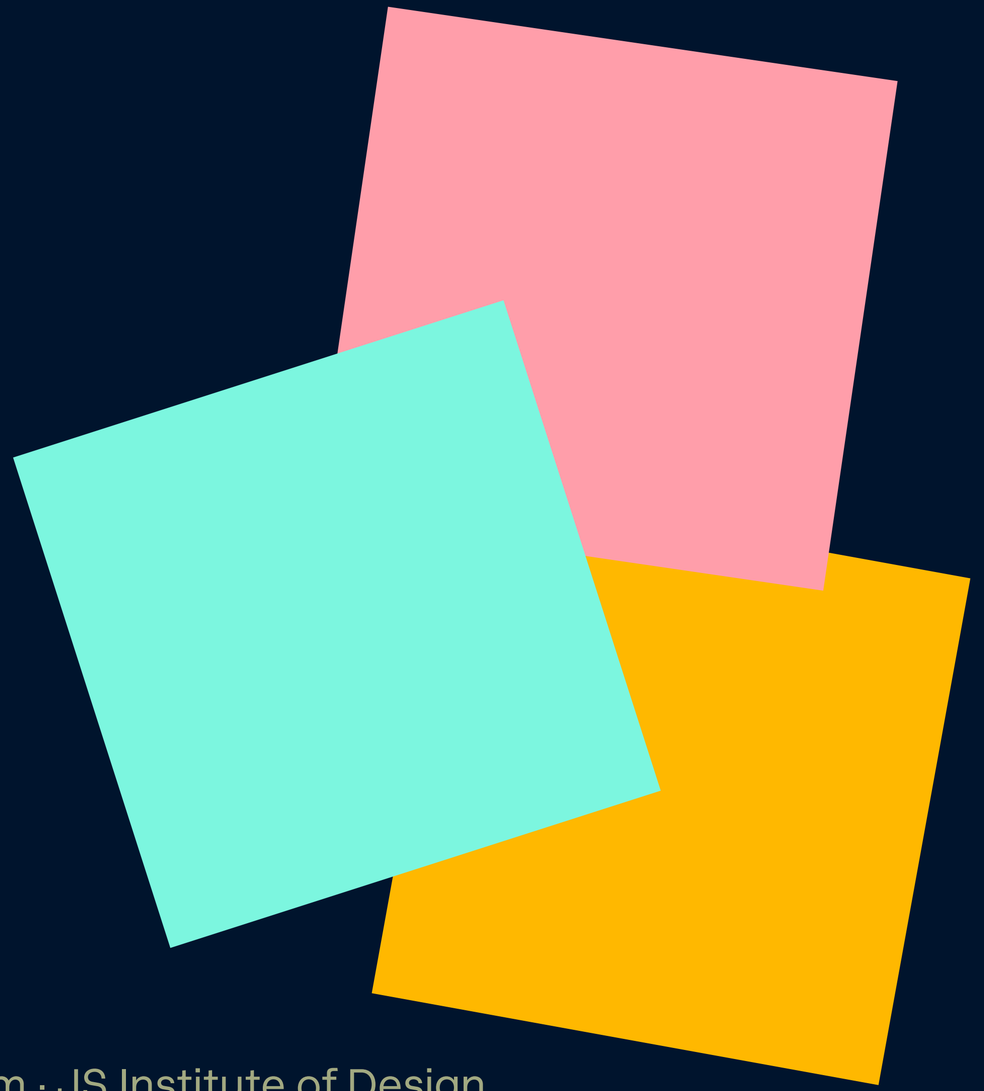
Lecture 3

Ergonomics - Physical and Cognitive

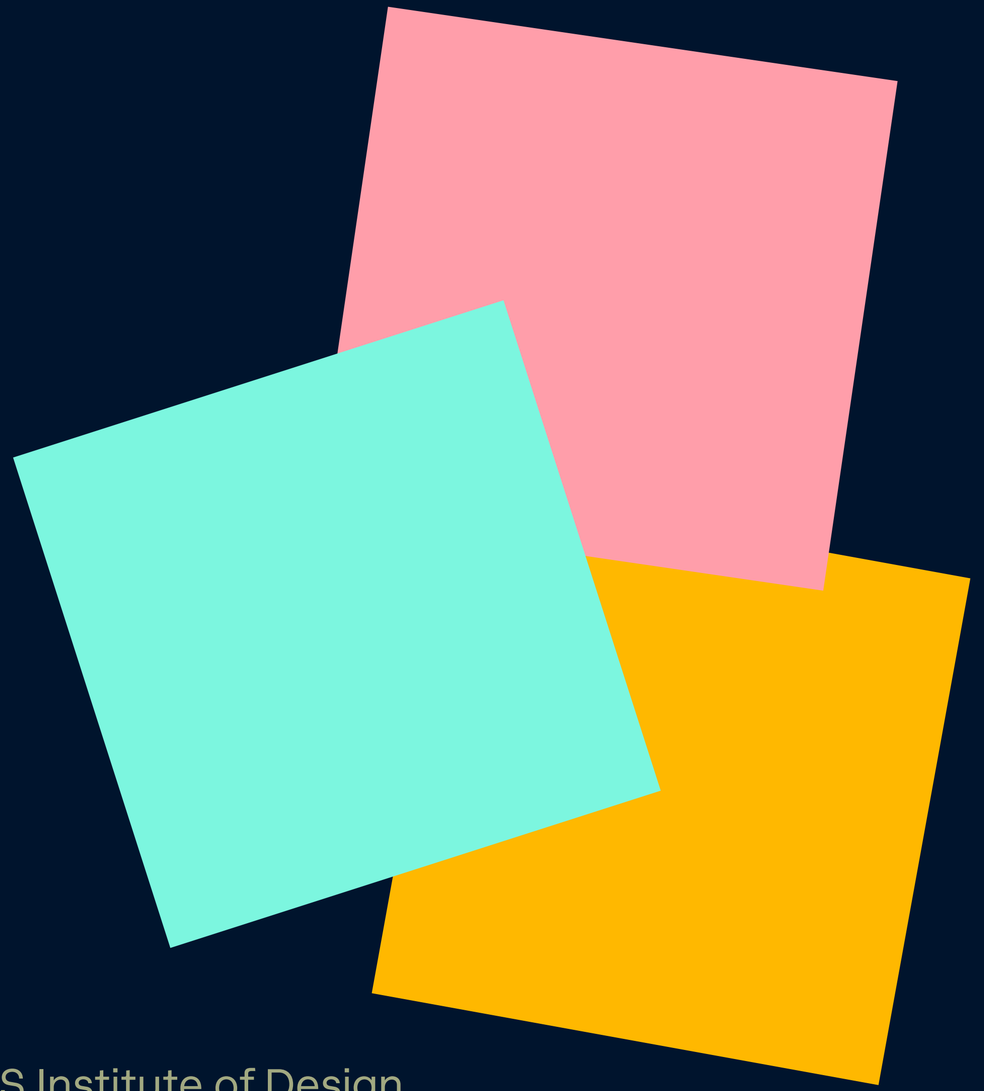


Cognitive Ergonomics

12 September 2025 · Gyan Lakhwani · gyanlakhwani@gmail.com · JS Institute of Design

Lecture 2

Ergonomics - Physical and Cognitive

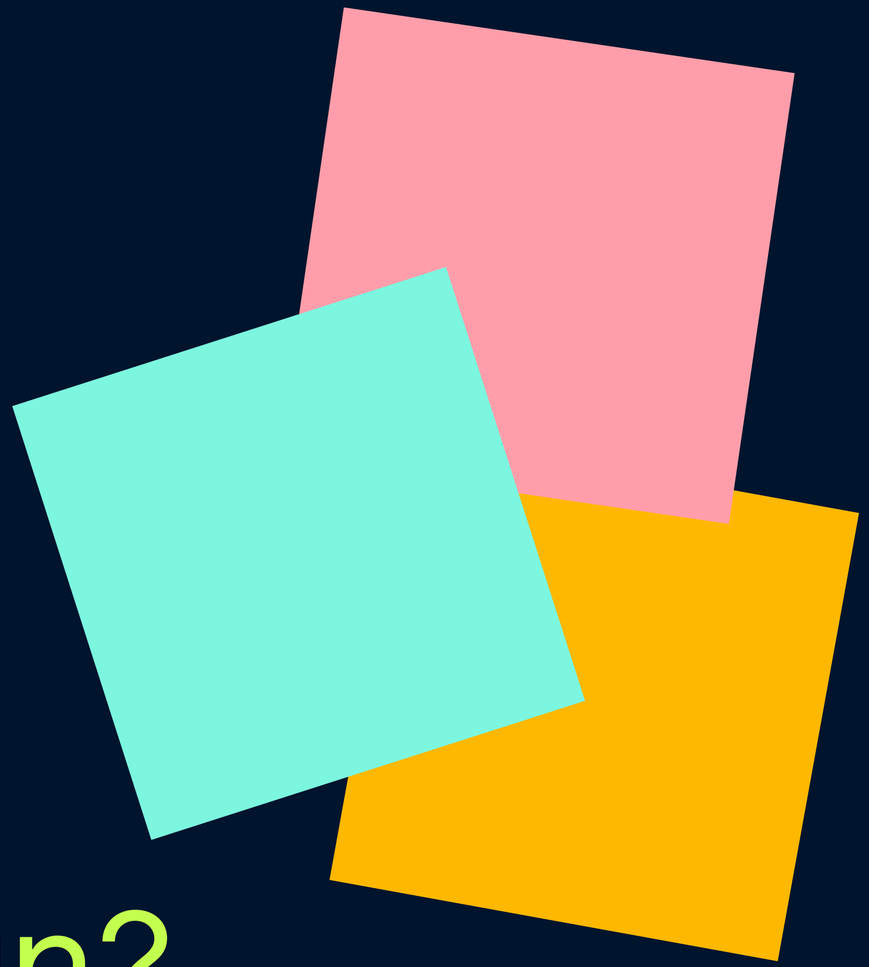


Physical Ergonomics

29 August 2025 · Gyan Lakhwani · gyanlakhwani@gmail.com · JS Institute of Design

Lecture 1

Ergonomics - Physical and Cognitive



Introduction: What is Good design?

22 August 2025 · Gyan Lakhwani · gyanlakhwani@gmail.com · JS Institute of Design

RECAP

Last Friday

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designyatra

DESIGN YATRA 2025

4–6 SEPTEMBER 2025

TAJ CIDADE DE GOA, HORIZON

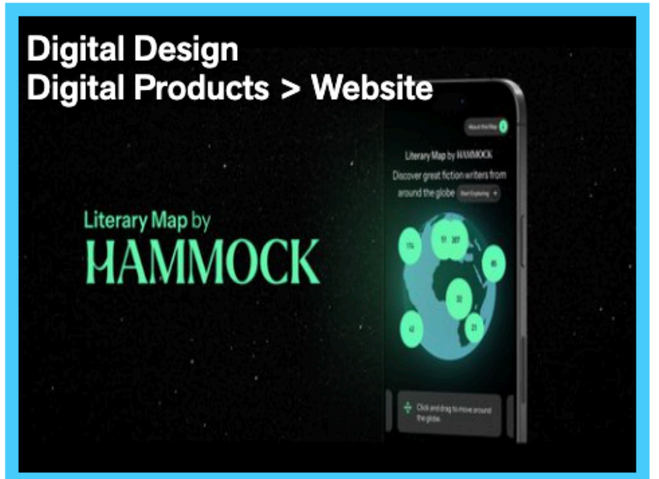
designyatra

SCHEDULE SIDEQUESTS FRAMES AFTER DARK DESIGNYATRA ARCHIVES NEED HELP?

DESIGN YATRA 2025

4–6 SEPTEMBER 2025

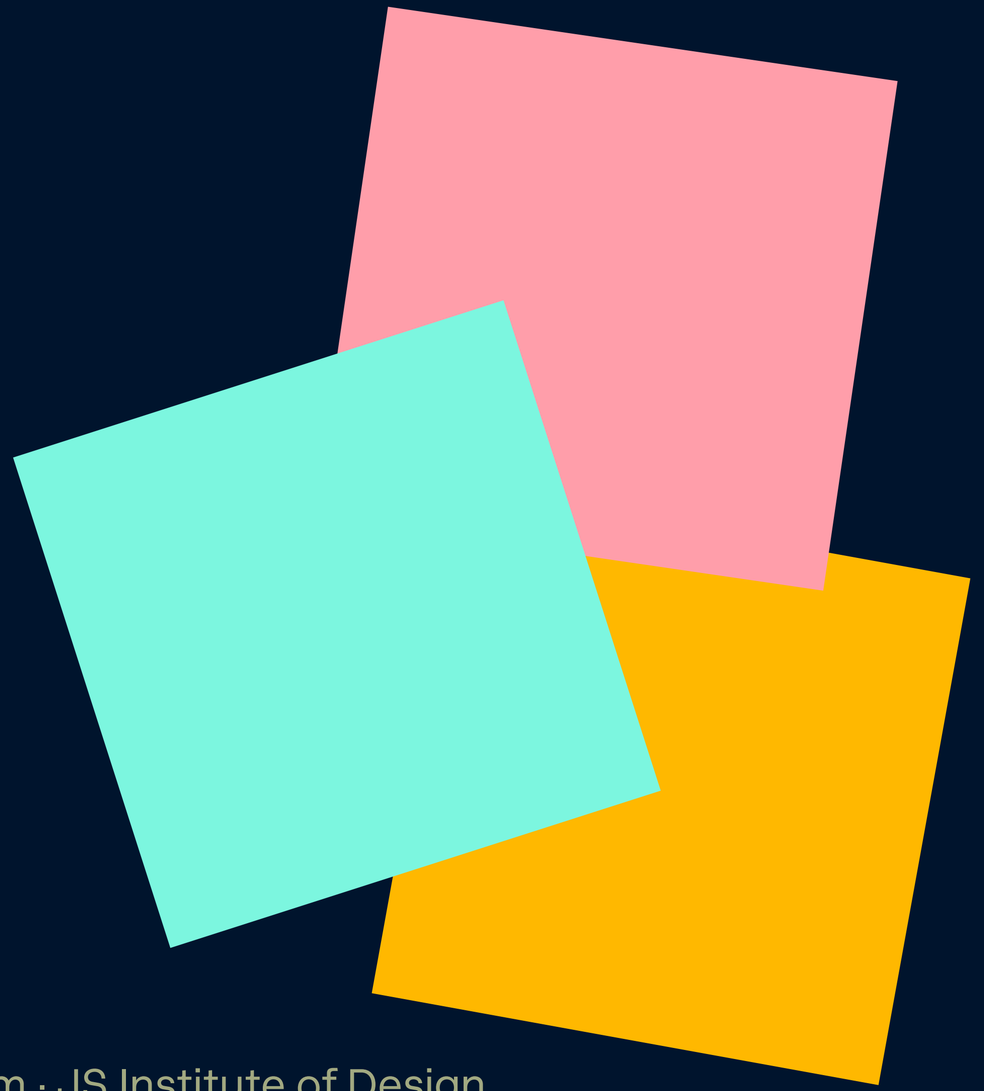
TAJ CIDADE DE GOA, HORIZON



Literary Map by Hammock Mag
Hammock Mag
Public Knowledge Studio

Lecture 3

Ergonomics - Physical and Cognitive



Cognitive Ergonomics

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Cognition

The mental process of acquiring knowledge and understanding through thought, experience, and the senses.

how the brain takes in, processes, and uses information to interact with the world.

