

Scientific Creativity

Tim Linden



15 November 2024

Why are You Giving a Talk?

Invitation to “Next Frontiers in the Search for Dark Matter”: 23–27 September 2019 at GGI ➤ Inbox x



Francesco D'Eramo <fderamo@pd.infn.it>

Wed, Jan 16, 2019, 10:33 PM



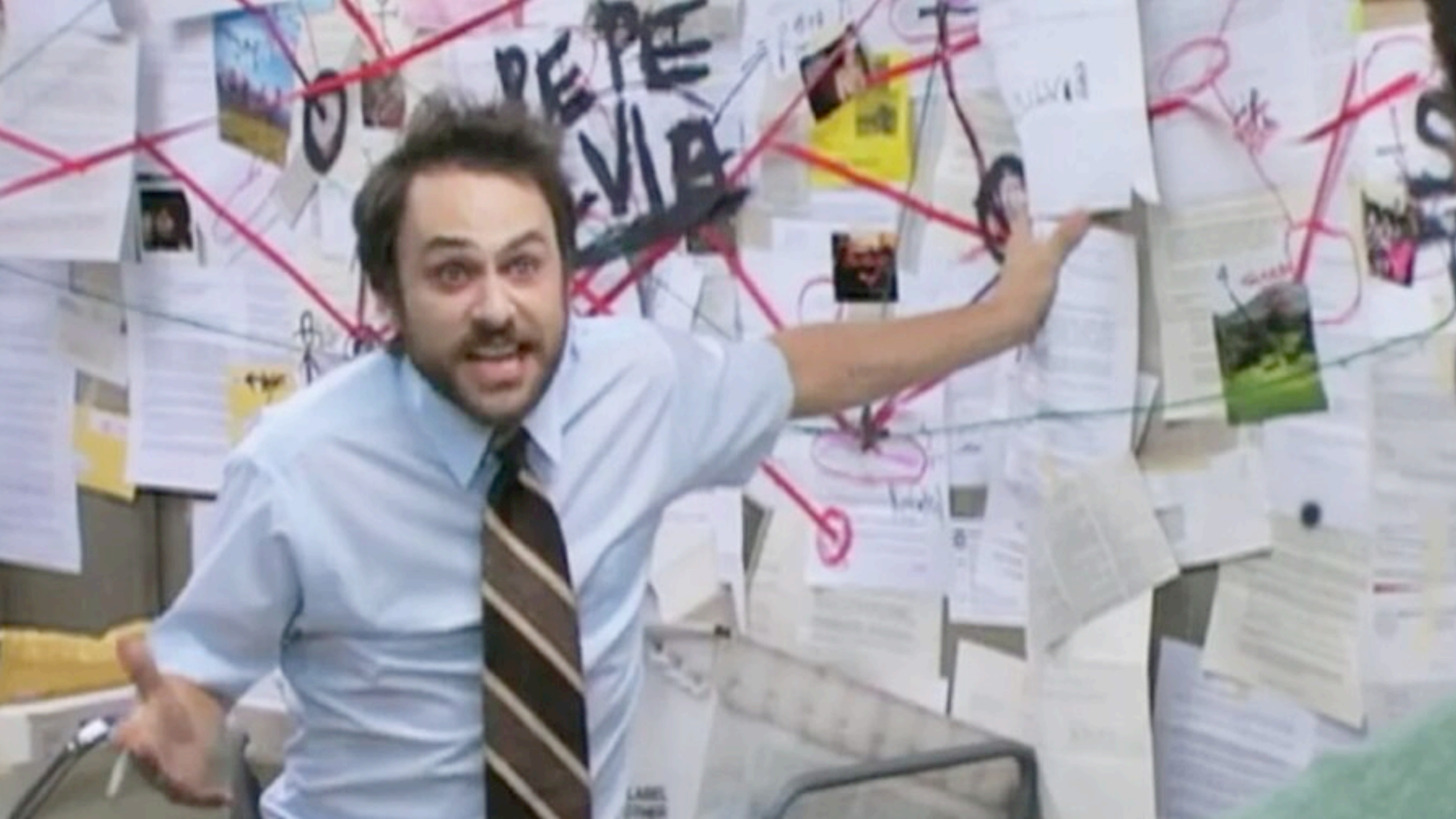
to linden.70, Francesco ▼

Dear Tim,

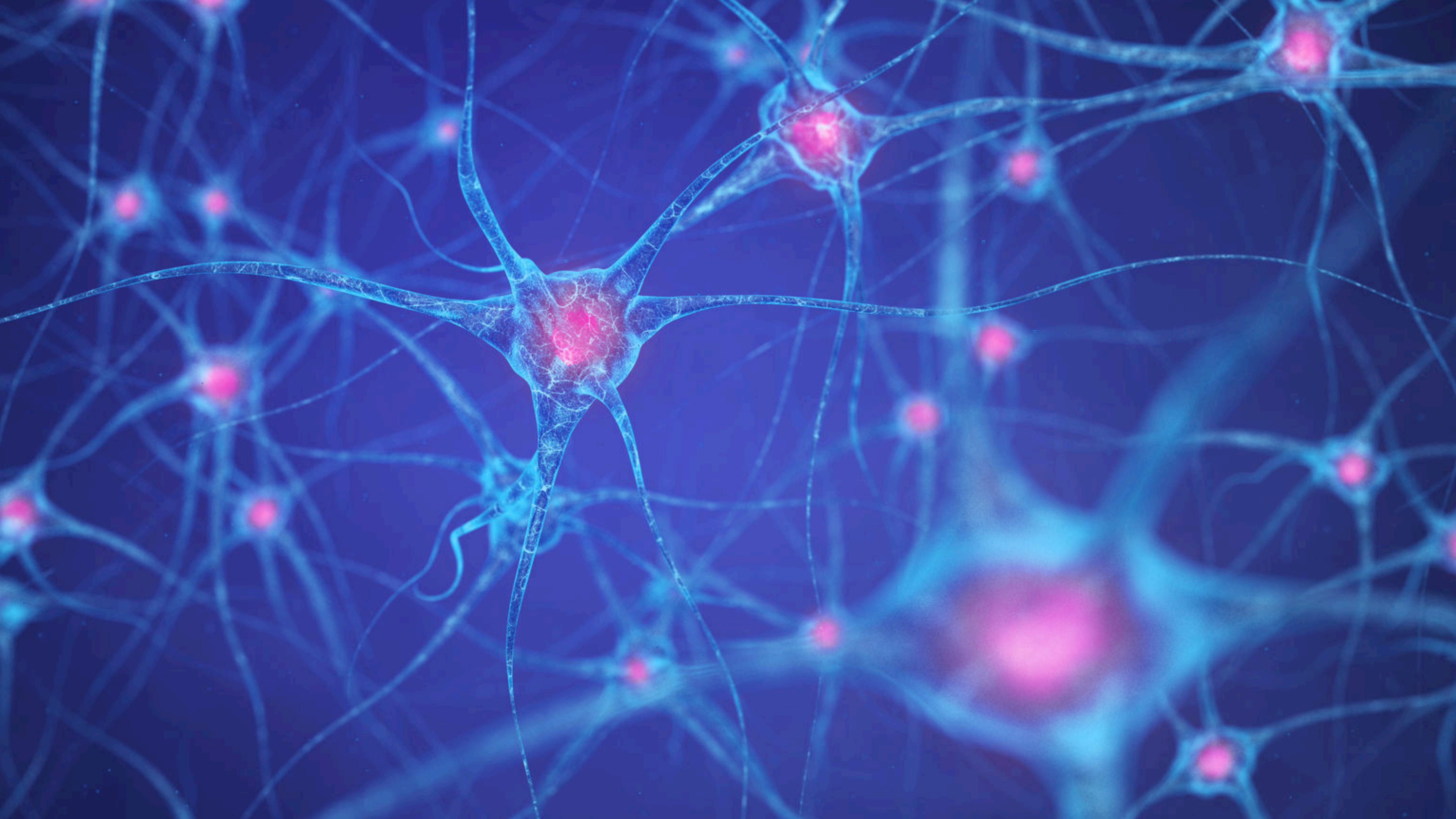
I am writing to **invite** you to give a **talk** at the conference “Next Frontiers in the Search for Dark Matter”. The program will be held this year at the Galileo Galilei Institute (GGI) for Theoretical Physics in Florence from September 23rd to September 27th. Here is the indico webpage of the event: <https://indico.cern.ch/event/782948/overview>

