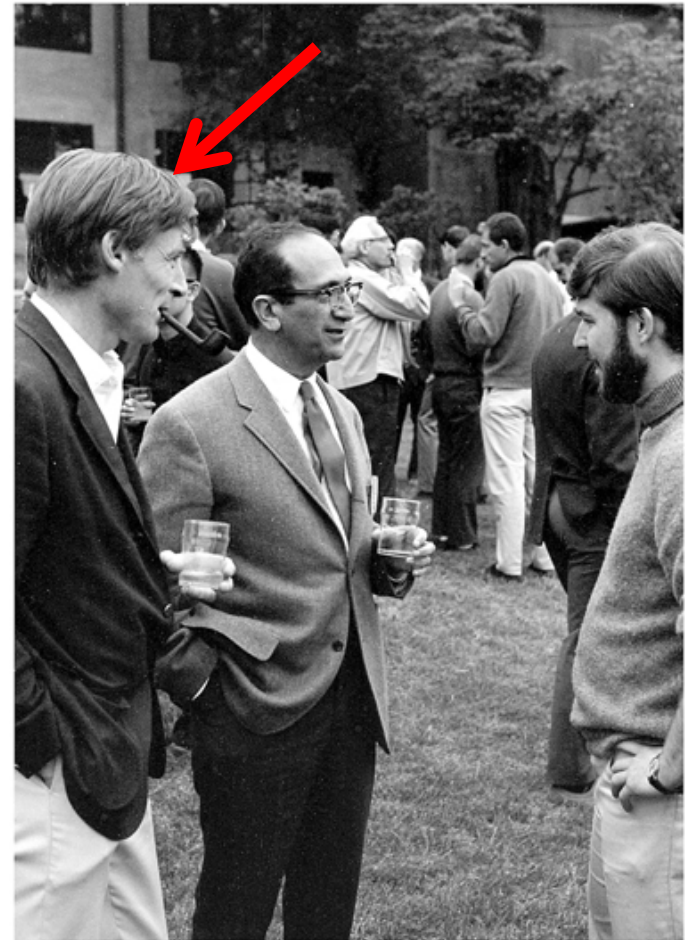


Scientists Often Write “Scripts”



- “As a scientist I imagine possible worlds that are closely based on my understanding of aspects of the real world. In other words, I try to imagine a ‘story’, with a very strong plot and characters, that completely meshes with the real world yet reveals that world in a new way...neurons and synapses are as vivid to me as knights and pawns to the chess player: as vivid as food on the table, or flowers in the garden, to the average person.”

Liz Lerman Asks, John Cairns Answers:

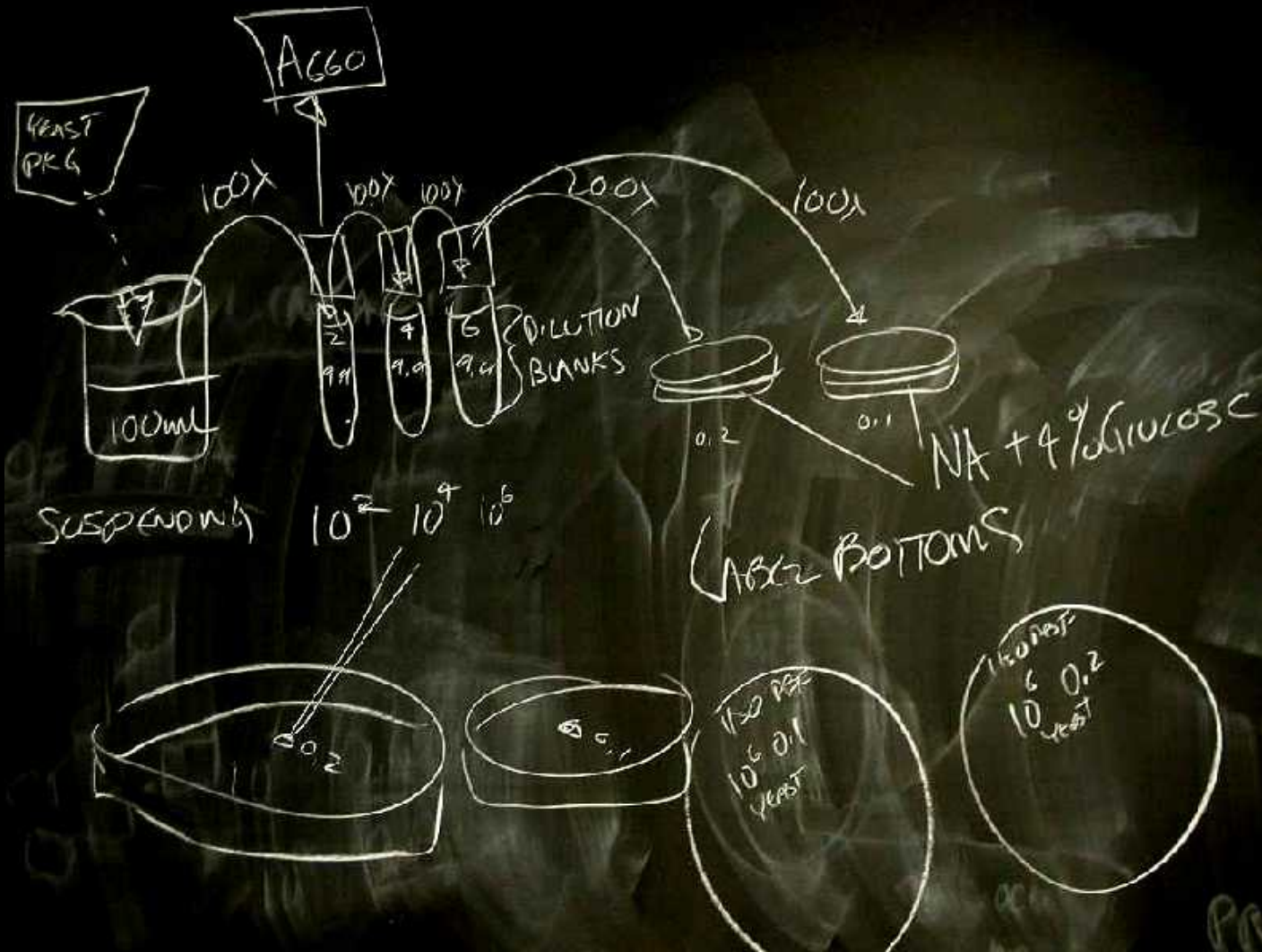


Zafra Lerman Has Her Chemistry Students Script, Choreograph *and* Dance



- What happens when the couple Na-OH meets another couple, H-Cl at a dance?!
- The action really heats up as each partner finds a partner more to their taste!

Every Experiment Is A Logical Story Embodied as Processes through Space and Time by People Acting on Things



Synosia, or Synthetic Thinking

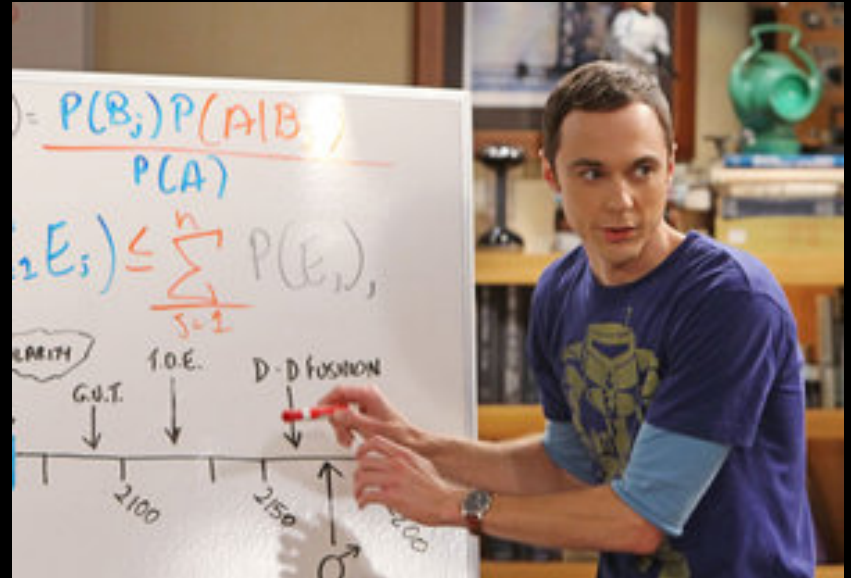
- Synosia = Synaesthesia + Gnosis
- Synaesthesia = feeling with all your senses simultaneously
- Gnosis = formal knowledge
- So, synosia = knowing and feeling simultaneously
- Objective and subjective
- Intuitive and analytical
- Embodied and cerebral

Synosia in Action: Conveying Information through Sensation and Perception



A Synosic Education:

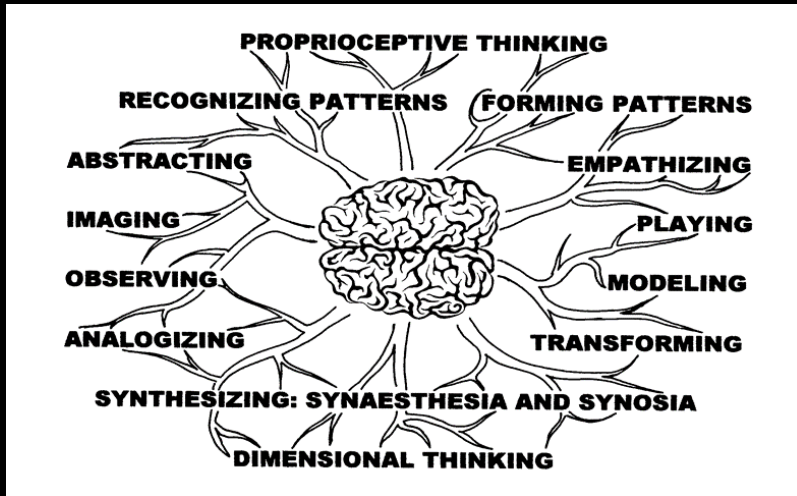
To think is to feel
To feel is to think
When the two are
one
Understanding is
achieved



Why You?!



So Let's Celebrate the Fact that a Theater Production Has It All!



So provide your students the energy of STEAM “play”
Plant SEADS that will grow for a lifetime! Build TEAMS!