It includes:

- thinking
- learning
- memory
- perception
- attention
- language
- decision-making
- problem-solving

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The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information

Author(s):
George A. Miller (1956)

Source:
First published in Psychological Review, 63, 81-97.

The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information[1]

George A. Miller (1956)
Harvard University

First published in *Psychological Review*, *63*, 81-97.

My problem is that I have been persecuted by an integer. For seven years this number has followed me around, has intruded in my most private data, and has assaulted me from the pages of our most public journals. This number assumes a variety of disguises, being sometimes a little larger and sometimes a little smaller than usual, but never changing so much as to be unrecognizable. The persistence with which this number plagues me is far more than a random accident. There is, to quote a famous senator, a design behind it, some pattern governing its appearances. Either there really is something unusual about the number or else I am suffering from delusions of persecution.

I shall begin my case history by telling you about some experiments that tested how accurately people can assign numbers to the magnitudes of various aspects of a stimulus. In the traditional language of psychology these would be called experiments in absolute judgment. Historical accident, however, has decreed that they should have another name. We now call them experiments on the capacity of people to transmit information. Since these experiments would not have been done without the appearance of information theory on the psychological scene, and since the results are analyzed in terms of the concepts of information theory, I shall have to preface my discussion with a few remarks about this theory.

Information Measurement

Information Theory

1 Bit of Information

1 0

Yes No

Information Theory

Is the person taller than 5′6″?

1 0

Yes No

Information Theory

Is the person taller than 5′6″?
Is the person male?

00 01 10 11
No-No, No-Yes, Yes-No, Yes-Yes

I will show you some numbers for 5 seconds - try and memorise them.

7 2 9 5 4 8 3

What were the numbers?

How did you remember them?

Ready for the next one?

0 1 1 8 9 9 9 8 8 1
9 9 9 1 1 9 7 2 5 3

What were the numbers?

Was this harder?

- Miller found that the human brain is good at remembering up to 7 items at once in working memory, past which error rates increase.
- This holds true for different types of stimulus like sounds, taste, numbers, etc.
- This working memory can be increased a little by “chunking” each item.
- More modern research suggests this number is more like 4 chunks.

Ready for the next one?

9 1 7 9 8 2 1 2 1 5 4 6

How about now?

(+91) 79—8212—1546

What would I need to know to design the Aeron chair so that it is comfortable for everyone?

Anthropometry

Refers to the measurement of human individuals

- ánthrōpos: 'human'
- métron: ‘measure

Relevant for industrial design, clothing design, ergonomics and architecture where statistical data about the distribution of body dimensions in the population are used to optimize products.

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Sampling

It may not be possible to get data for every person, so we use some people as a representation of the population.

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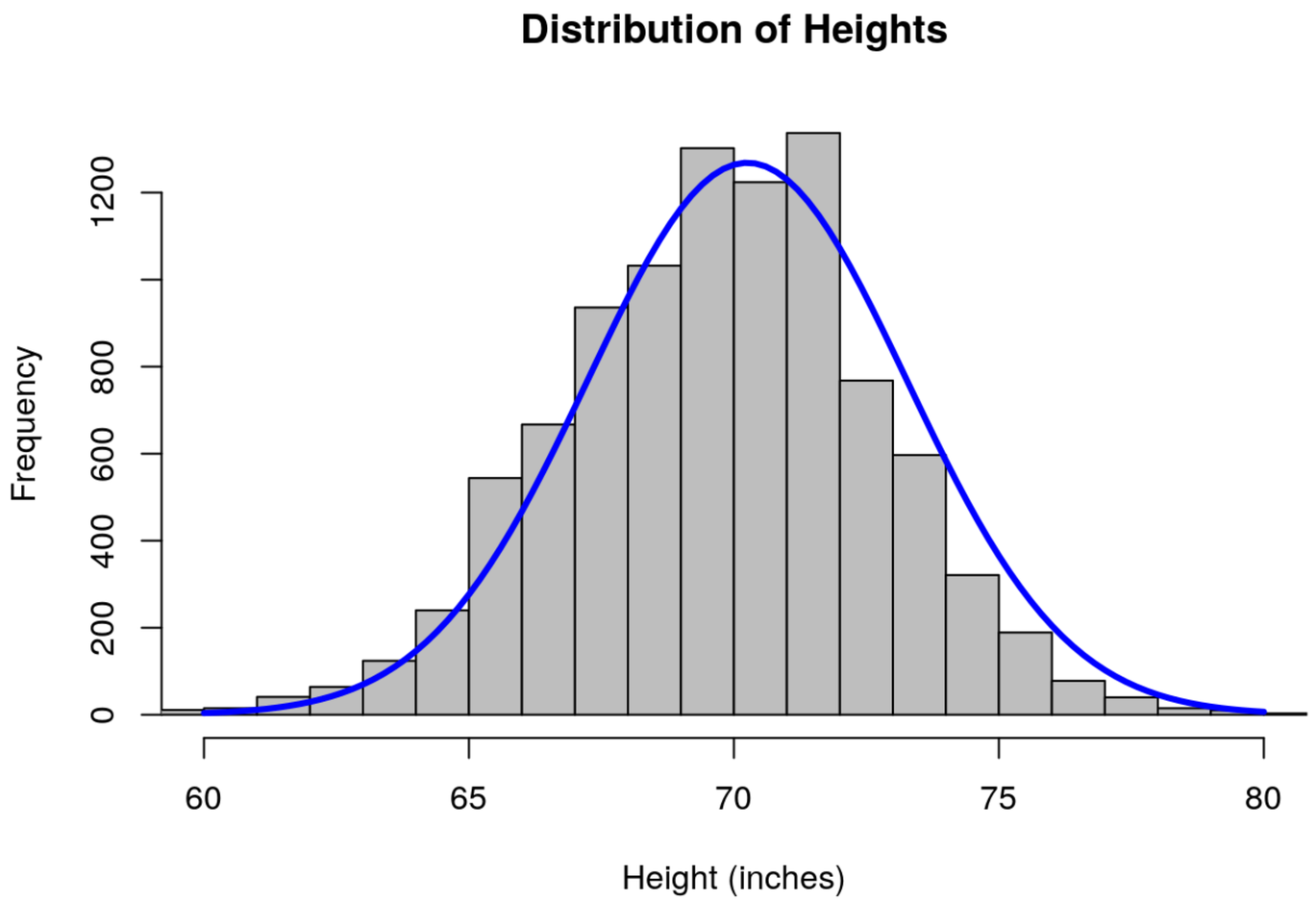
Distribution of Heights of Men in USA

Below is a histogram showing the distribution of heights from a sample of 9569 randomly selected men who participated in a CDC study. The superimposed blue curve is a normal distribution that models the histogram.



For physical ergonomics we discussed how anthropometry can help with making decisions about designing physical environments.

	Male			Female		
	Percentile					
Dimension	5th	50th	95th	5th	50th	95th
Stature	1560	1655	1750	1450	1530	1610
Eye height	1445	1540	1635	1350	1425	1500
Shoulder height	1250	1340	1430	1075	1145	1215
Elbow height	965	1035	1105	895	955	1015
Hip height	765	830	895	700	755	810
Sitting height	850	900	950	800	845	890
Sitting eye height	735	785	835	690	735	780
Sitting elbow height	220	260	300	215	250	285
Thigh thickness	110	135	160	105	130	155
Buttock-knee length	500	550	600	485	530	575
Buttock-popliteal	410	470	510	405	450	495
Knee height	450	490	530	420	450	480
Popliteal height	360	400	440	325	360	395
Shoulder breadth	405	440	475	365	395	425
Hip breadth	280	305	330	270	305	340
Elbow span	790	870	950	715	780	845
Vertical reach (stand)	1805	1940	2075	1680	1795	1910
Vertical reach (sit)	1105	1185	1265	1030	1095	1160

For physical ergonomics we discussed how anthropometry can help with making decisions about designing physical environments.

What about cognitive ergonomics? What could we measure?

	Male			Female		
	Percentile					
Dimension	5th	50th	95th	5th	50th	95th
Stature	1560	1655	1750	1450	1530	1610
Eye height	1445	1540	1635	1350	1425	1500
Shoulder height	1250	1340	1430	1075	1145	1215
Elbow height	965	1035	1105	895	955	1015
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Sitting height	850	900	950	800	845	890
Sitting eye height	735	785	835	690	735	780
Sitting elbow height	220	260	300	215	250	285
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Shoulder breadth	405	440	475	365	395	425
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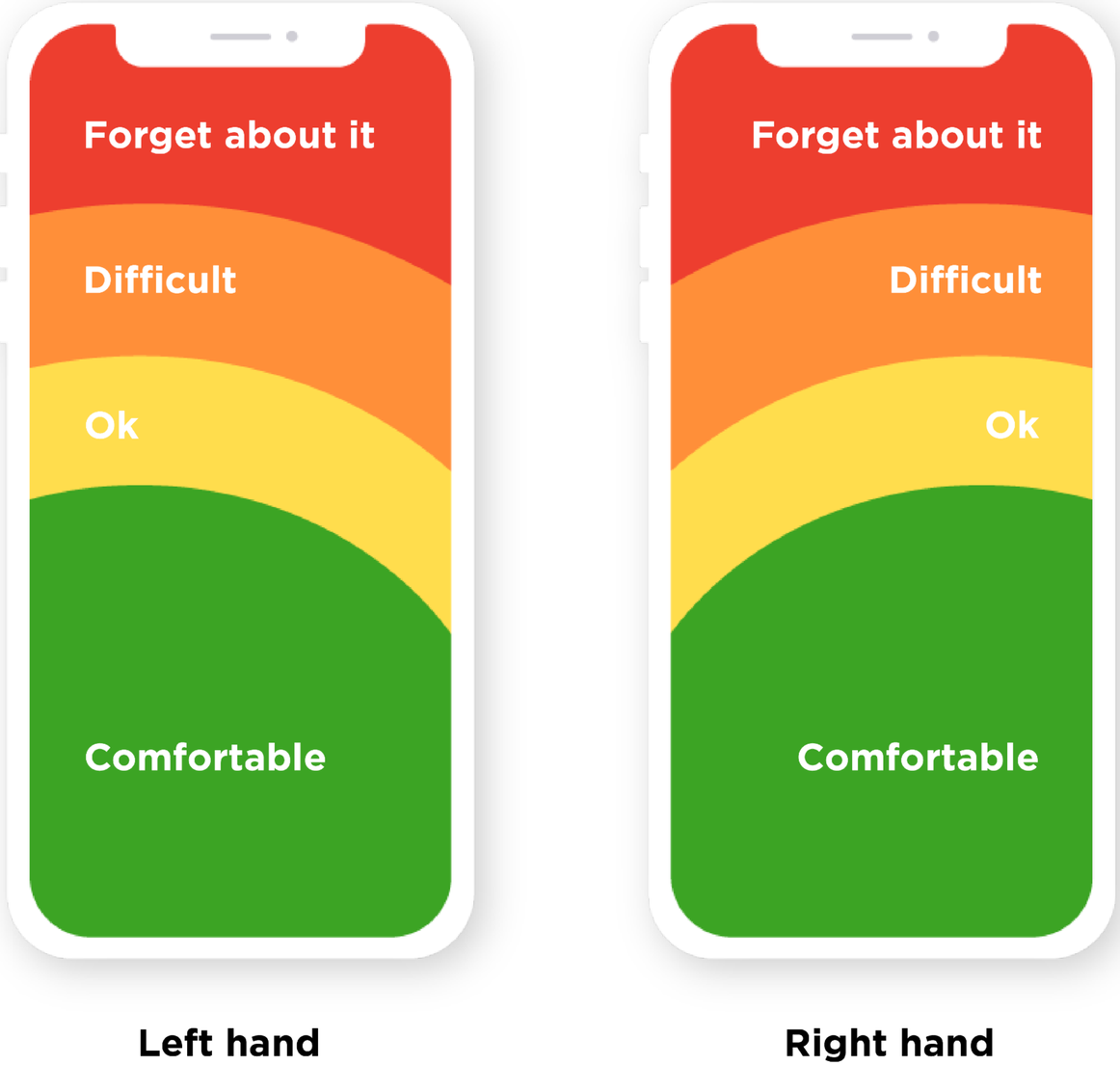
Vertical reach (stand)	1805	1940	2075	1680	1795	1910
Vertical reach (sit)	1105	1185	1265	1030	1095	1160

What would I need to know to design digital apps so that they are comfortable for everyone?

What would I need to know to design digital apps so that they are comfortable for everyone?

(Some physical ergonomics factors are still relevant)



Left hand

Right hand

But we'll talk more about cognition today.

What would I need to know to design digital apps so that they are comfortable for everyone?

Visual Perception

Do we perceive the world exactly how it is?

Visual Perception

Do we perceive the world exactly how it is?

Signal vs Noise

- Using special properties of the visual system to help us think.
- Your visual system is good at specific tasks.
- All visualizations are made from a series of compromises.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Visual Perception

Stroop Test

Read out words in the text
and ignore the colors.

Orange Blue Green Pink Orange Purple Pink
Purple Yellow Green Blue Green Blue Purple
Yellow Orange Gray Red White Red Pink
Blue Gray Red Blue Orange Red Blue
Purple Red Purple Orange Gray Red Green
Blue Purple Pink Yellow Pink Green Yellow
Orange Yellow Red Yellow Pink Orange Green
Purple Gray Red Orange Green Blue Green
Pink Gray Red Yellow Purple Blue White
Pink Blue Green Purple Yellow Gray Yellow

Orange Blue Green Pink Orange Purple Pink
Purple Yellow Green Blue Green Blue Purple
Yellow Orange Gray Red White Red Pink
Blue Gray Red Blue Orange Red Blue
Purple Red Purple Orange Gray Red Green
Blue Purple Pink Yellow Pink Green Yellow
Orange Yellow Red Yellow Pink Orange Green
Purple Gray Red Orange Green Blue Green
Pink Gray Red Yellow Purple Blue White
Pink Blue Green Purple Yellow Gray Yellow

Visual Perception

Stroop Test

Why do you think this was hard to do?