Your **talk** will be in the session “Indirect Searches”. You will have 25 minutes for the presentation plus 5 minutes for questions and discussion.

The conference will take place during the 5th week of a longer (seven week) workshop at GGI: <https://www.ggi.infn.it/showevent.pl?id=291>









Creativity

“That’s probably the
highest currency [in
science]”

Stephen Chu





“Writing is the art of
applying the ass to the
seat.”

Dorothy Parker

1893-1967



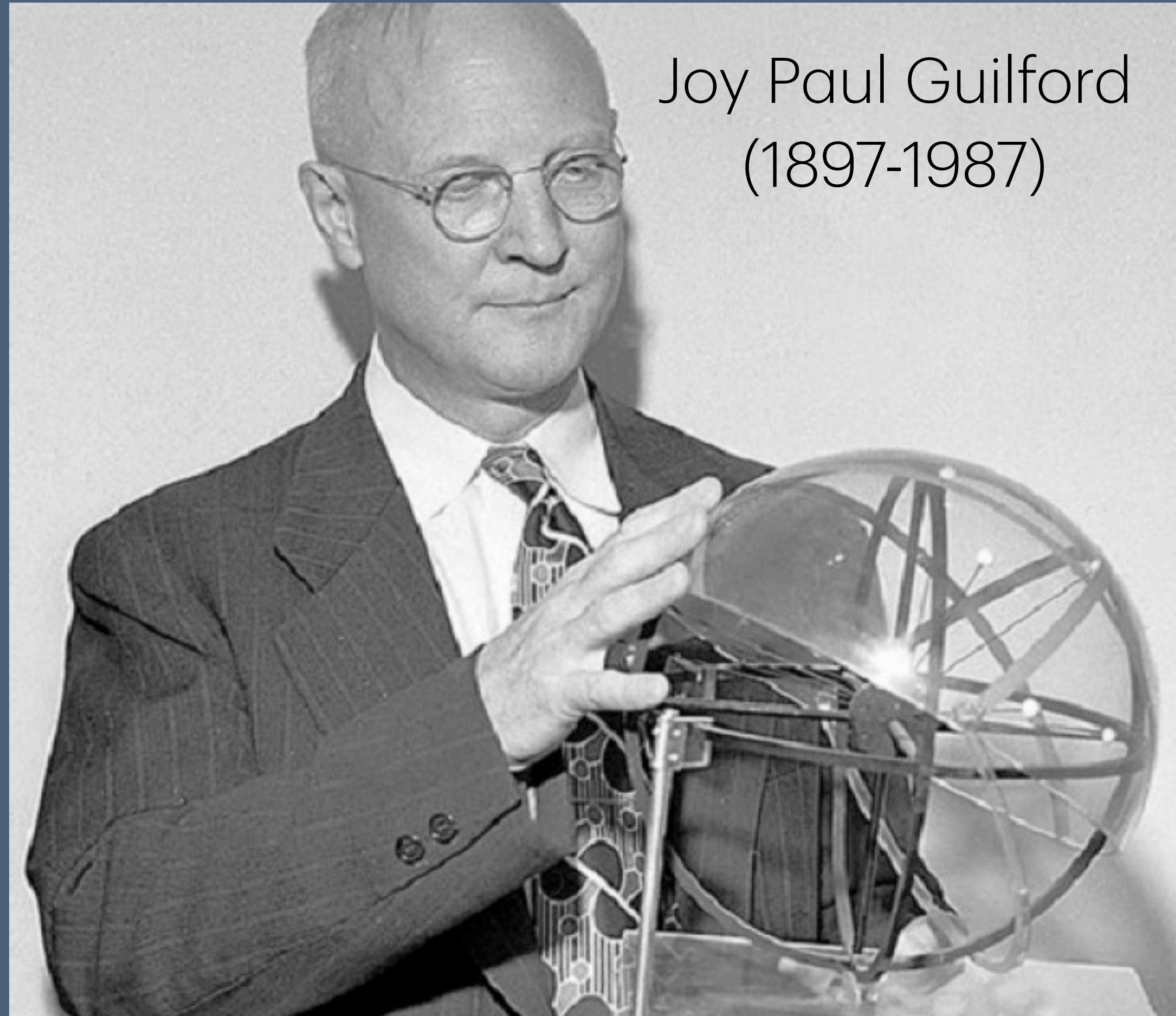
Creativity



Creativity is the ability to form novel and valuable ideas or works using your **imagination**. Products of creativity may be intangible (e.g., an **idea**, a **scientific theory**, a **literary work**, a **musical composition**, or a **joke**) or a physical object (e.g., an **invention**, a **dish** or meal, an item of **jewelry**, a **costume**, or a **painting**). Creativity may also describe the ability to find new solutions to problems, or new methods of performing a task or reaching a goal. Creativity, therefore, enables people to solve problems in new or innovative ways.

Divergent vs. Convergent Thinking

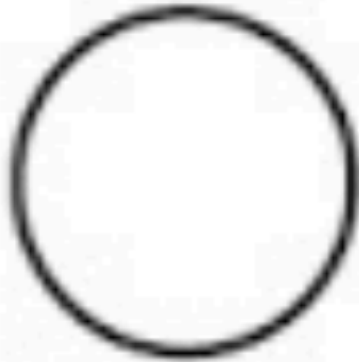

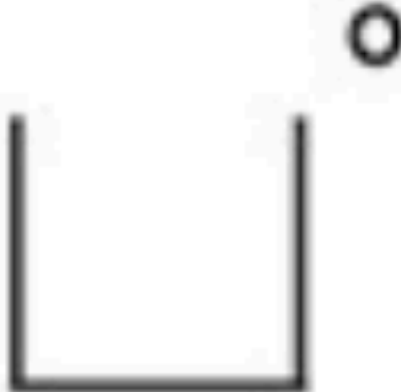
- Convergent Thinking - Putting multiple pieces together in order to obtain the correct solution.
- Divergent Thinking - Finding multiple uses for the same object.



