Perception & Color

Designing charts for the human visual system — then learning how to *read* charts defensibly.

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Today's Plan

01 · PERCEPTION

How people see charts

Preattentive cues, grouping, and limits.

02 · COLOR

Mapping colors to data

Palette types + accessibility basics.

03 · CHART READING

Spot misleading encodings

Pitfalls that break trust.

04 · PRACTICE

Audit + redesign

A workflow you can repeat.

Learning Outcomes

PERCEPTION

Choose channels that humans compare well

Position and length beat area and angle.

COLOR

Match palette type to data type

Qualitative vs sequential vs diverging.

ACCESSIBILITY

Design beyond “color only”

Contrast + redundancy + clear labeling.

CHART READING

Audit charts for misleading choices

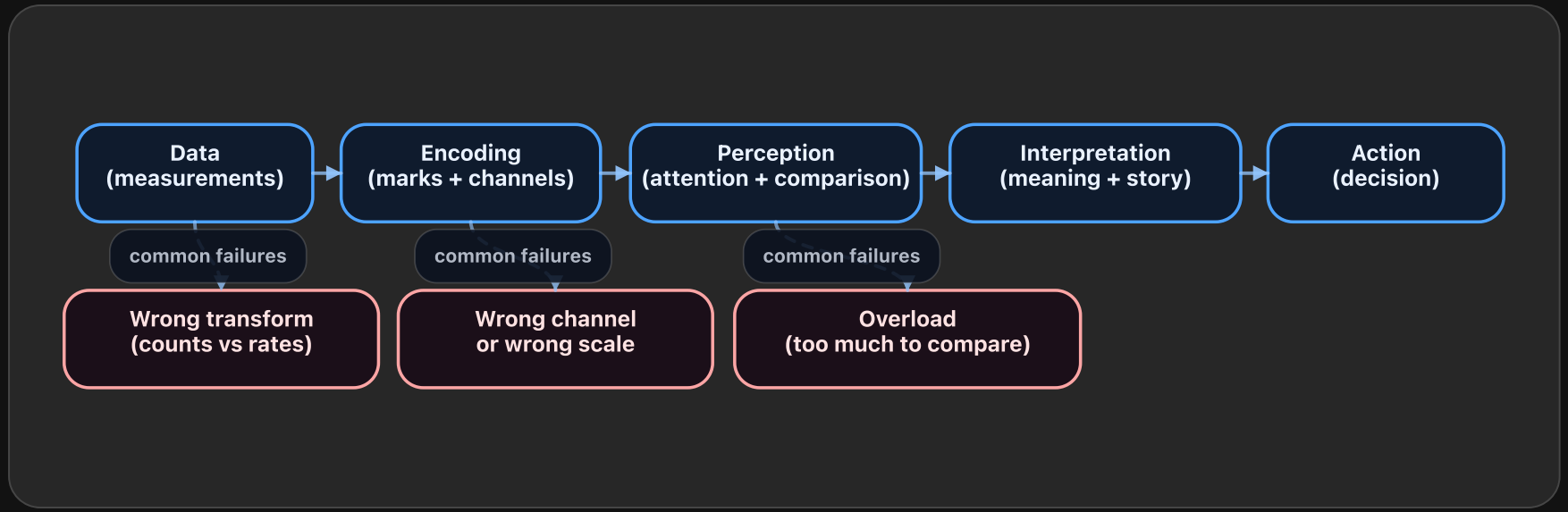
Axes, baselines, scales, and aggregation.

PART 1 · PERCEPTION

Perception is the interface

The chart is not the message. The *viewer's perception* is.