Visual Perception

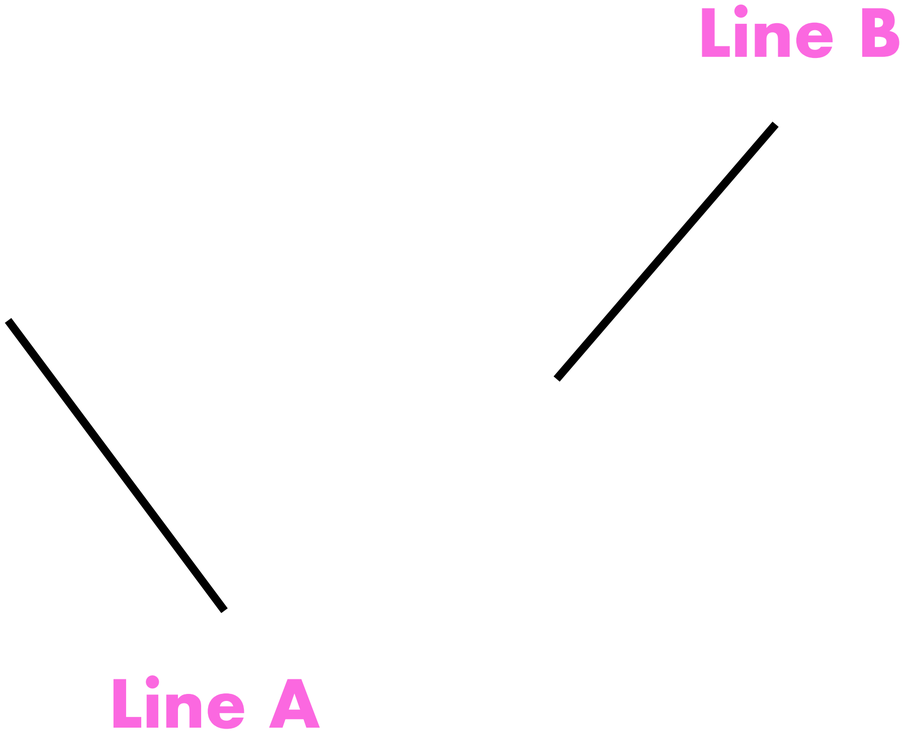
Stroop Test

Why do you think this was hard to do?

What does the Stroop Test reveal about human perception?

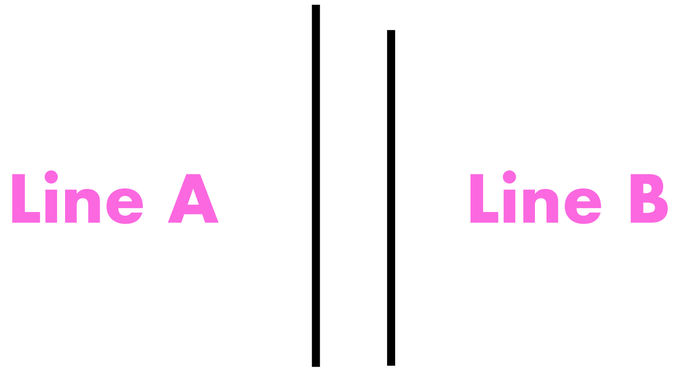
Visual Perception

Which line is bigger?



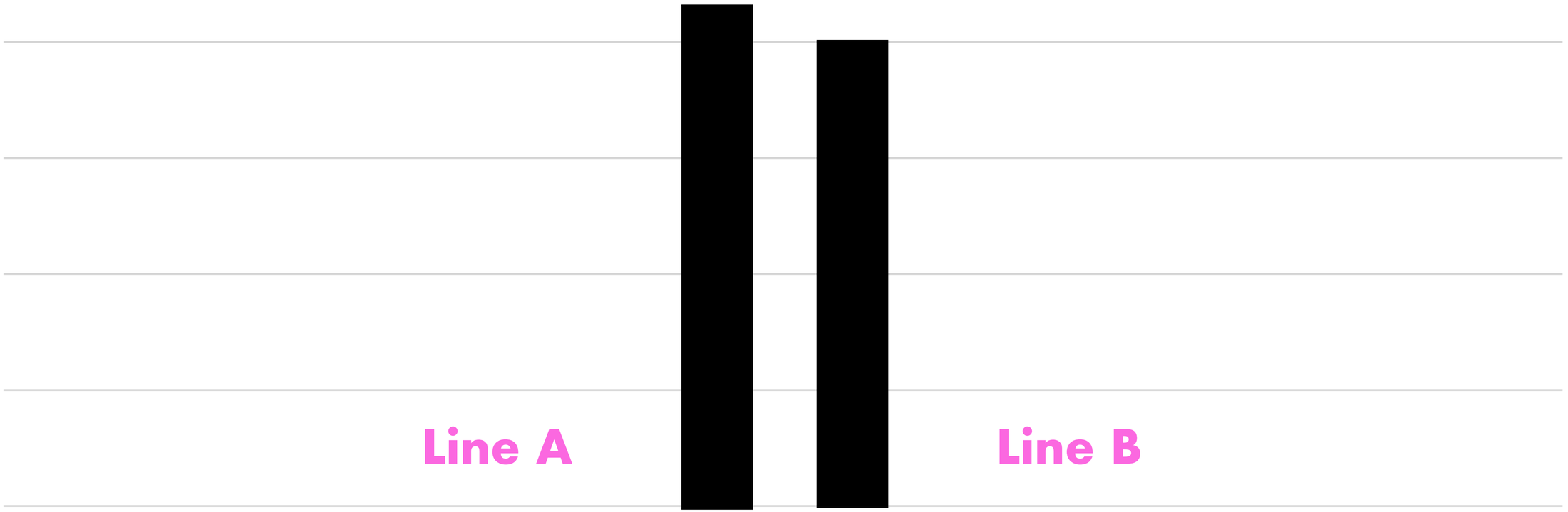
Visual Perception

Which line is bigger?



Visual Perception

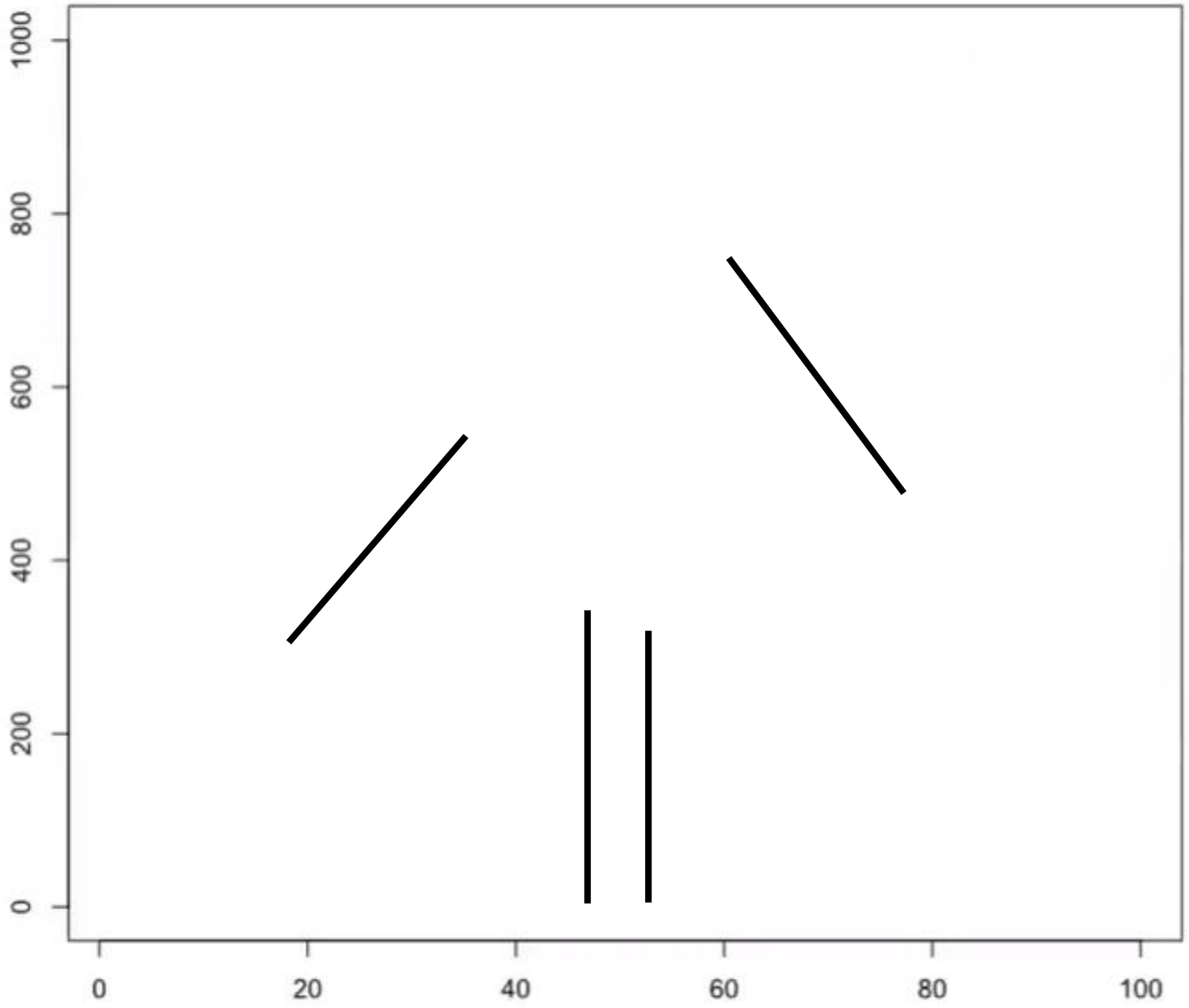
Which line is bigger?



Visual Perception

Which line is bigger?

It is easier to compare widths when 2 lines are compared on the same axis.



Visual Perception

Which area is bigger?

‘JK Rowling’ or ‘Others’?

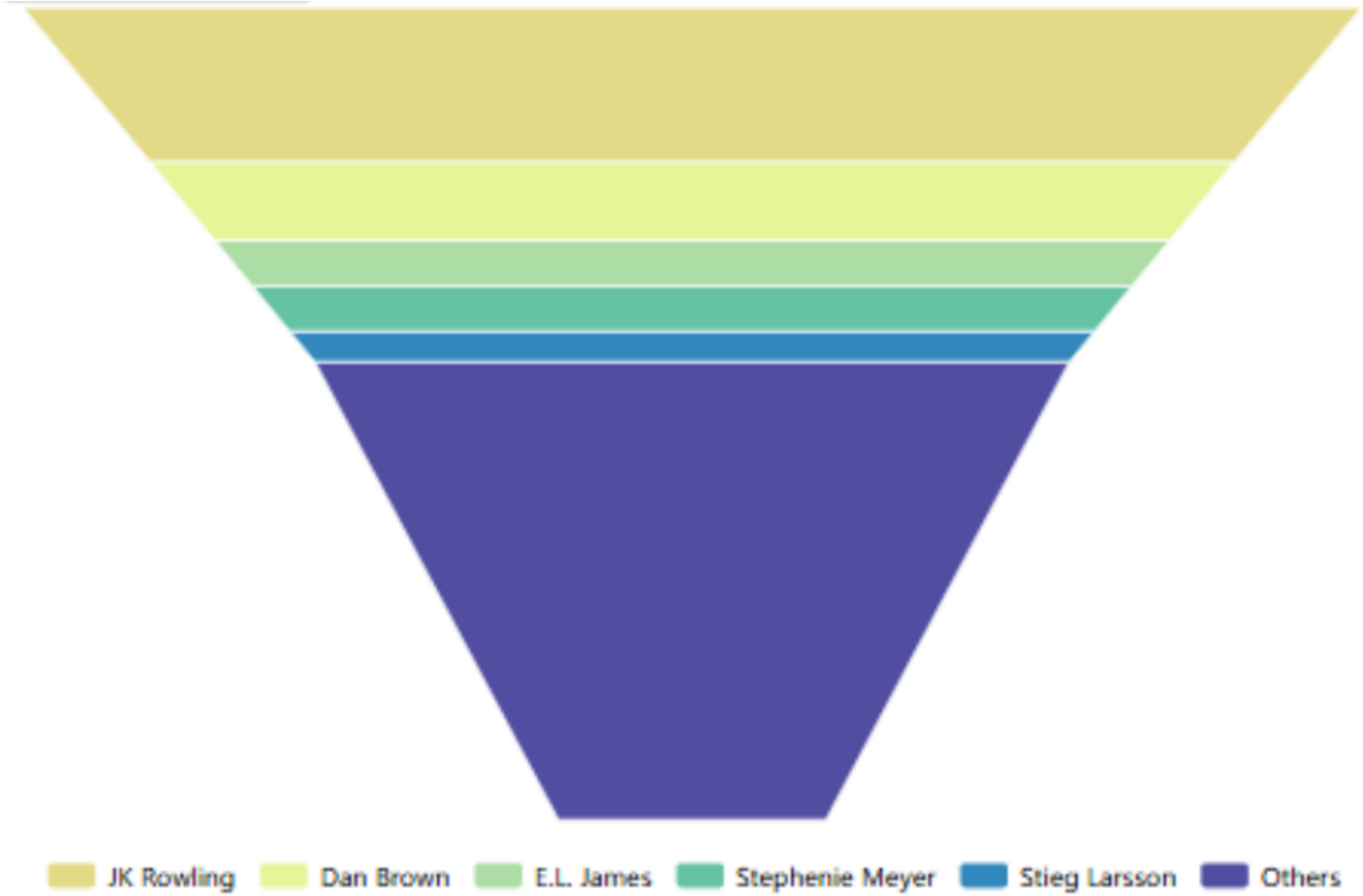
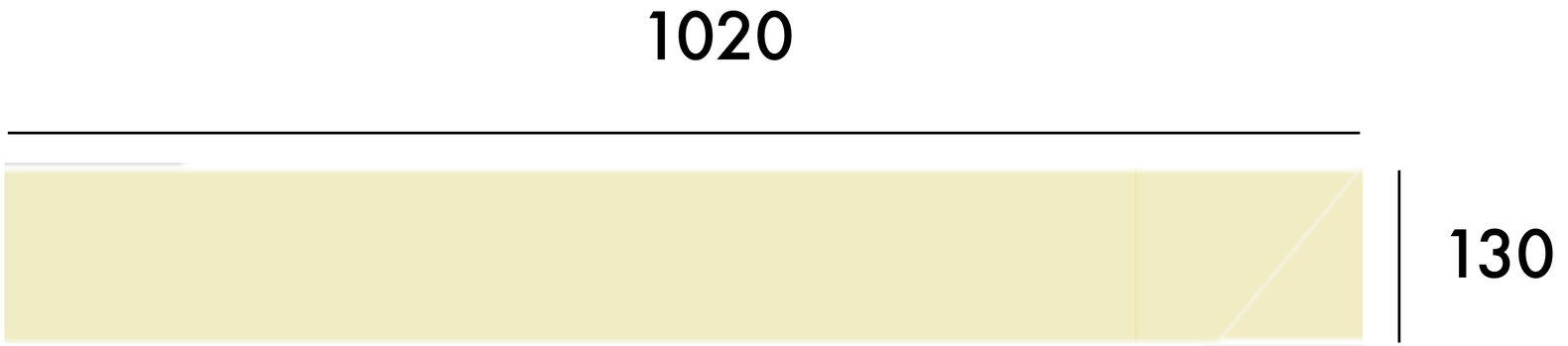


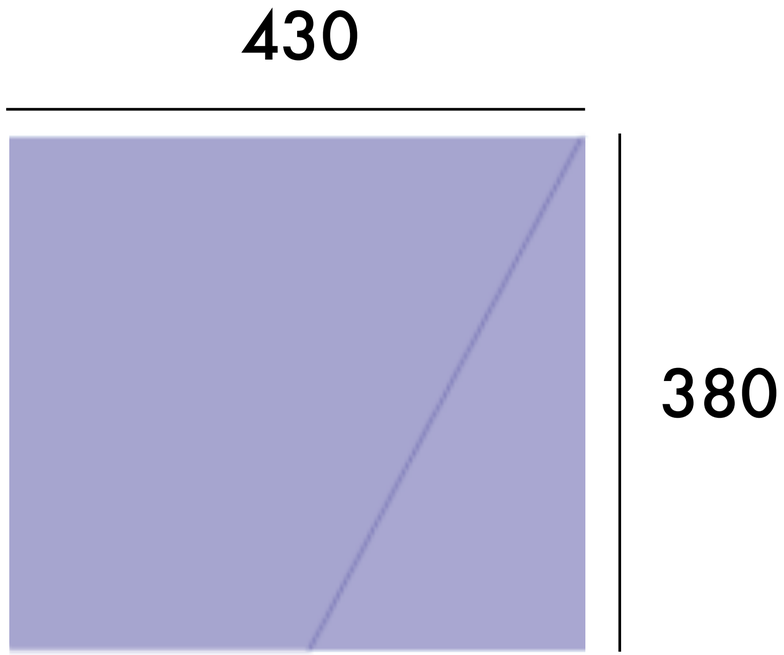
Chart by Isshita Bansal

Visual Perception

Which area is bigger?