Joy Paul Guilford
(1897-1987)

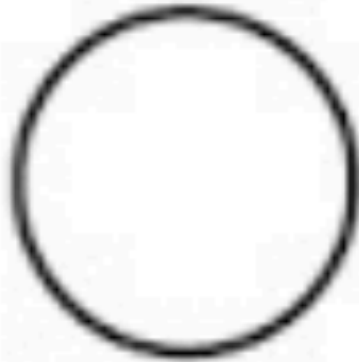


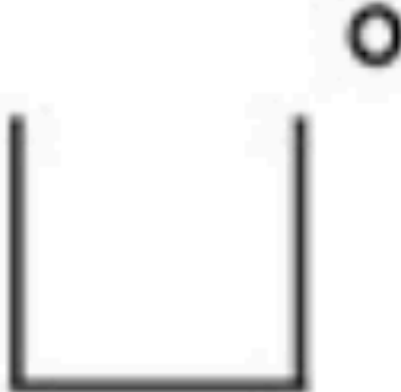
Torrance Test

In a standardized Torrance Test of Creative Thinking, subjects are given simple shapes (*left column*) and are asked to use them (*top row*) or combine them (*middle row*) in a picture or to complete a partial picture (*bottom row*). Evaluators judge whether the results are more or less creative.

	Starting Shapes	Completed Drawing	
		More Creative	Less Creative
Use			
Combine			
Complete			

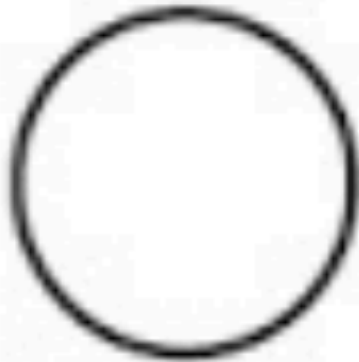



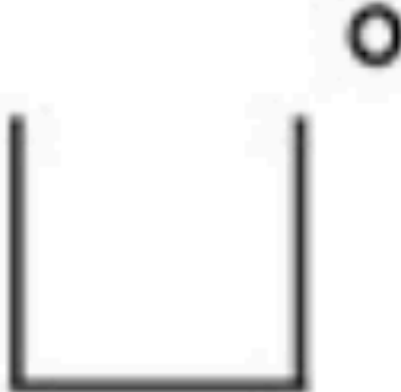
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	Starting Shapes	Completed Drawing	
		More Creative	Less Creative
Use			 Chain
Combine			
Complete			

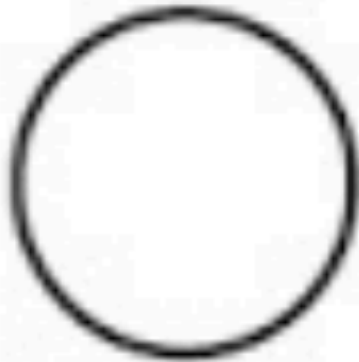




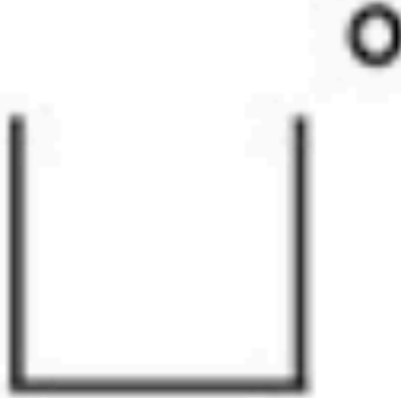
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	Starting Shapes	Completed Drawing	
		More Creative	Less Creative
Use		 Mickey Mouse	 Chain
Combine			
Complete			

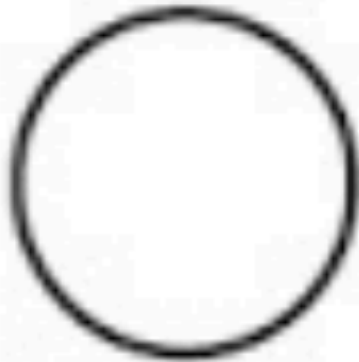





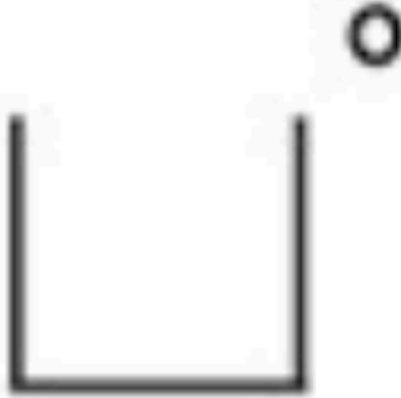
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	Starting Shapes	Completed Drawing	
		More Creative	Less Creative
Use		 Mickey Mouse	 Chain
Combine			 Face
Complete			

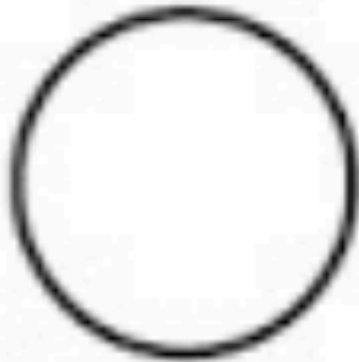





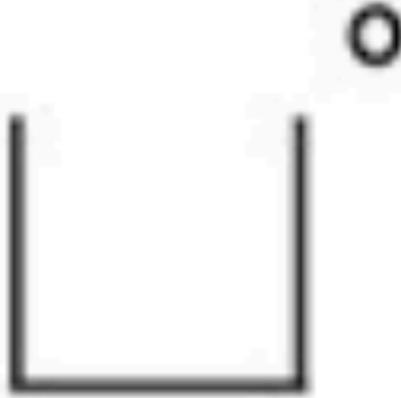
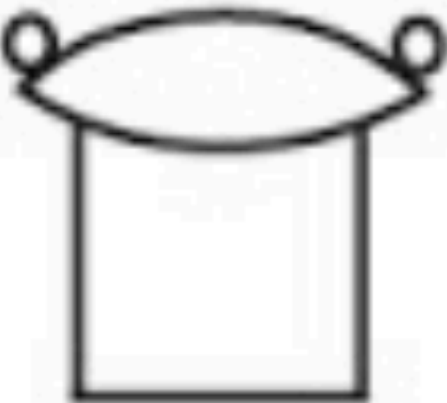
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	Starting Shapes	Completed Drawing	
		More Creative	Less Creative
Use		 Mickey Mouse	 Chain
Combine		 King	 Face
Complete			