The Visualization Pipeline (Where Errors Enter)



Preattentive Cues (What the Eye Sees “Immediately”)

FAST COMPARISONS

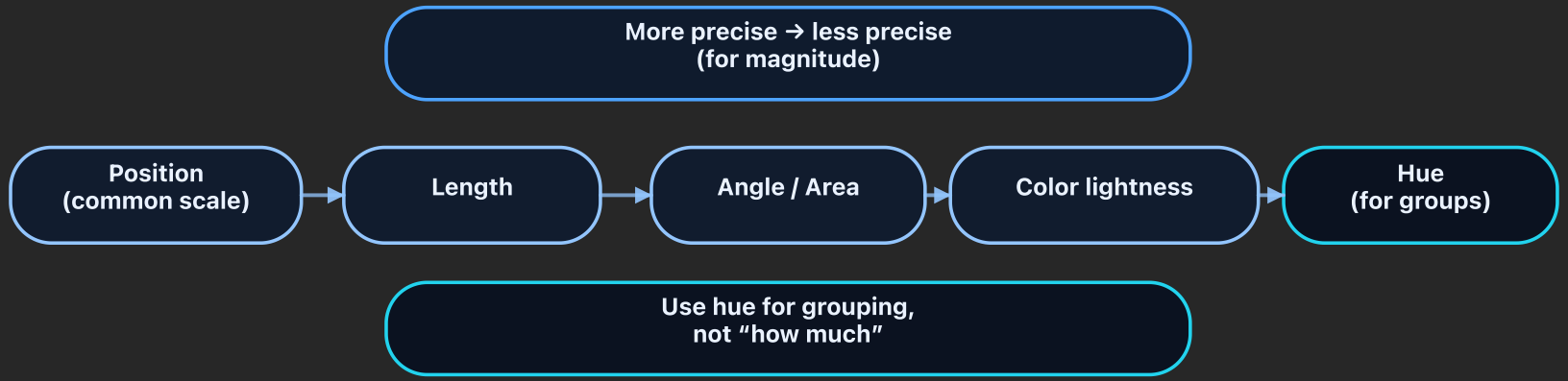
Position, length, slope

Best for “how much” and trends.

FAST GROUPING

Hue, shape, enclosure

Best for “which group?”



Attention + Working Memory (Why “Too Much” Breaks Charts)

ATTENTION

Selective

Viewers don’t read everything.

MEMORY

Limited

Don’t force “legend hunting.”