‘JK Rowling’ or ‘Others’?


1020
130


430
380

1020

130

1,32,600
sq units

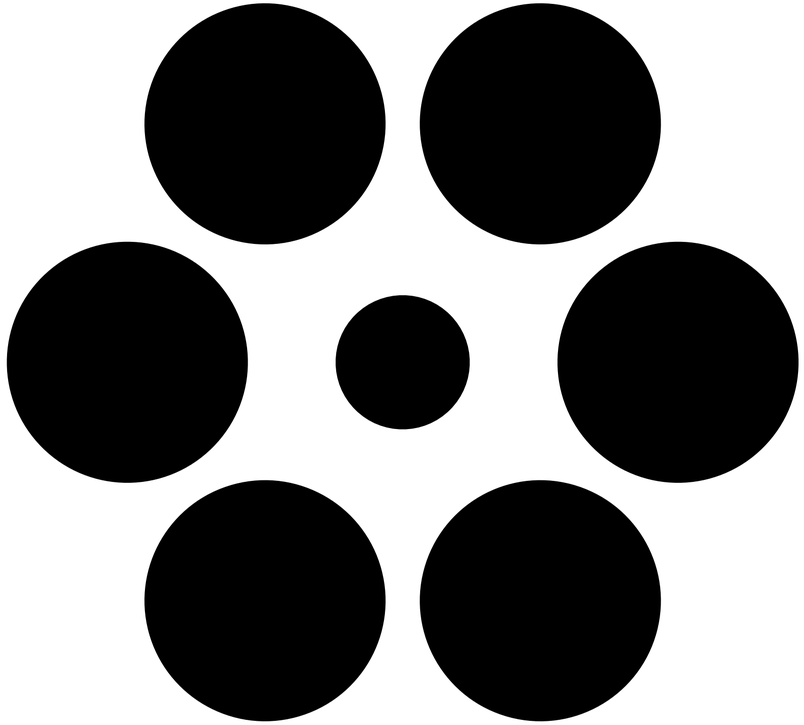
430

380

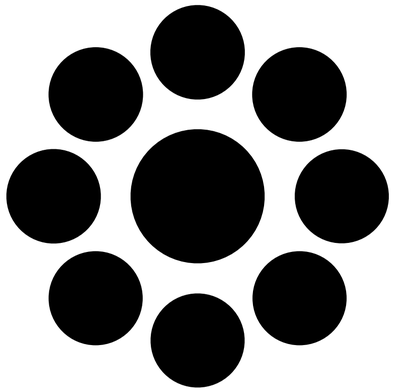
1,63,400
sq units

Visual Perception

Which inner circle is bigger?



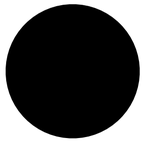
Circle A

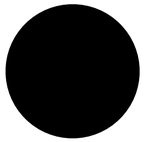


Circle B

Visual Perception

Which inner circle is bigger?





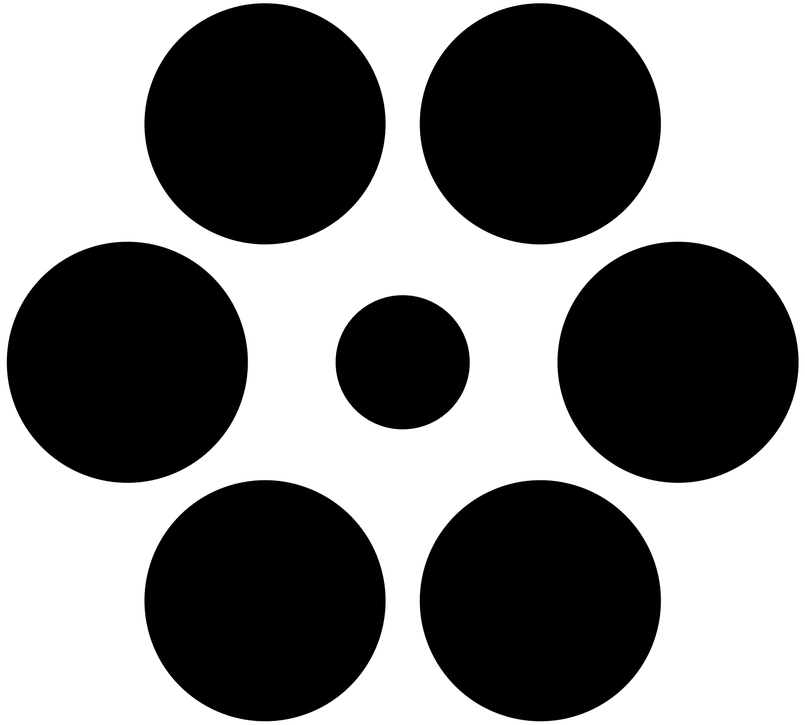
Circle A

Circle B

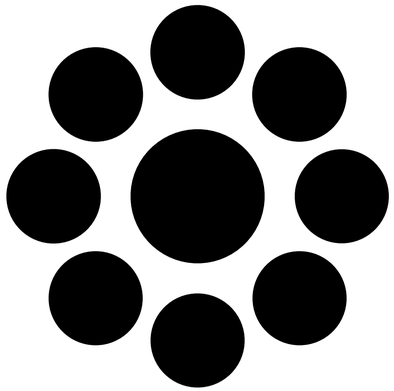
Visual Perception

Which inner circle is bigger?

Neighbouring objects can make an object feel smaller or larger by comparison.



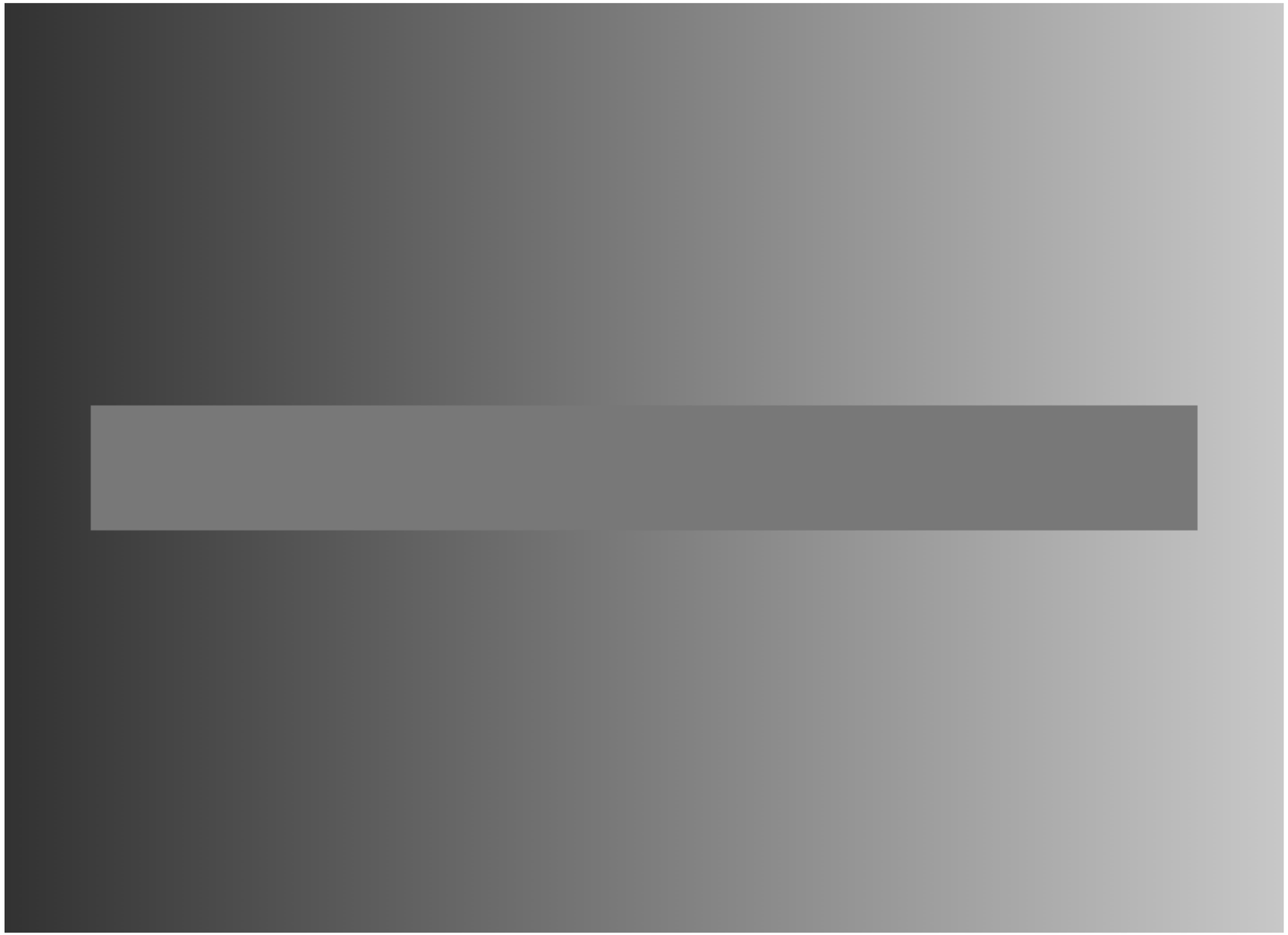
Circle A



Circle B

Visual Perception

Is the centre rectangle a gradient?



Visual Perception

Is the centre rectangle a gradient?

Visual Perception

Is the centre rectangle a gradient?

Visual Perception

Is the centre rectangle a gradient?

Visual Perception

Is the centre rectangle a gradient?

#787878

Visual Perception

Psychophysics

What do you think this means?

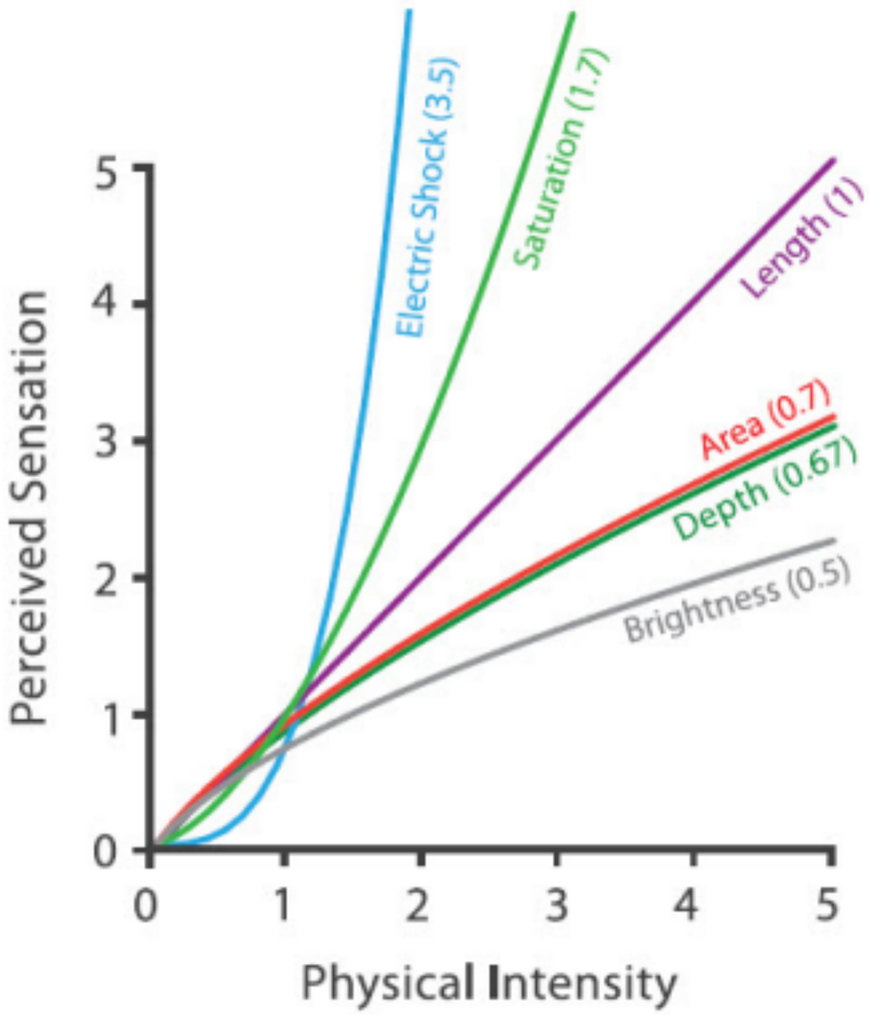
Visual Perception

Psychophysics

Branch of psychology that deals with the relations between physical stimuli and mental phenomena.