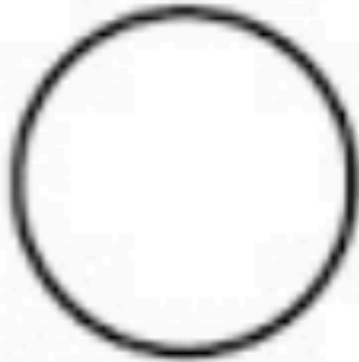






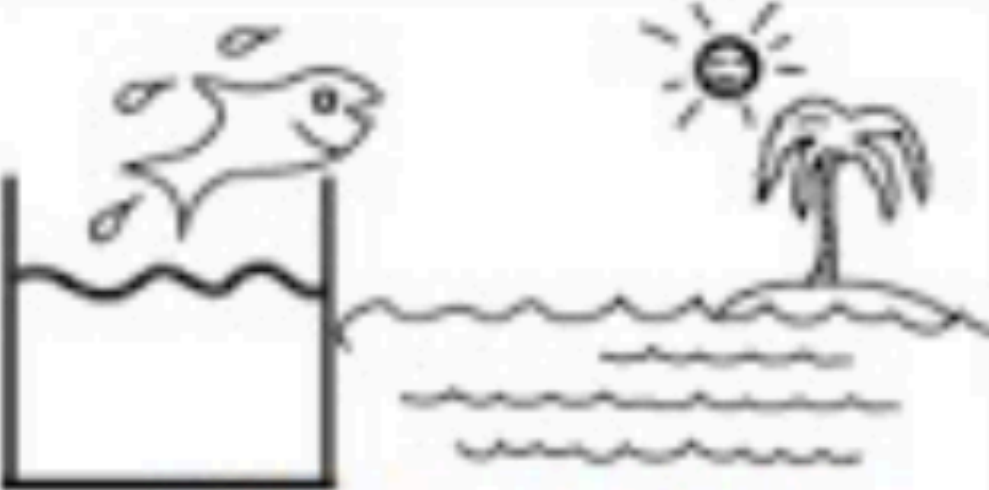
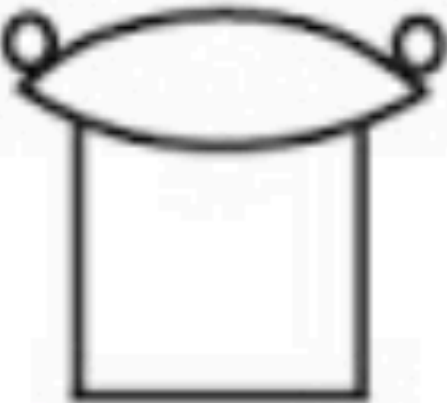
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	Starting Shapes	Completed Drawing	
		More Creative	Less Creative
Use		 Mickey Mouse	 Chain
Combine		 King	 Face
Complete			 Pot

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	Starting Shapes	Completed Drawing	
		More Creative	Less Creative
Use		 Mickey Mouse	 Chain
Combine		 King	 Face
Complete		 A fish on vacation	 Pot

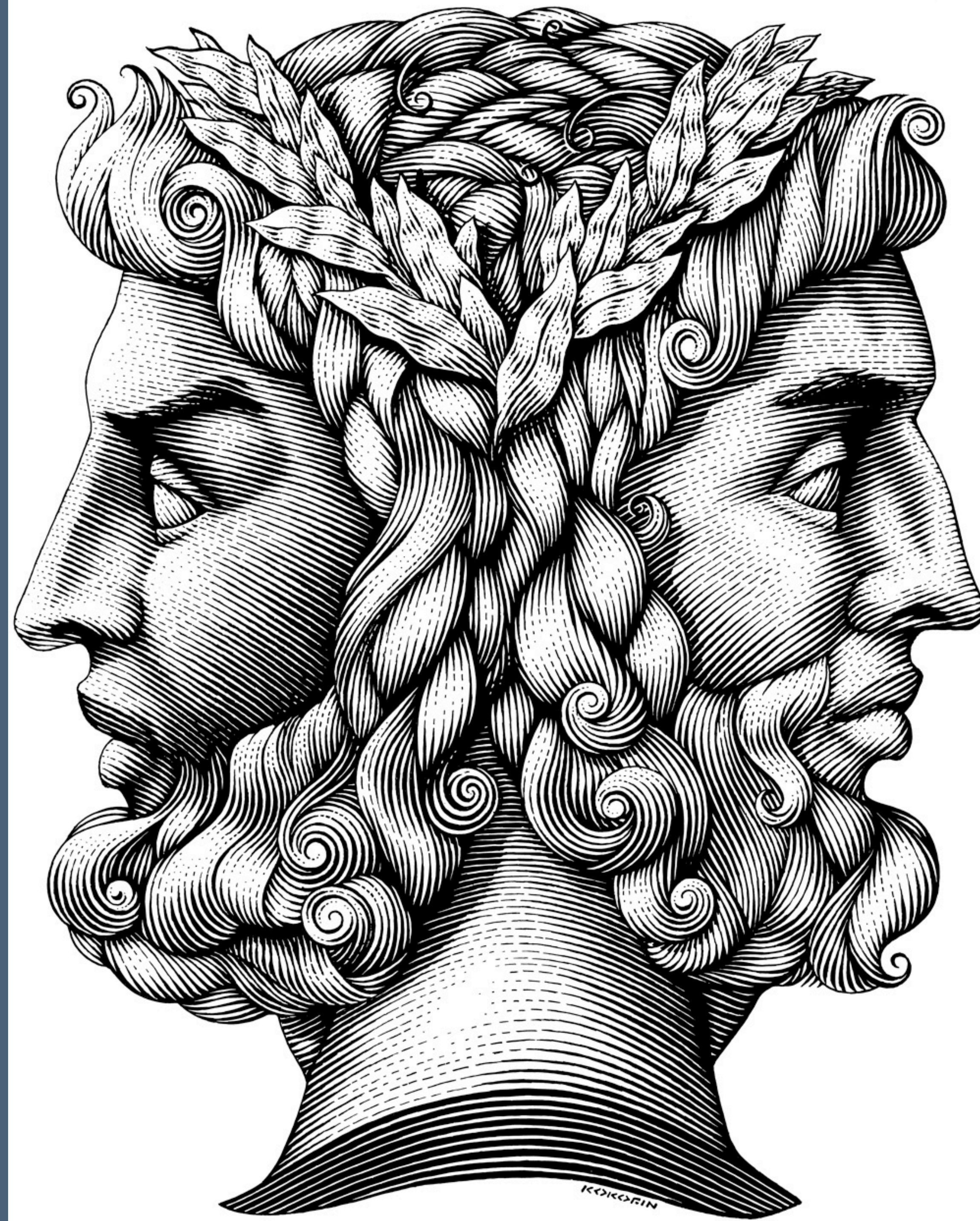
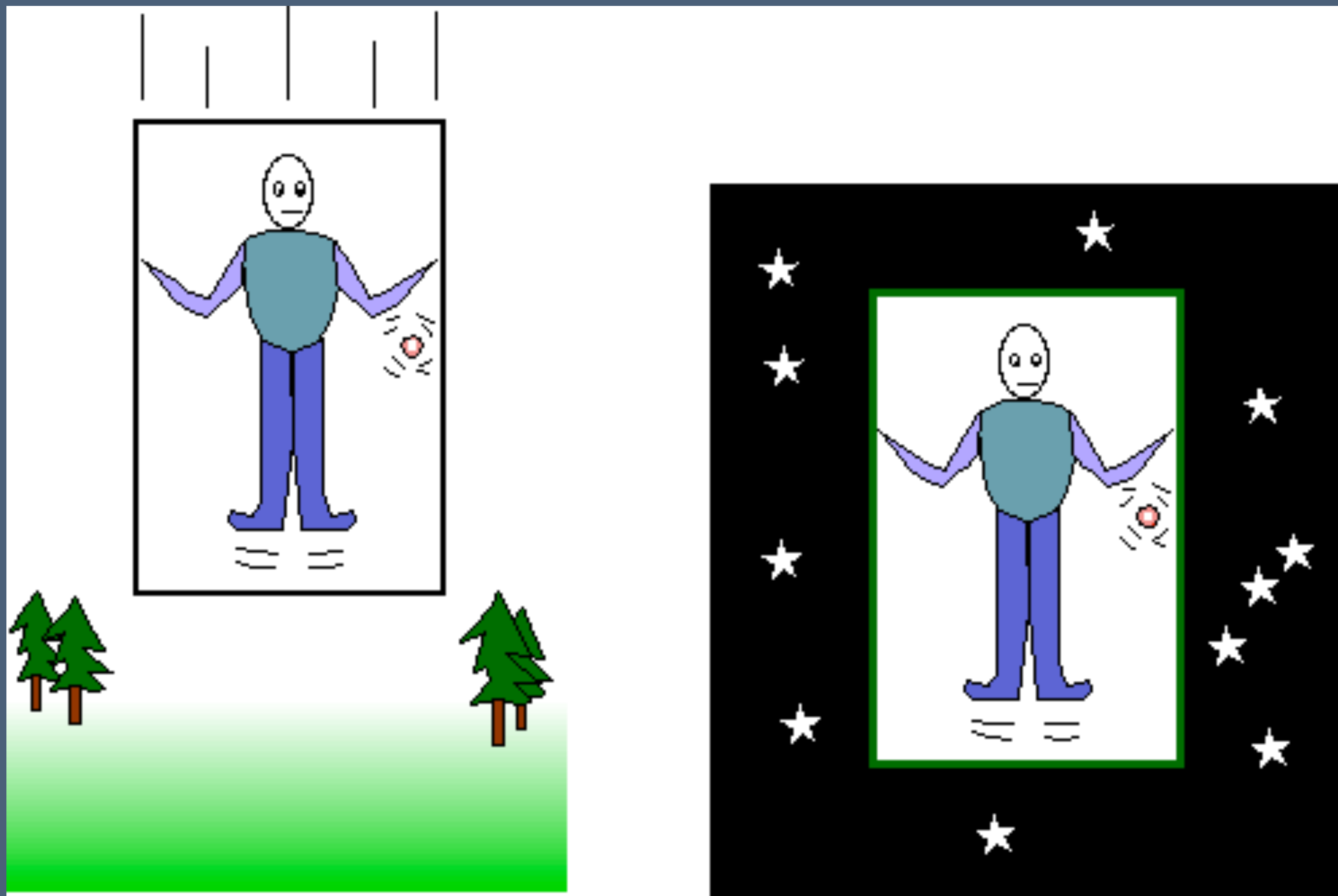
Types of Creativity