COMPARISON

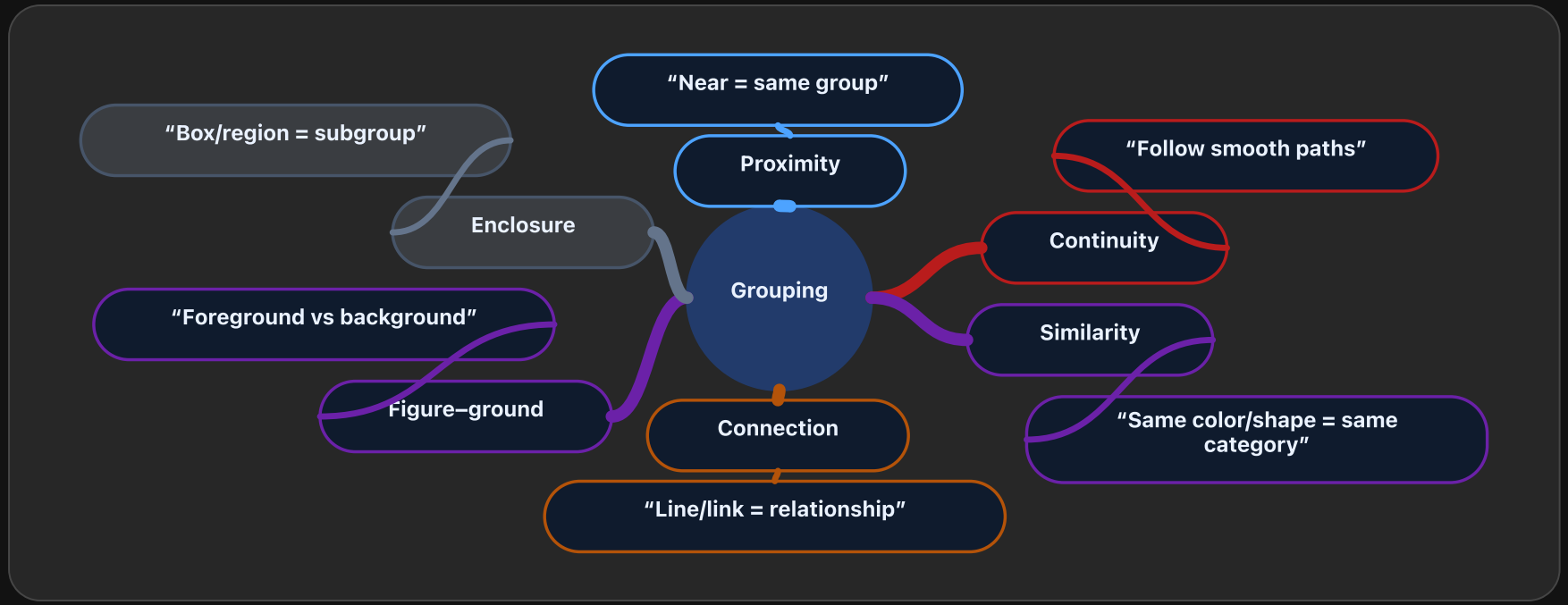
Fragile

Use shared scales + alignment.

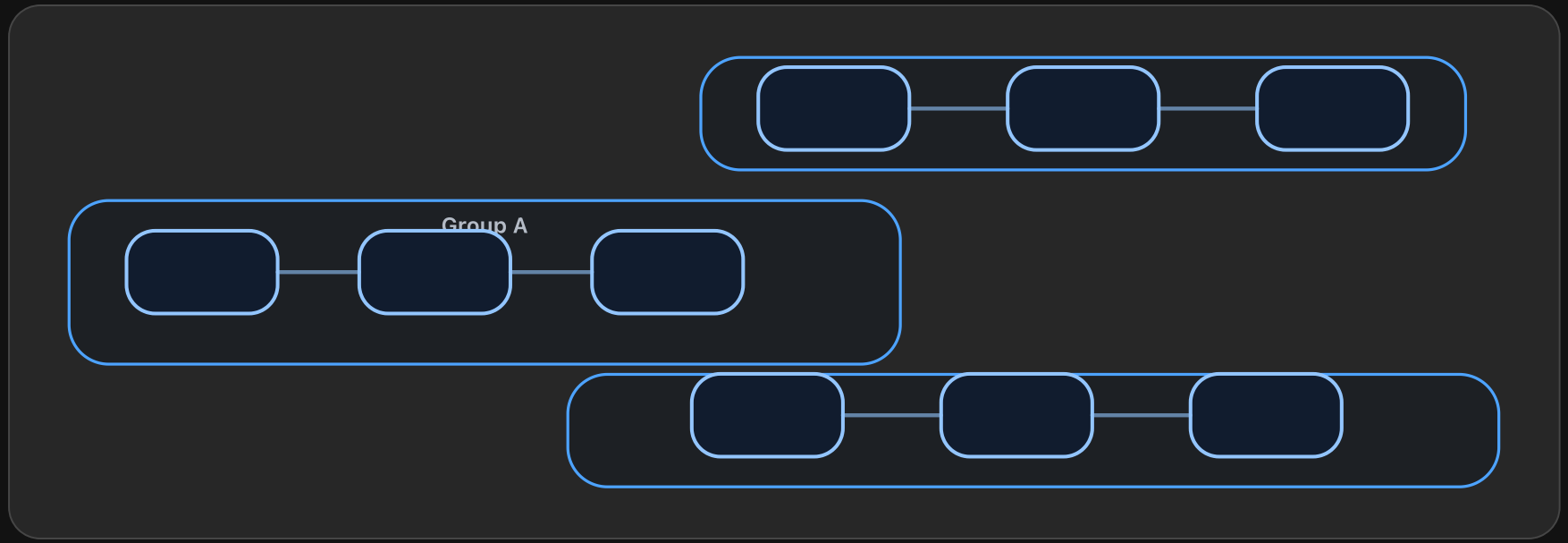
RULE OF THUMB

If your chart needs a paragraph to explain how to read it, redesign the chart.