Visual Perception

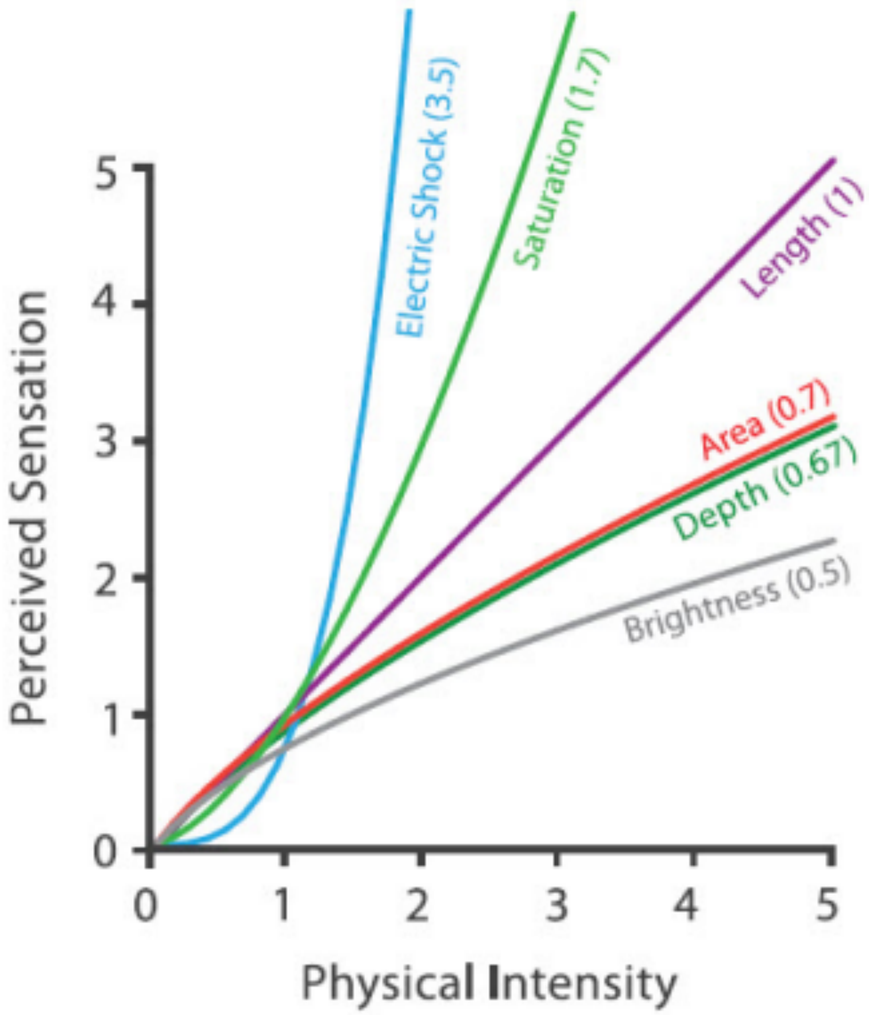
Steven's Psychophysical Power Law



Visual Perception

Steven's Psychophysical Power Law

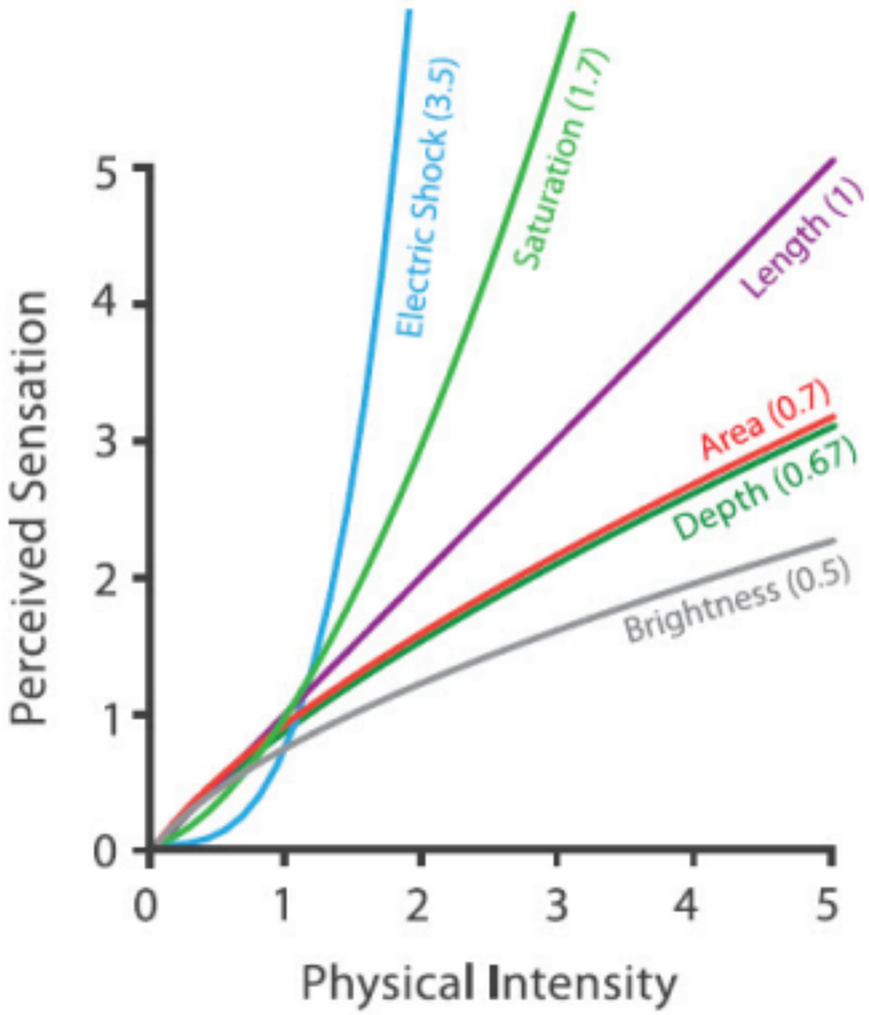
Humans perceive different stimulus differently.

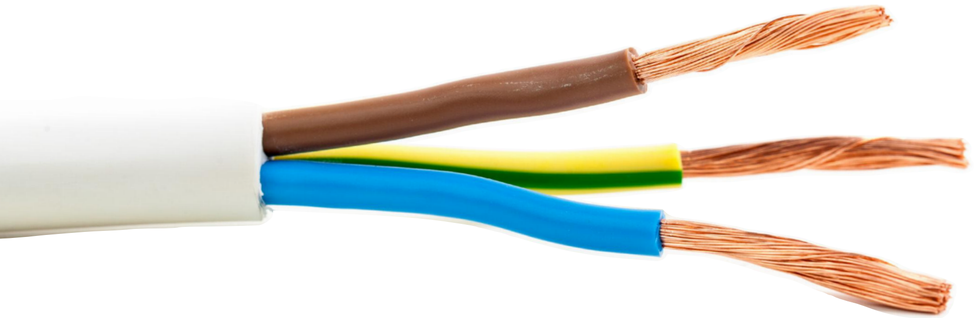


Visual Perception

Steven's Psychophysical Power Law

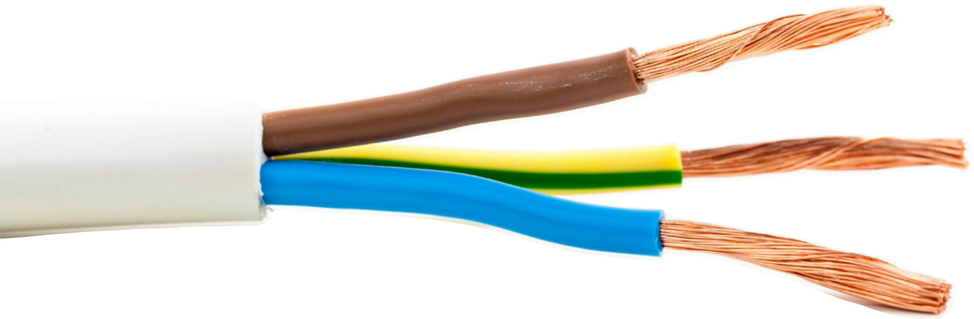
For eg, small increases in electric current are felt very sharply.





5 milli Amp

Ouch!

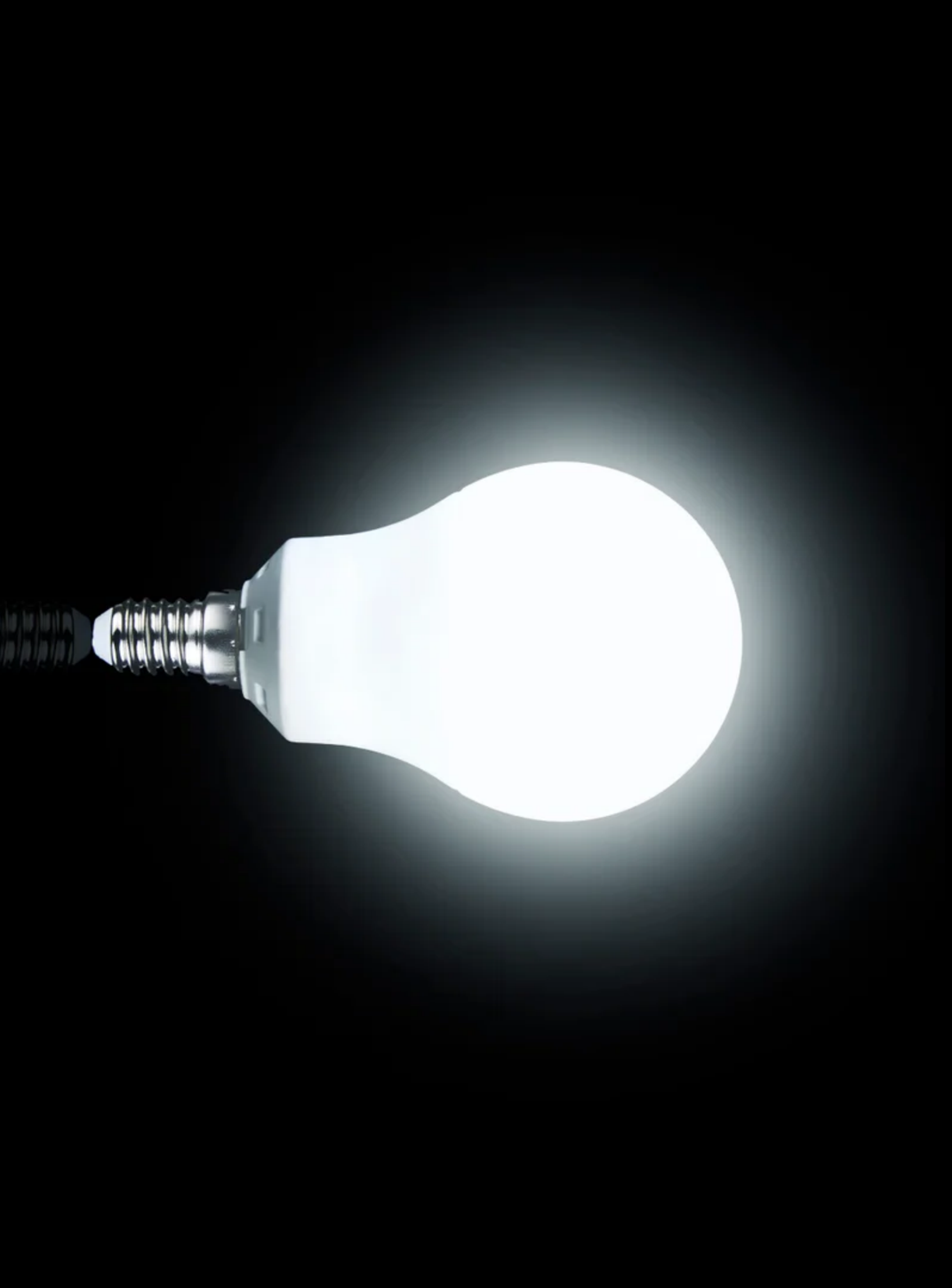


5 milli Amp

Ouch!

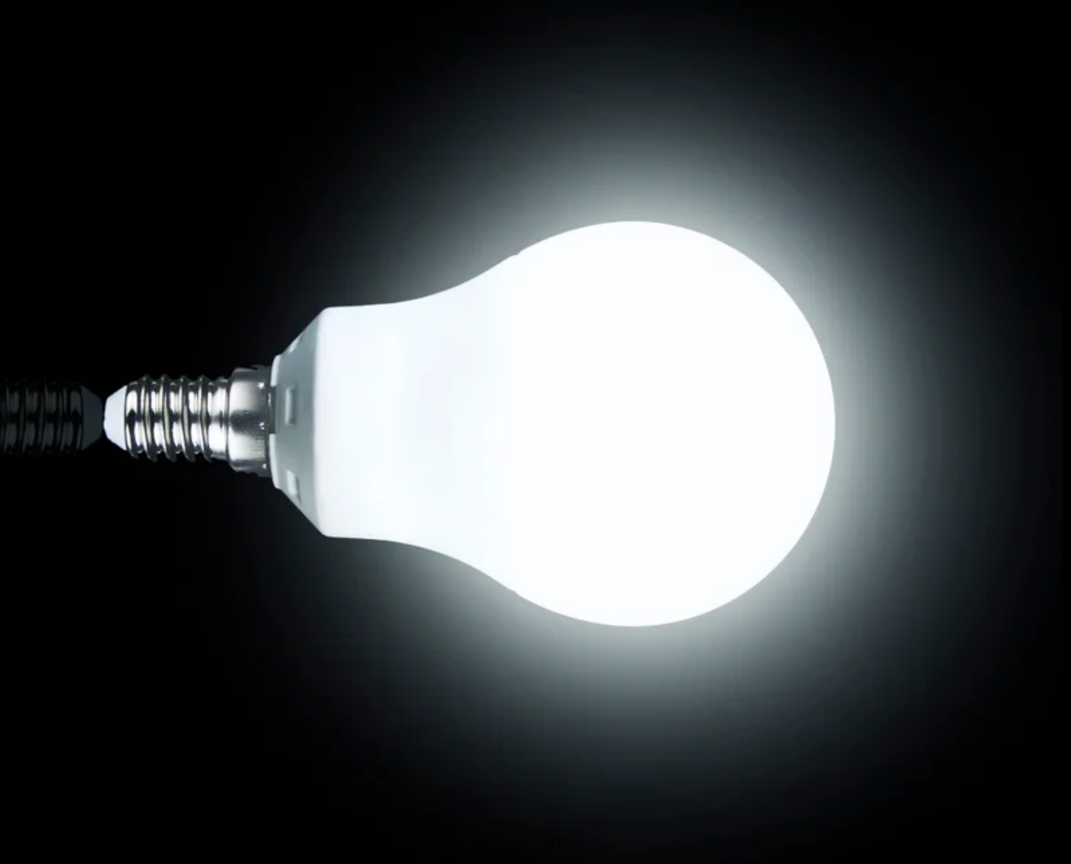
10 milli Amp

Can’t let go!