What types of creativity
produce results in Science?



Albert Rothenberg

Janussian Process



Homospatial Process

- The creativity associated with imagining two distinct physical entities occupying the same location in space.



Pierre-Gilles de Genens (Noble Prize 1991)



Sep-Con Articulation

- Short for Separation/Connection
- Connecting Separate Ideas, while keeping the tension of what differentiates them clear.
- By deviating from the customary approach - you produce a connection between two ideas, which simultaneously brings forth their differences.

Jennifer Doudna (Nobel Prize 2020)
CRISPR-CAS9



Comedians



Emo Philips

Unlocking Personal Creativity

- Creativity requires discomfort.
- It is natural not to want to experience discomfort — to take the tried and true path.
- Being creative is an active choice.



Unlocking Personal Creativity



Tina Seelig

Unlocking Personal Creativity



Tina Seelig

Turn Off Self-Censorship



This Is Your Brain On Jazz: Researchers Use MRI To Study Spontaneity, Creativity

Date: February 28, 2008

Source: Johns Hopkins Medical Institutions

Summary: A pair of Johns Hopkins and government scientists have discovered that when jazz musicians improvise, their brains turn off areas linked to self-censoring and inhibition, and turn on those that let self-expression flow.

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Mind & Brain

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FULL STORY

A pair of Johns Hopkins and government scientists have discovered that when jazz musicians improvise, their brains turn off areas linked to self-censoring and inhibition, and turn on those that let self-expression flow.

The joint research, using functional magnetic resonance imaging, or fMRI, and musician volunteers from the Johns Hopkins University's Peabody Institute, sheds light on the creative improvisation that artists and non-artists use in everyday life, the investigators say.

“Once you free your mind
about a concept of
Harmony and of music
being *correct*, you can do
whatever you want.”