Gestalt Principles (How Viewers Group Marks)



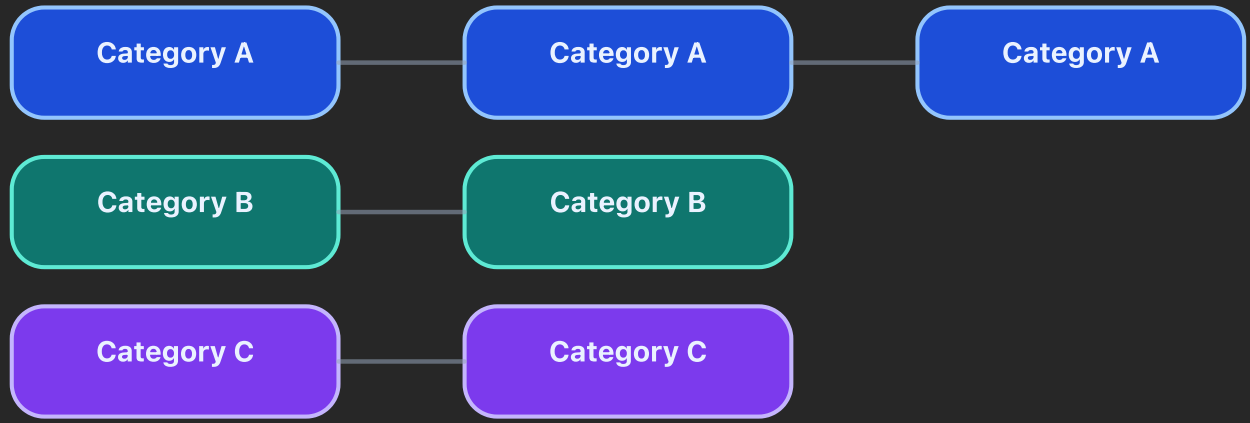
Proximity: Grouping Without Extra Ink



DESIGN MOVE

Use spacing and faceting to group — before adding more colors.

Similarity: When Color Creates Categories



USE SIMILARITY FOR

Grouping, not magnitude

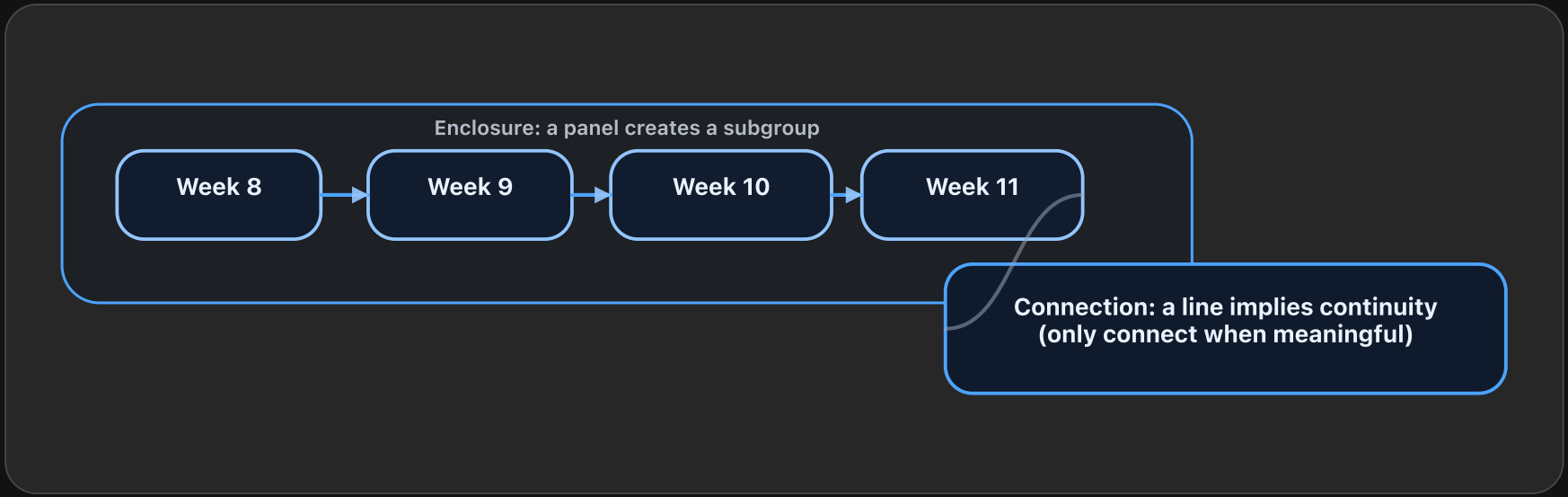
Hue answers “which group?”