100 Lumens

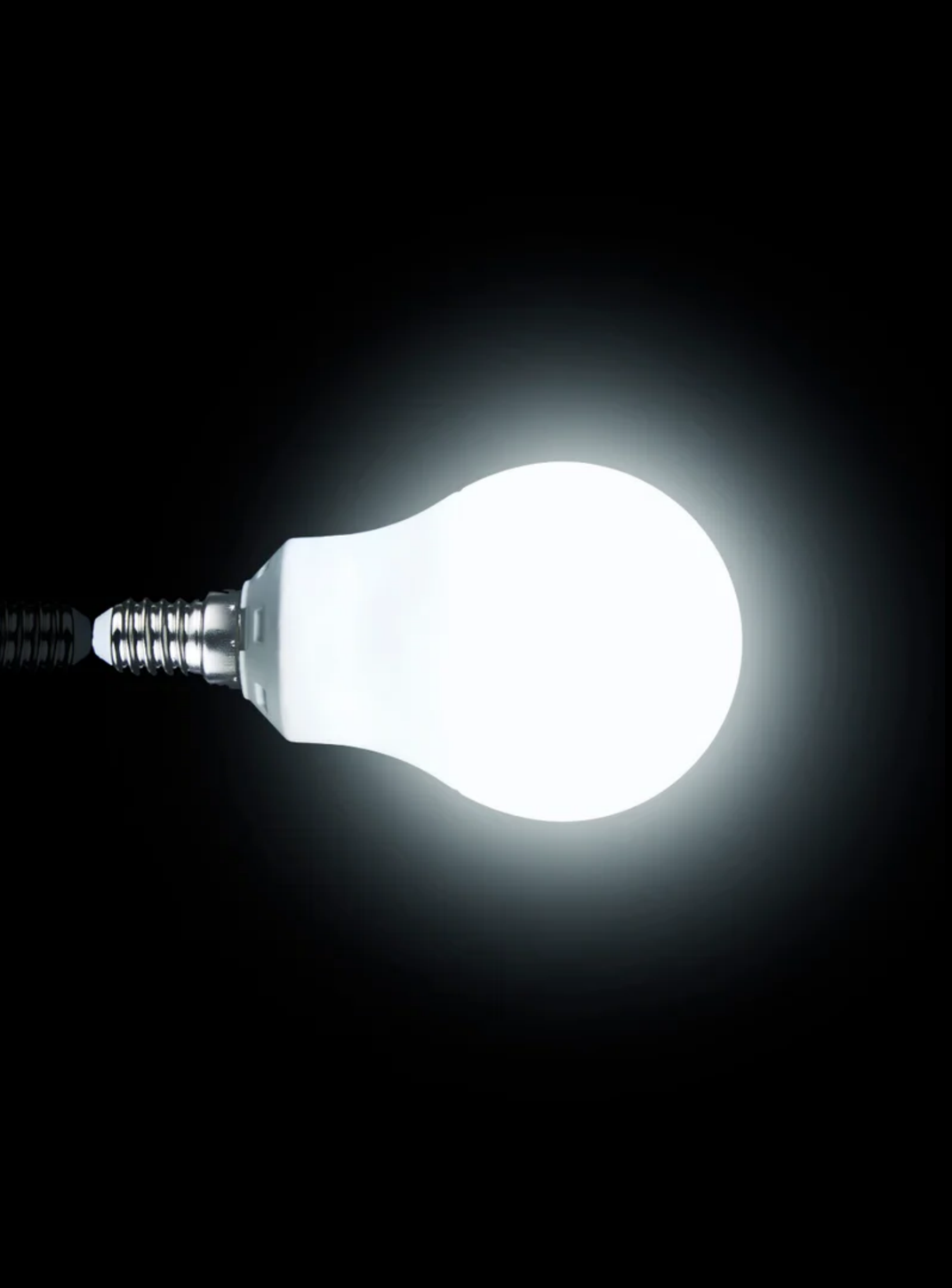
Bright



100 Lumens

Bright

200 Lumens



100 Lumens

Bright

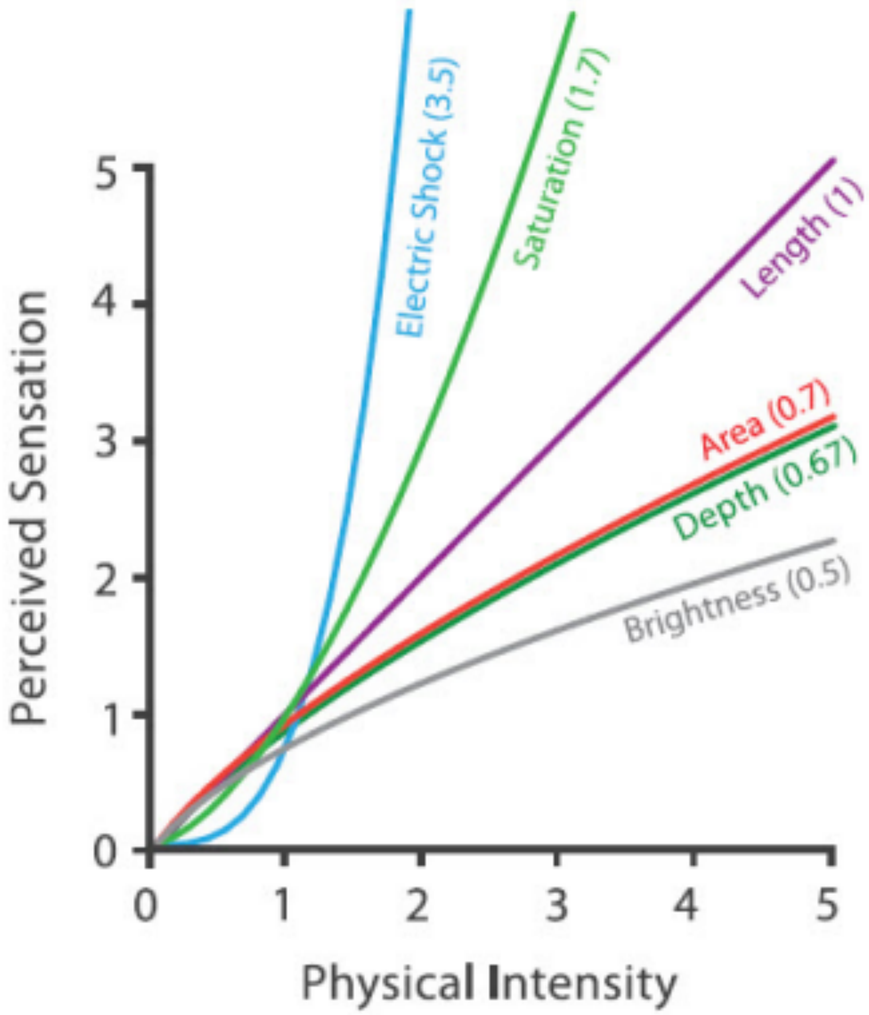
200 Lumens

Only a little brighter

Visual Perception

Steven's Psychophysical Power Law

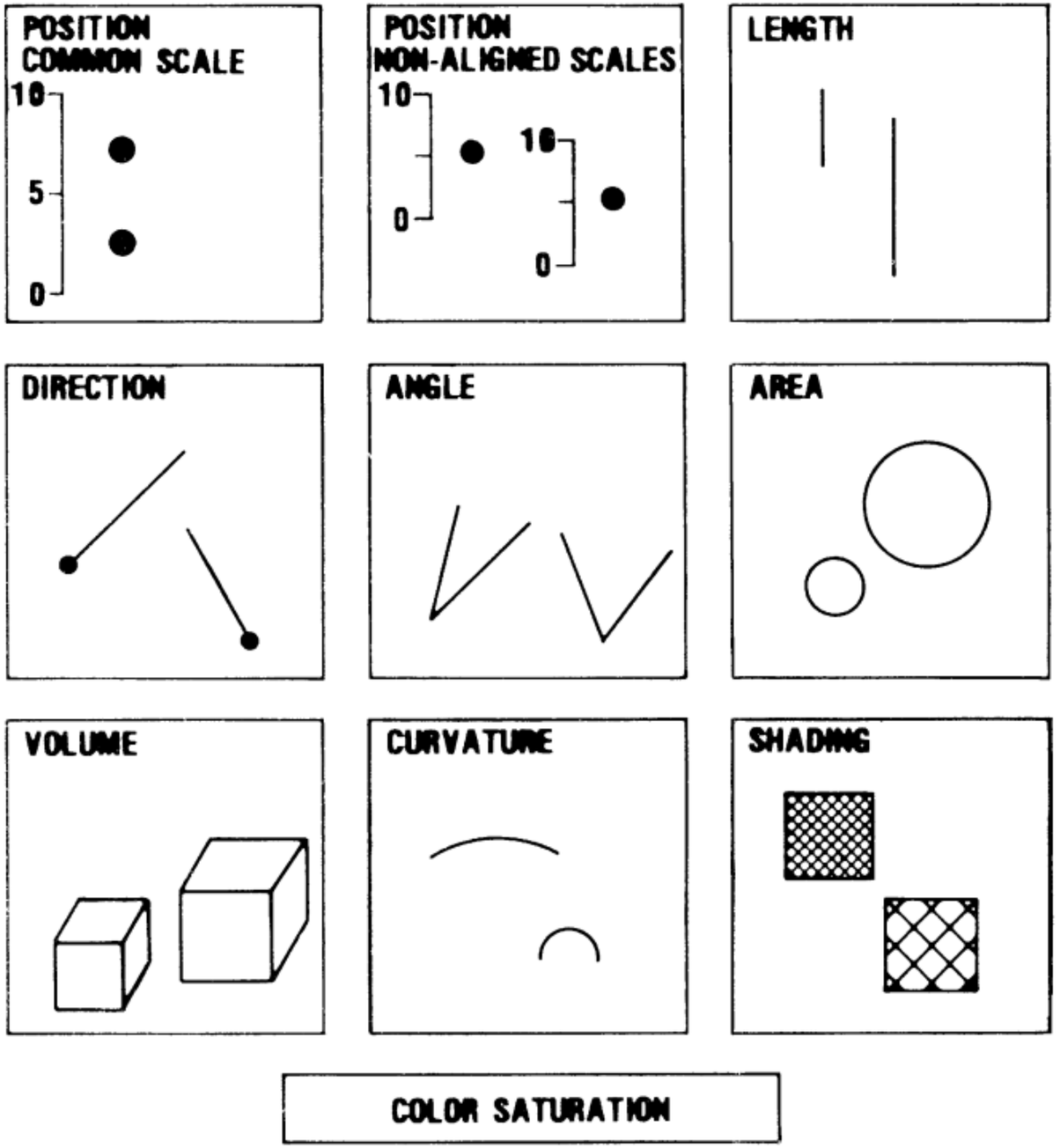
Difference in brightness is harder to tell apart for humans, and the least amount of brightness difference required for two sources to be identifiably different is also higher.



Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods

Author(s):
William S. Cleveland and Robert McGill

Source:
Journal of the American Statistical Association , Sep., 1984, Vol. 79, No. 387 (Sep., 1984), pp. 531-554



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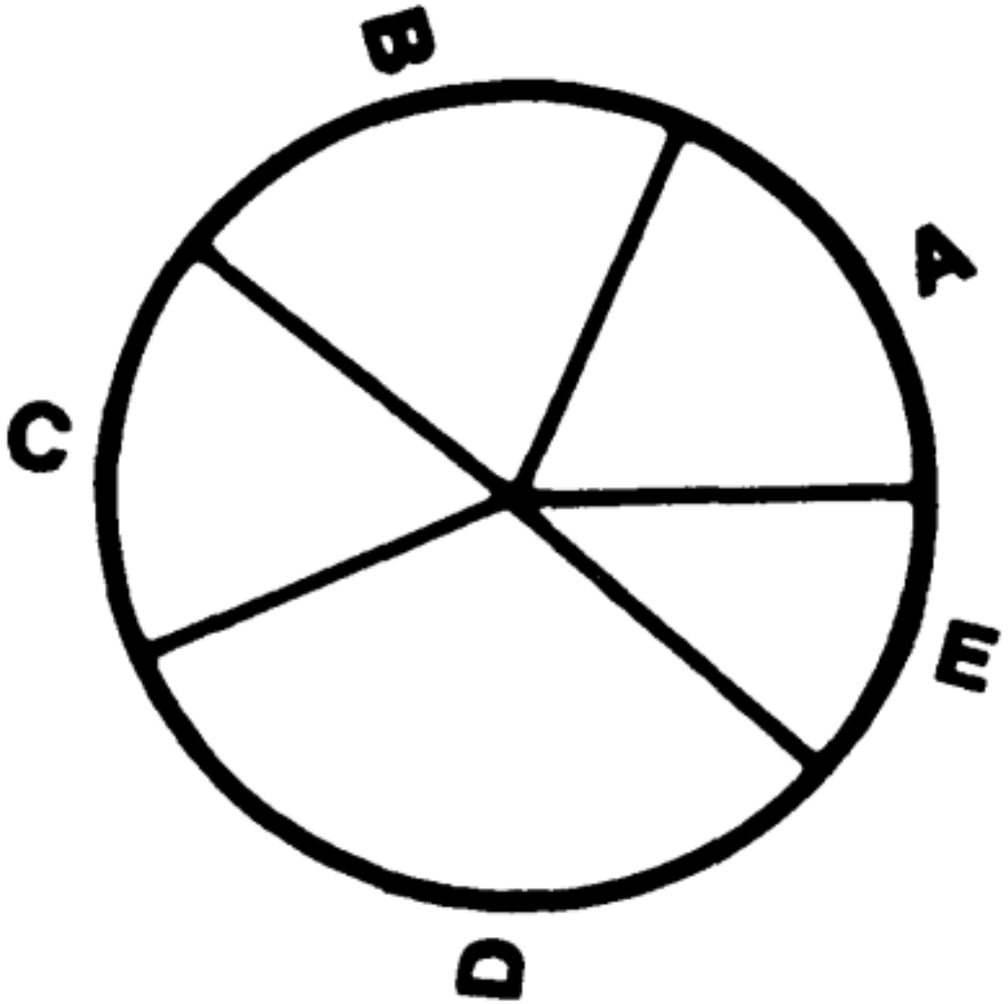

Is A bigger or C?