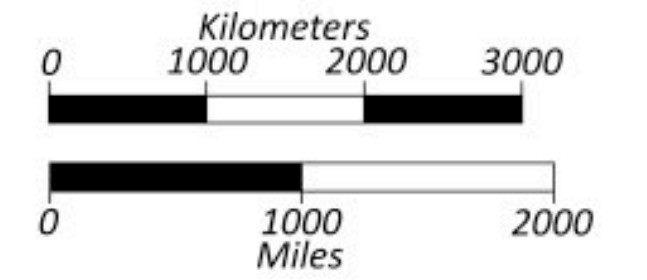
Giorgio Morder



Create Distance



World Map





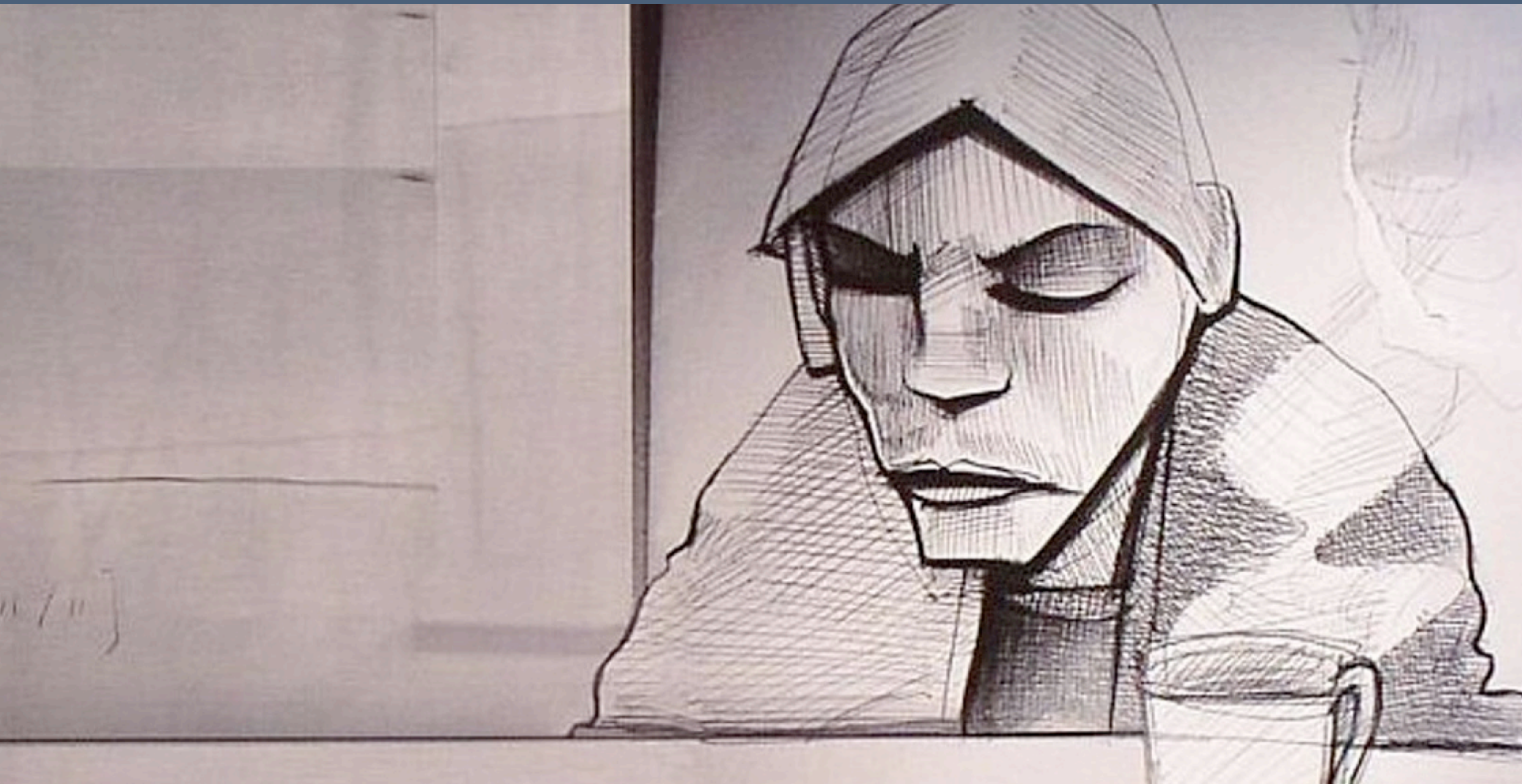
The three components of Creativity



Motivation and Drive

- Creativity comes from a combination of focused attention and unfocused attention.
- Perseverance in science requires working hard on ideas when you don't know whether they will work out.





Motivation and Drive

Thankfully I've never gotten writer's block. The way I think of it is that my father worked at a sweater knitting factory for 35 years and he never got "factory block". Sometimes the words and ideas don't come as easily as you'd like, but you do what you can.



Joe Posnanski



Publish **O**r **P**erish?

The three components of Creativity





1.



Stand with your shoulders down, back and legs straight and head facing forwards. Lean slightly forward so you feel the pull of gravity downwards but remain in control.

2.



Bend your left knee slightly, point your left foot downwards, stabilizing your straight right leg.

3.



With great exaggeration, thrust your left knee upwards in a forward arial half turn towards your chest. Bend your right leg, round your back and bring your chest into your knee.

4.



Slam your left foot to the ground allowing your body to follow. Keep your knees slightly above the ground. Lean your torso forward to stabilize the stance.

5.



Swing your right foot from the crouched position upwards, so that your right knee is at chest level. Extend your right leg and keep your chest away from your knee. Keep your left leg bent.

6.



Swing your right foot backwards, toe pointed. Flatten your back and lean forward for balance. If you have a cane or walking stick handy, place on ground for optimal stability.

7.



Staighthen your torso slightly, bring your right leg slightly forward. Once stability is achieved, lift respective cane or walking stick from ground.

8.



Bring your right leg forward, bending your right knee at a 90° angle. Staighthen your torso completely, keep your left knee bent slightly.

9.



Extend your right leg and bring your torso closer to your right leg. Bend your left knee more but keep your tailbone upwards.

10.



Swing your right leg bakwards, extending it until completely straight. You should land in a shallow lunge position. Keep your body forward and left knee bent.

11.



Swing your right leg in a circular motion upwards and forwards. Keep left leg bent.

12.



Extend your right leg to its maximum length upwards. Bring your face towards your upwards knee, rounding your back. Bend left knee forwards, while raising your heel off the ground.

END



Recent submissions

Any replacements are listed farther down

[4945] [viXra:2411.0095](#) [pdf] submitted on 2024-11-13 16:08:02

A Generalized Tachyonic Scalar Field Lagrangian for Cosmological Phenomena

Authors: [Alem Solomon](#)

Comments: 8 Pages.

We establish a generalized tachyonic field framework with a unique universal speed of ($v_t = \sqrt{1/(\Lambda t_P^2)}$ approx 5.931 times $10^{60}c$), derived through Lorentz transformation and dimensional analysis of physical constants. Implications for quantum mechanics, particularly in the context of pilot wave theory, suggest a novel perspective on non-locality and quantum entanglement. The corresponding generalized tachyonic Lagrangian provides a unified description of inflation, dark matter, and dark energy. In the early universe, the theory predicts inflationary observables with a modified Lorentz factor; at galactic scales, it accommodates MOND phenomenology; and in the late universe, it reduces to a modified quintessence model with corrections of order c^2/v_t^2 to the dark energy equation of state. The extremely high value of v_t ensures compatibility with existing constraints while allowing for small, potentially observable effects at cosmological scales.

Category: [Relativity and Cosmology](#)

[4944] [viXra:2411.0093](#) [pdf] submitted on 2024-11-11 22:38:57

Dark Energy from Cosmological Energy Conservation

Authors: [Manuel Uruena Palomo](#)

Comments: 4 Pages.

The value of the gravitational wave energy density is unknown. Current progress in gravitational wave detection suggests that the energy density of the stochastic gravitational wave background (SGWB) will be estimated in the next decades. We present a derivation of its value under the assumption that energy lost due to cosmic redshift is fully responsible for the energy gained by the cosmological constant in the expanding universe. This unknown non-local mechanism of energy conservation on the cosmic scale could explain dark energy and hint at a property of a theory of quantum gravity.

Category: [Relativity and Cosmology](#)

[4943] [viXra:2411.0092](#) [pdf] submitted on 2024-11-11 22:40:48

On Regular Negative Mass Black Holes Under Unitary Time and Proper Antichronous Transformations

Authors: [Manuel Uruena Palomo](#)

Comments: 10 Pages.

A non-singular black hole solution is briefly presented which violates energy conditions only at its interior by postulating a consistent shift to negative energies and gravitationally repulsive negative masses at the event horizon. This shift is the unitary parity-time PT transformation of relativistic quantum mechanics and the proper antichronous transformation of the full Lorentz group. The transformation at the event horizon respects Einstein's equivalence principle, and the considered negative mass interaction does not result in the runaway motion paradox or vacuum instability. The correspondence of these regular black holes with observed ones is studied by proposing another mechanism of black hole growth independent of accretion and merging due to interior increasing entropy, which attempts to solve the unexplained size and formation of high-redshift supermassive black holes, the intermediate mass gap, and the information paradox.