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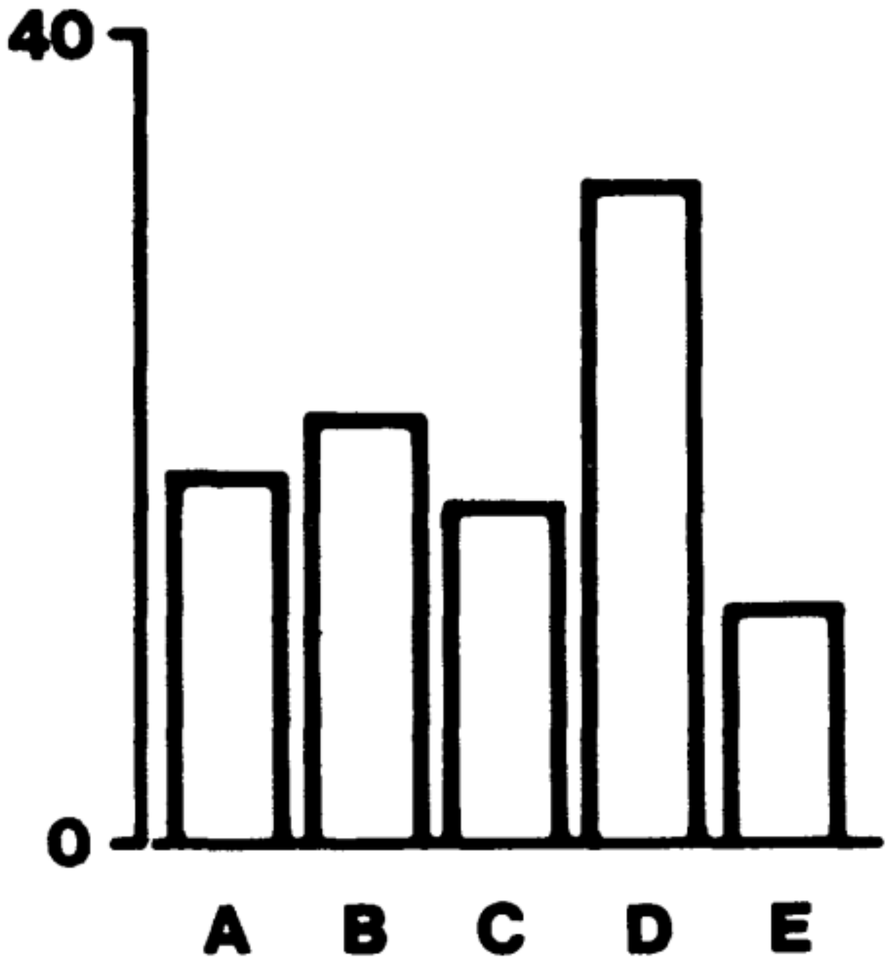

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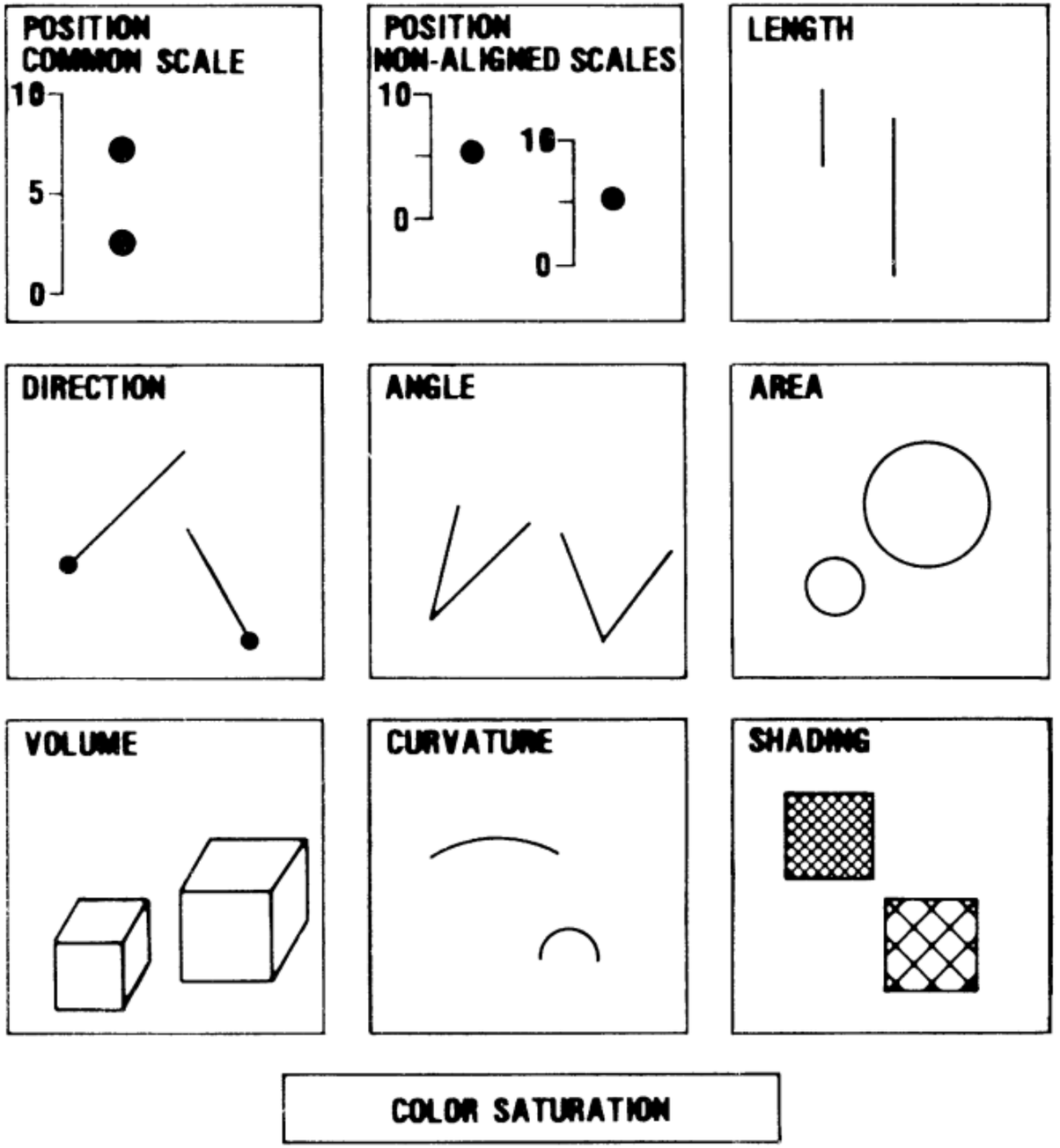


Visual Perception

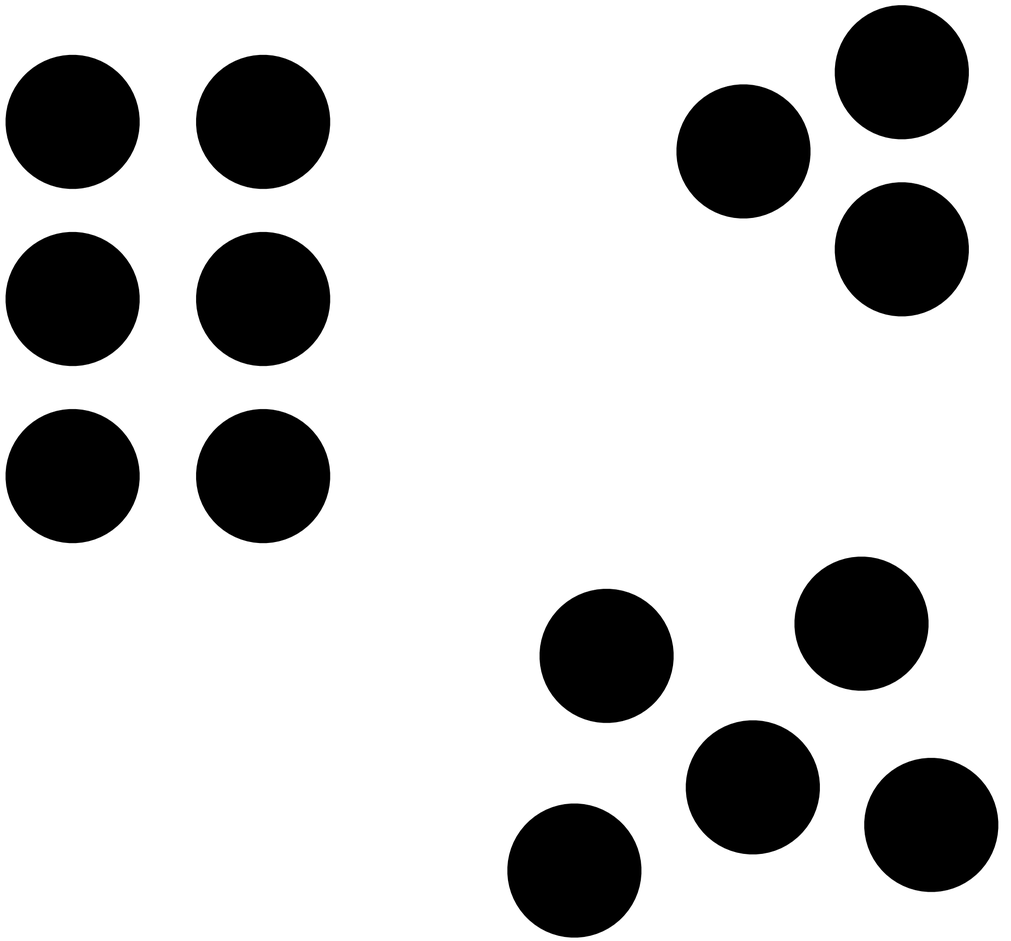
Gestalt Principles

Proximity

Gestalt Principles

Proximity

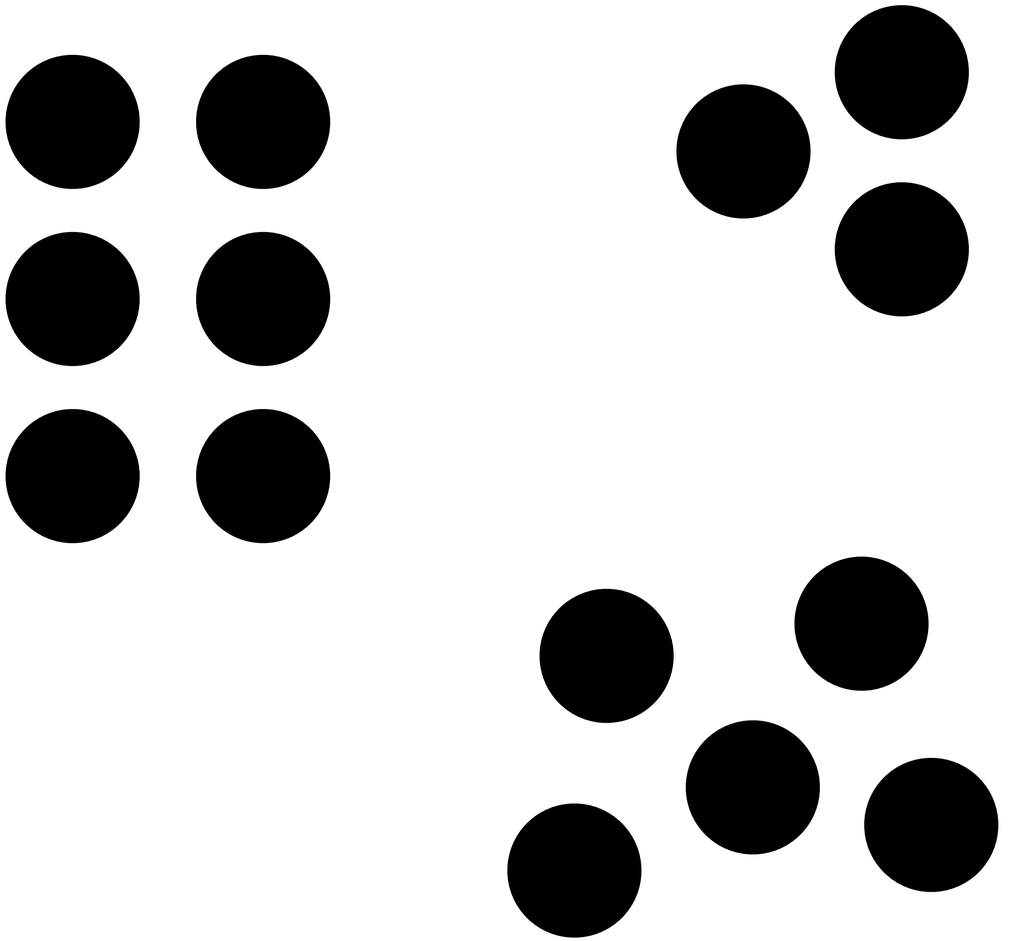
Objects that are close together are perceived as a group



Gestalt Principles

Proximity

- Titles
- Legends
- Related Charts
- Properties
  grouped together

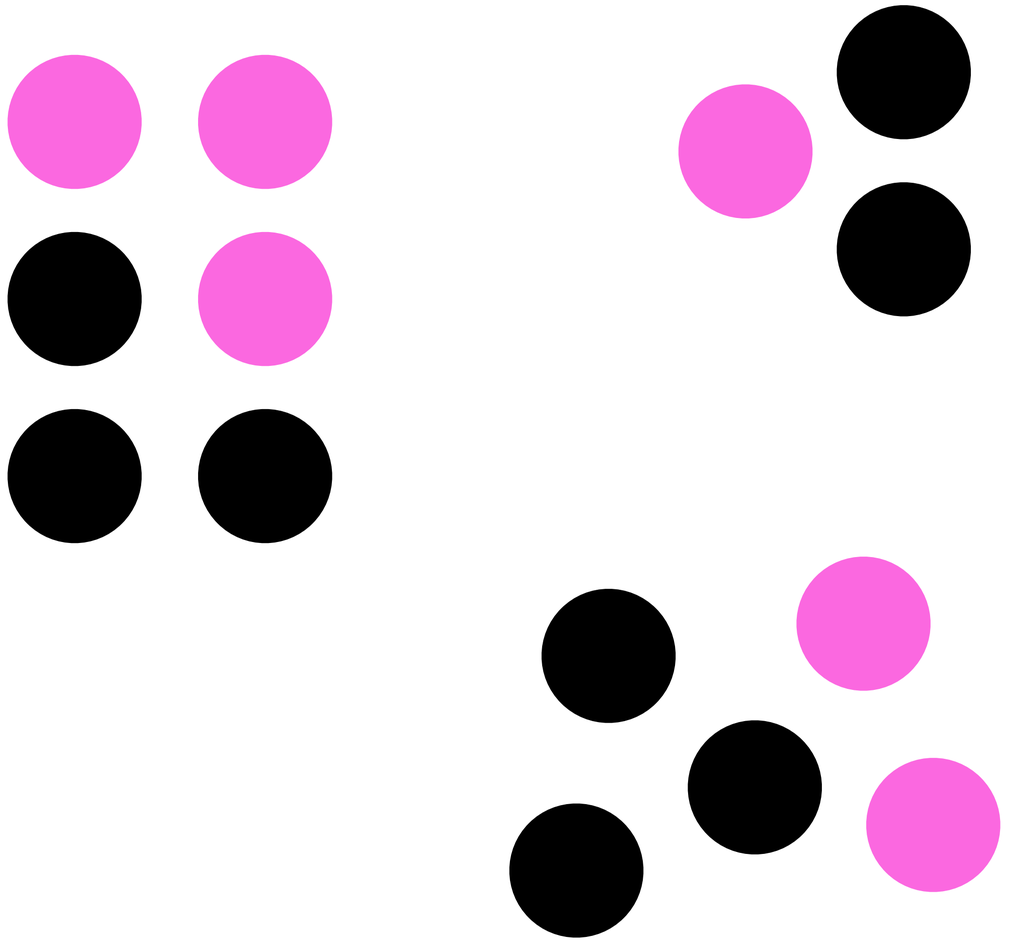


Similiarity

Gestalt Principles

Similiarity

Objects with the same visual properties are assumed to be similar and are grouped together.