Category: [Relativity and Cosmology](#)

[4942] [viXra:2411.0081](#) [pdf] submitted on 2024-11-11 21:00:17

The Relative Nonlocality or the Illusion of Superluminal Speed Due to Curvature Difference Between Different Spacetime Intervals

How do we develop productive creativity?

Adding an Element of Divergence

FERMILAB-PUB-17-080-A

Using HAWC to Discover Invisible Pulsars

Tim Linden,^{1,*} Katie Auchettl,^{1,†} Joseph Bramante,^{2,‡} Ilias Cholis,^{3,§}
Ke Fang,^{4,5,¶} Dan Hooper,^{6,7,8,**} Tanvi Karwal,^{3,††} and Shirley Weishi Li^{1,‡‡}

¹*Center for Cosmology and AstroParticle Physics (CCAPP), and*

Department of Physics, The Ohio State University Columbus, OH, 43210

²*Perimeter Institute for Theoretical Physics, Waterloo, Ontario, N2L 2Y5, Canada*

³*Department of Physics and Astronomy, The Johns Hopkins University, Baltimore, Maryland, 21218*

⁴*University of Maryland, Department of Astronomy, College Park, MD, 20742*

⁵*Joint Space-Science Institute, College Park, MD, 20742*

⁶*Fermi National Accelerator Laboratory, Center for Particle Astrophysics, Batavia, IL 60510*

⁷*University of Chicago, Department of Astronomy and Astrophysics, Chicago, IL 60637*

⁸*University of Chicago, Kavli Institute for Cosmological Physics, Chicago, IL 60637*

Observations by HAWC and Milagro have detected bright and spatially extended TeV γ -ray sources surrounding the Geminga and Monogem pulsars. We argue that these observations, along with a substantial population of other extended TeV sources coincident with pulsar wind nebulae, constitute a new morphological class of spatially extended TeV halos. We show that HAWCs wide field-of-view unlocks an expansive parameter space of TeV halos not observable by atmospheric Cherenkov telescopes. Under the assumption that Geminga and Monogem are typical middle-aged pulsars, we show that ten-year HAWC observations should eventually observe 37^{+17}_{-13} middle-aged TeV halos that correspond to pulsars whose radio emission is not beamed towards Earth. Depending on the extrapolation of the TeV halo efficiency to young pulsars, HAWC could detect more than 100 TeV halos from mis-aligned pulsars. These pulsars have historically been difficult to detect with



The Moon (same scale)

Geminga



PSR B0656+14

Pulsar Wind Nebulae

- 1.) A Spinning Pulsar Accelerates e^+e^- in its magnetosphere, with an efficiency of around 10%.
- 2.) These electrons are accelerated to TeV or PeV energies in the termination shock of the pulsar wind.
- 3.) The wind continues to push back the interstellar medium (advection), leading to a pulsar wind nebula that has a scale that corresponds to the size of the pulsar.
- 4.) As the pulsar loses power, this wind is less able to push the ISM back, and the pulsar wind nebula shrinks and disappears.
- 5.) The remaining electrons will efficiently diffuse out of the pulsar, but will be too dim to observe.
- 6.) The timeframe for this is around 100 kyr, so we should only see very small very dim things around old pulsars.

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DIFFUSION!
- 3.) The wind continues to push back the interstellar medium (**advection**), leading to a pulsar wind nebula that has a scale that corresponds to the size of the pulsar.
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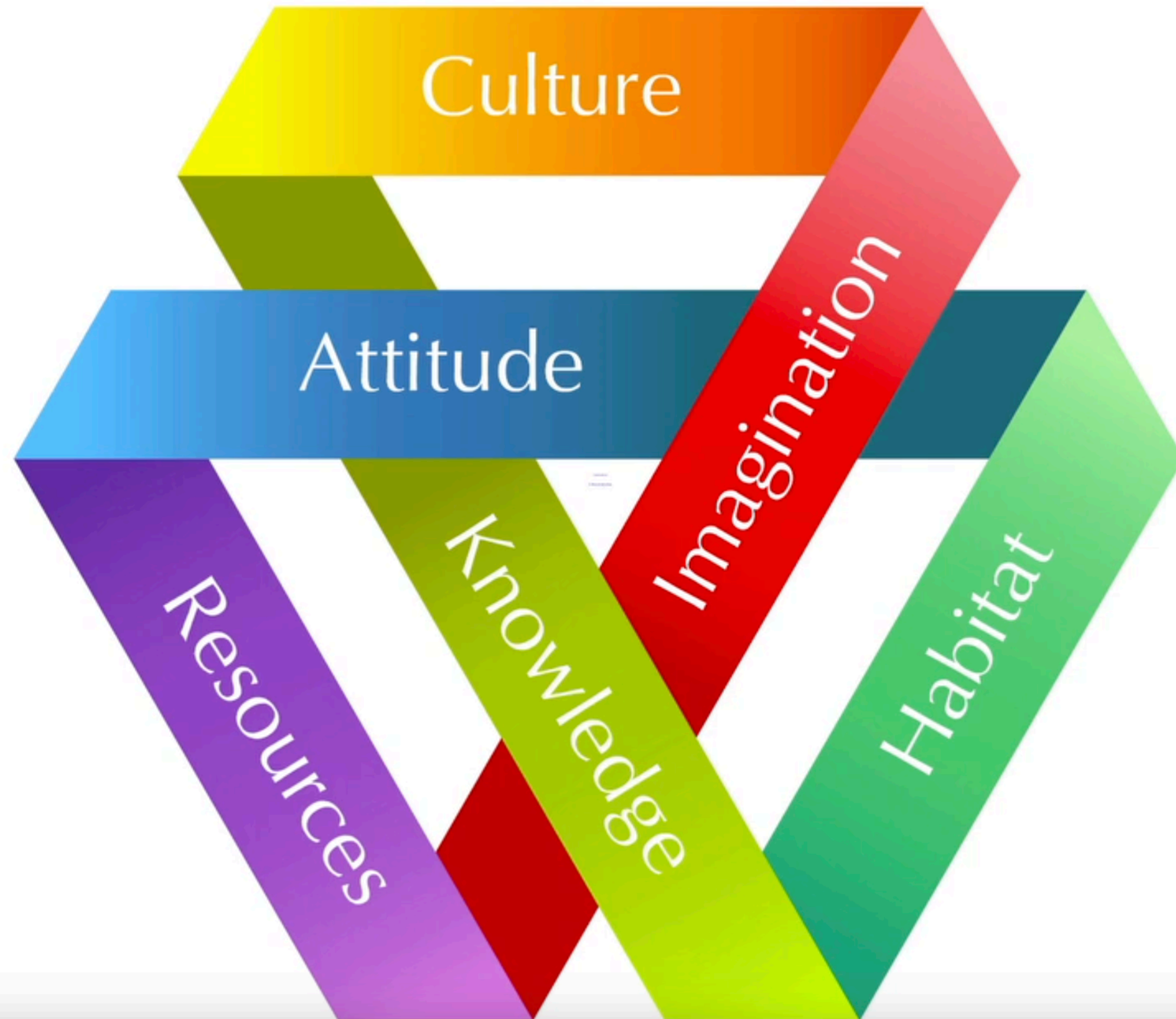
TeV halos

- 1.) A Spinning Pulsar Accelerates e^+e^- in its magnetosphere, with an efficiency of around 10%.
- 2.) These electrons are accelerated to TeV or PeV energies in the termination shock of the pulsar wind.
DIFFUSION!
- 3.) The wind continues to push back the interstellar medium (**advection**), leading to a pulsar wind nebula that has a scale that corresponds to the size of the pulsar.
- 4.) As the pulsar loses power, this wind is less able to push the ISM back, and the pulsar wind nebula shrinks and disappears.
Slow Diffusion!
- 5.) The remaining electrons will efficiently diffuse out of the pulsar, but will be too dim to observe.
- 6.) The timeframe for this is around 100 kyr, so we should only see very small very dim things around old pulsars.