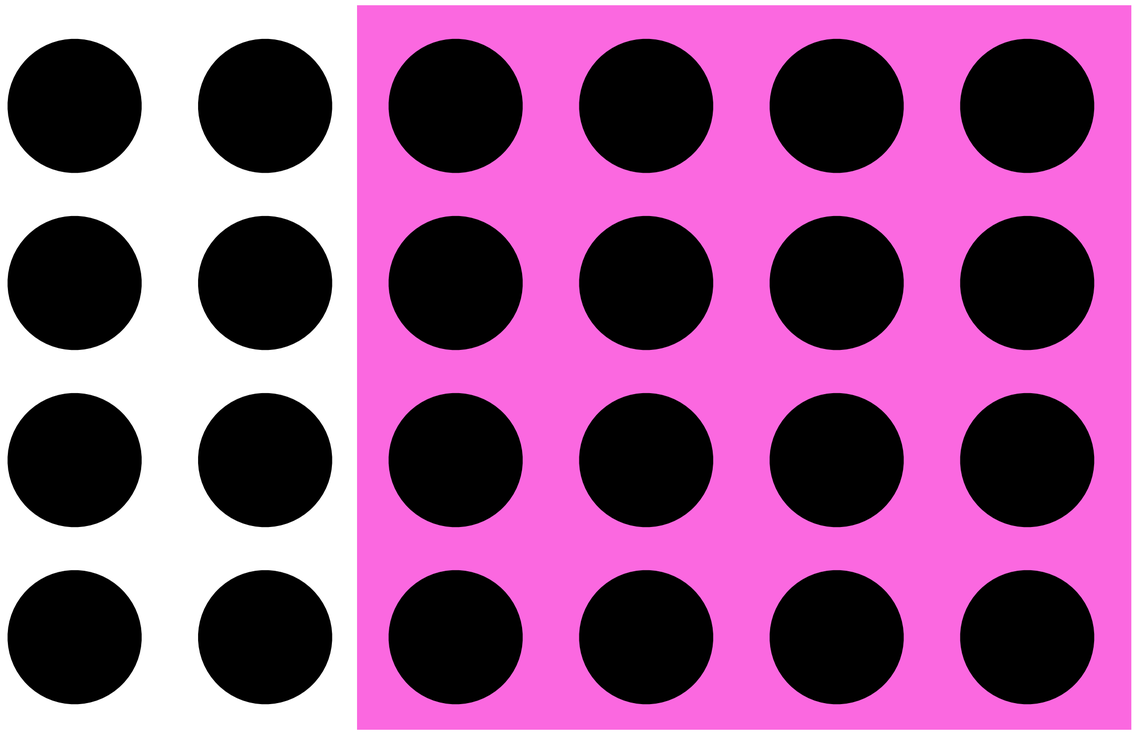


Enclosure

Gestalt Principles

Enclosure

Objects that appear to have a boundary around them (i.e., are found within the same common or enclosed region) are perceived as being related.

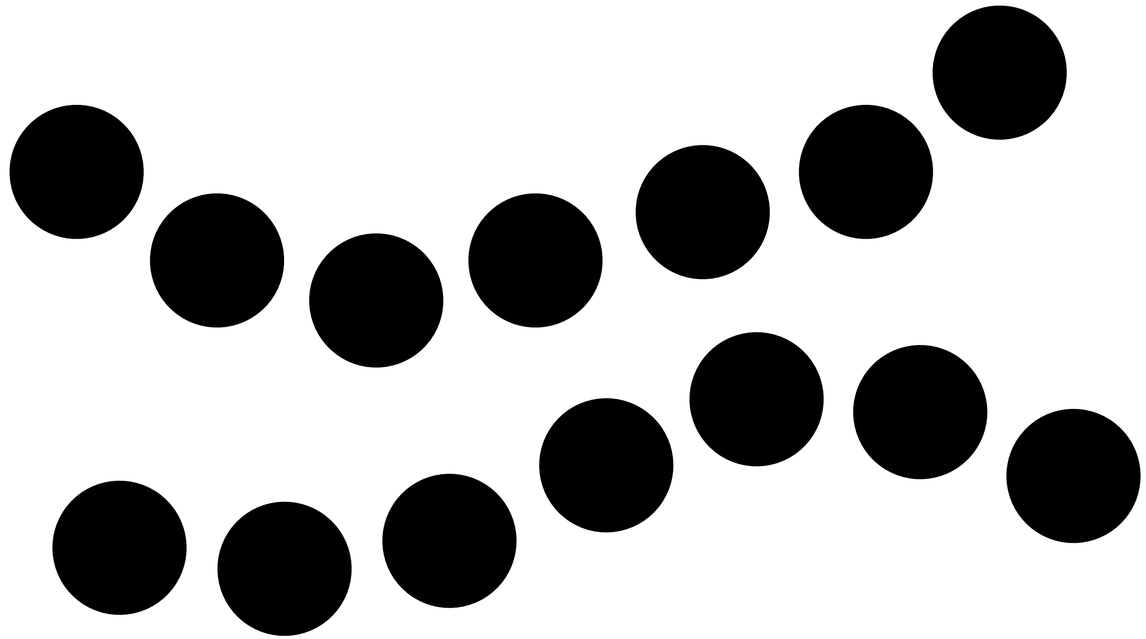


Continuity

Gestalt Principles

Continuity

Elements that are aligned (on the same line, curve, or plane) are perceived to be more closely related to each other than to other elements.

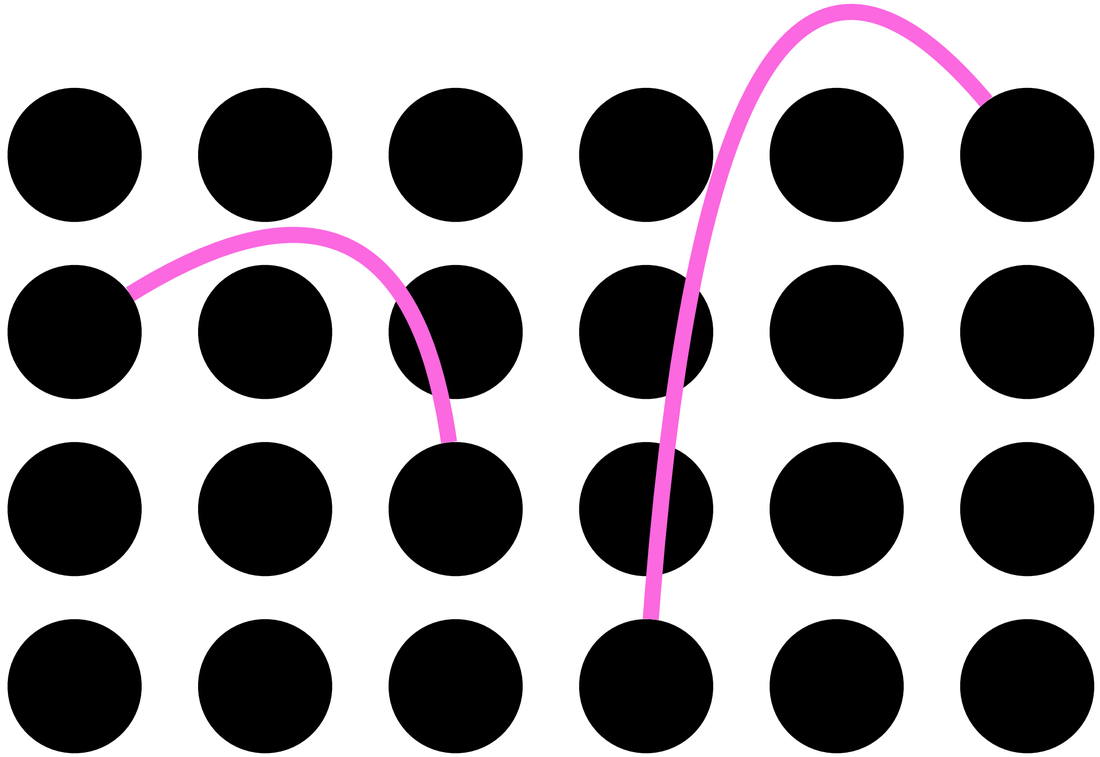


Connection

Gestalt Principles

Connection

Objects that are connected, such as by a line, are perceived as a group

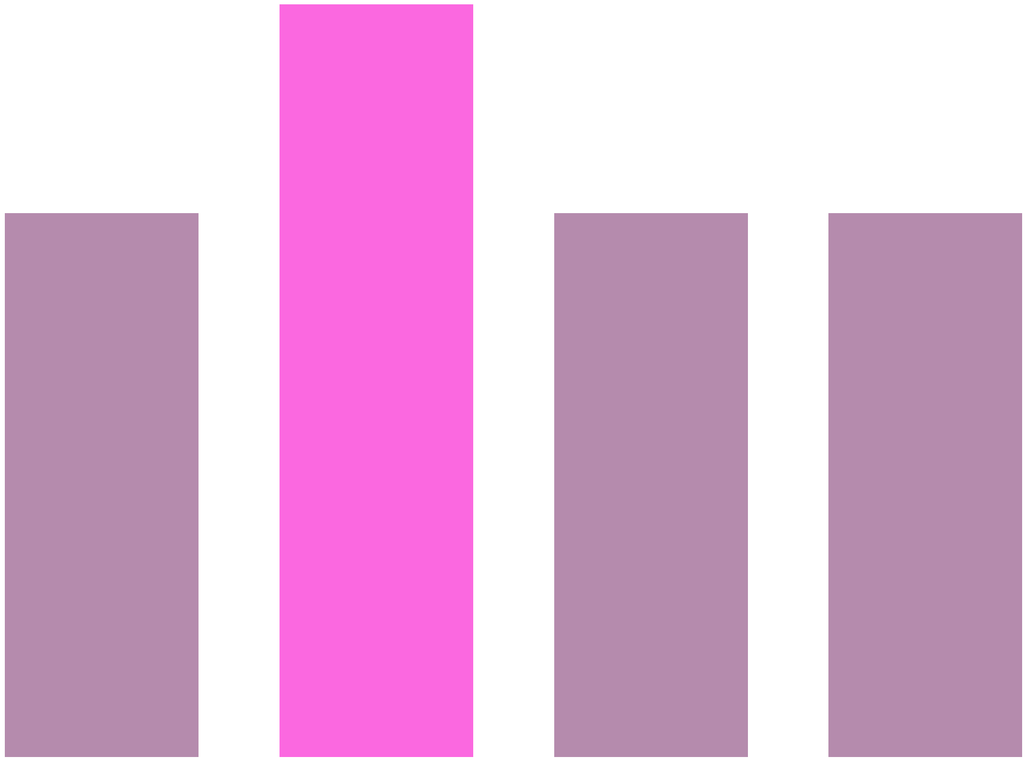


Focal Point

Gestalt Principles

Focal Point

Whatever stands out visually is perceived as the most important. It will grab our attention first, and hold it for the longest.



And finally this one

YOU WILL READ THIS FIRST!

And then you'll read this

Then this one

Figure and Ground

Gestalt Principles

Figure and Ground

The mind separates an image into a figure (the focal object or element) and the ground (the background or surrounding area)

Gestalt Principles

Figure and Ground

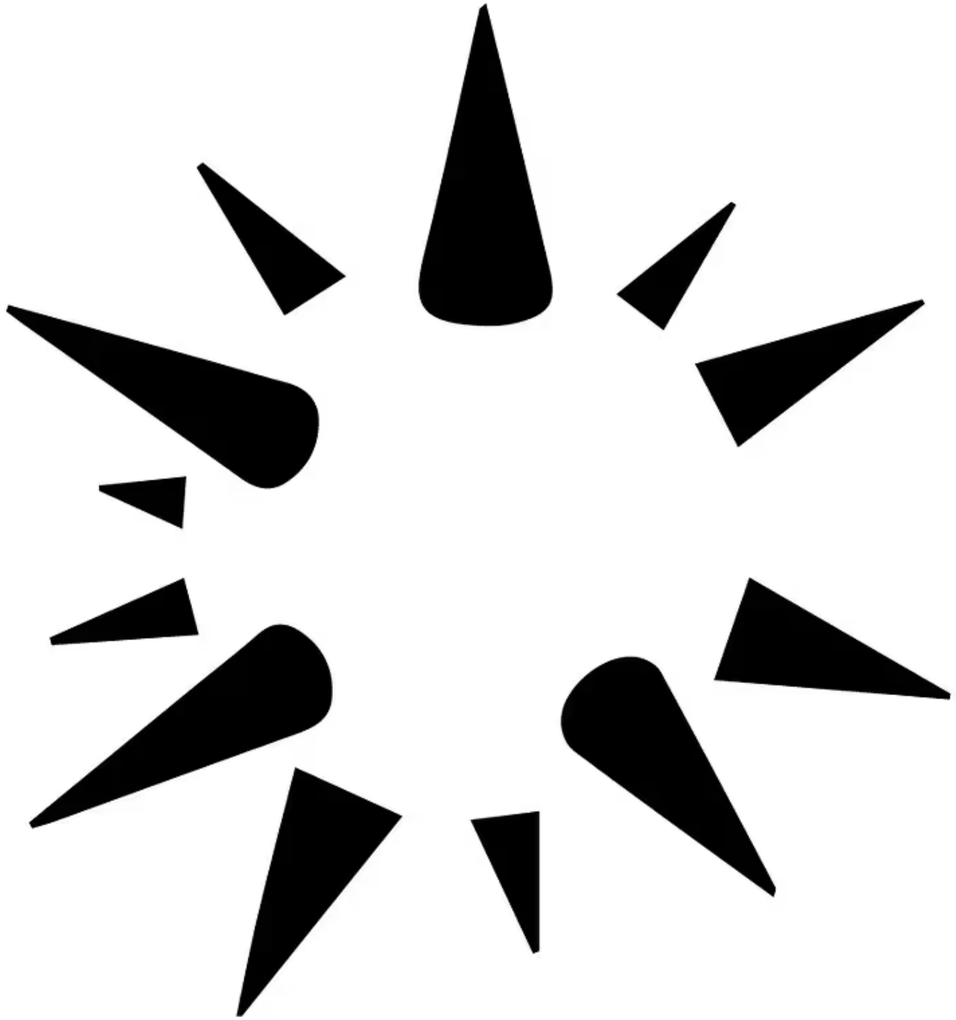
The mind separates an image into a figure (the focal object or element) and the ground (the background or surrounding area)

Closure

Gestalt Principles

Closure

The mind fills in the blanks to perceive a complete object whenever an external stimuli partially matches that object.



Gestalt Principles

How do we see?

- We don’t view in a fixed order
- We see first what stands out
- We see only a few things at once
- We seek meaning and make connections
- We rely on conventions and metaphors

Visual Perception and Encoding

- Using special properties of the visual system to help us think.
- Your visual system is good at specific tasks.
- All visualizations are made from a series of compromises.

Class Activity - Gestalt in Interfaces

- Find an app or website that you think is poorly designed.

- Identify which gestalt principles are used or violated in the design.

- Redesign the layout using pen and paper in 5 minutes using Gestalt principles to improve perception.

22 August 2025 · Gyan Lakhwani · gyanlakhwani@gmail.com · JS Institute of Design

gyanl.com/ergo

Ergonomics - Physical & Cognitive

Search notes..

LECTURES

Lecture 2

14 January 2025

Link to Slides Physical Ergonomics Ergonomics vs. human factors vs. human–system interaction