Practice

- 1.) Write down a physical model — with multiple steps, that you don't think is quite right.
- 2.) Circle all of the areas where you can break the model - add in a "divergence"
- 3.) Do these work?

Importance of Environment



Tina Seelig

Importance of Environment

- Organizations are built to mitigate risk.
- Hierarchical structures that punish mistakes will punish creativity.



Importance of Environment

Equation 6.41, and check your answer against

*****Problem 6.36** When an atom is placed in a uniform external electric field \mathbf{E}_{ext} , the energy levels are shifted—a phenomenon known as the **Stark effect** (it is the electrical analog to the Zeeman effect). In this problem we analyze the Stark effect for the $n = 1$ and $n = 2$ states of hydrogen. Let the field point in the z direction, so the potential energy of the electron is

$$H'_S = eE_{\text{ext}}z = eE_{\text{ext}}r \cos \theta.$$

Treat this as a perturbation on the Bohr Hamiltonian (Equation 6.42). (Spin is irrelevant to this problem, so ignore it, and neglect the fine structure.)

- (a) Show that the ground state energy is not affected by this perturbation, in first order.
- (b) The first excited state is 4-fold degenerate: ψ_{200} , ψ_{211} , ψ_{210} , ψ_{21-1} . Using degenerate perturbation theory, determine the first-order corrections to the energy. Into how many levels does E_2 split?
- (c) What are the “good” wave functions for part (b)? Find the expectation value of the electric dipole moment ($\mathbf{p}_e = -e\mathbf{r}$) in each of these “good” states.

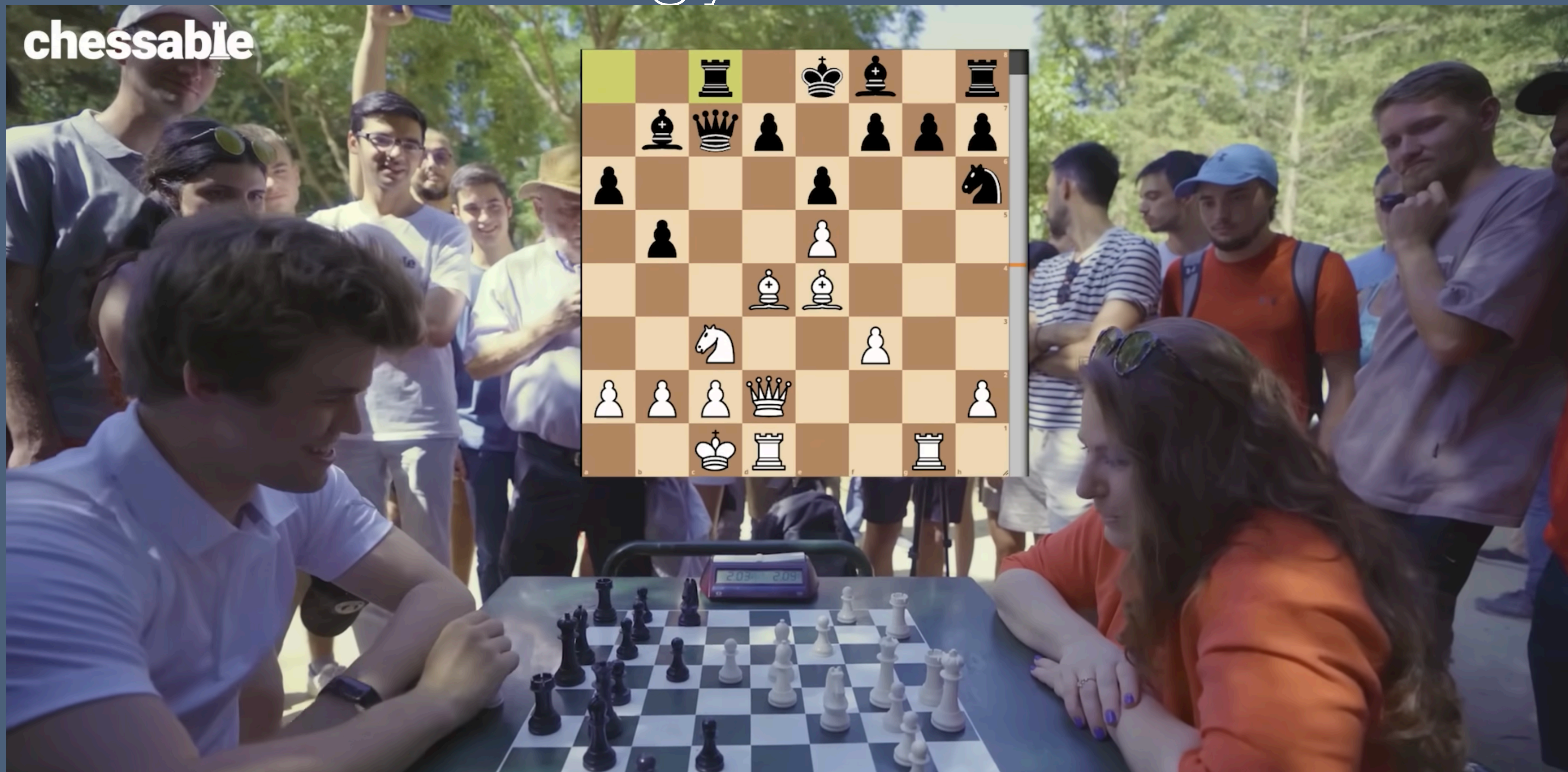
Tactics vs. Strategy

1.) Tactics - What to do when there is something to do.

2.) Strategy - What to do when there is nothing to do.



Tactics vs. Strategy



Tactics vs. Strategy

2023

FREEDOM HOLDING CORP.

GENERAL PARTNER

FREEDOM HOLDING CORP.

FIDE

FIDE WORLD CHAMPIONSHIP 2023

UNSTOPPABLE MINDS

LIVE FROM ASTANA, KAZAKHSTAN

IM TANIA SACHDEV
TANIASACHDEV

DING LIREN 1:27

1.5

1.5

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Importance of Environment

- 1.) If you are a group leader that mocks bad ideas - you are inhibiting science.
- 2.) If you are a collaboration that mocks other results, you are preventing your group from being creative.
- 3.) If you are a collaboration that aims to never publish an incorrect result - you are not doing good science.

Good science is correct.

Good scientists are provocative.