COMMON MISTAKE

Hue implies “how much”

Prefer lightness for ordered data.

Connection + Enclosure (When Lines and Boxes Mean Something)



Visual Hierarchy (Make the Intended Reading Obvious)

HIERARCHY RECIPE

1 headline + 1 takeaway

State what to look for before showing details.

REDUCE NOISE

De-emphasize non-data ink

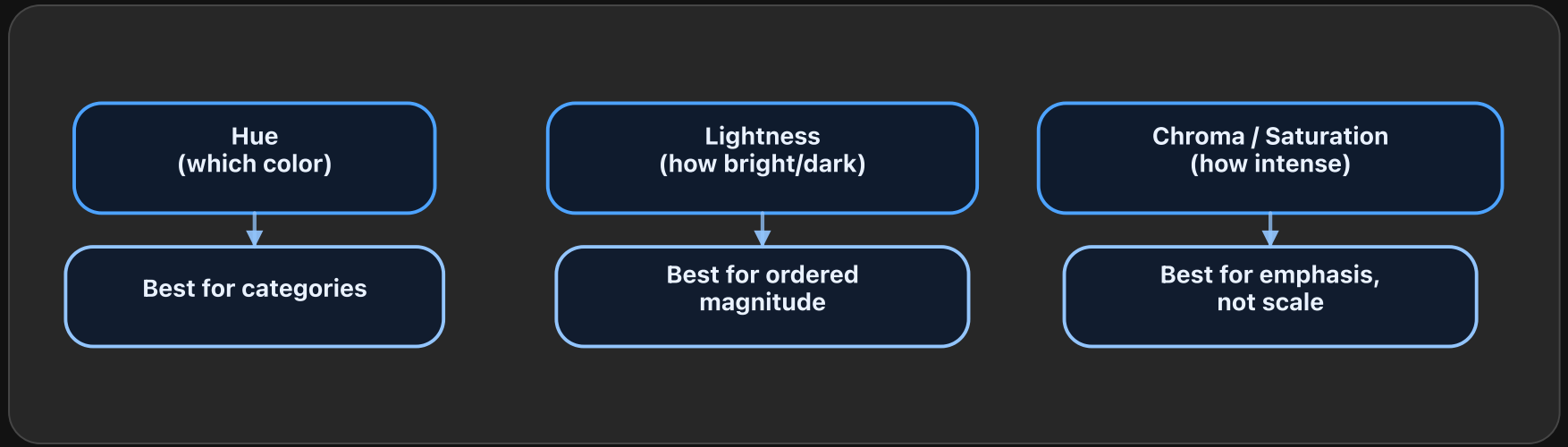
Light gridlines, fewer ticks, direct labels.

PART 2 · COLOR

Mapping Color to data

Color is powerful — and easy to misuse.

Color Has Three Useful Dimensions



KEY MESSAGE

Hue answers “which group?” Lightness answers “how much?”

Three Palette Types You Should Know

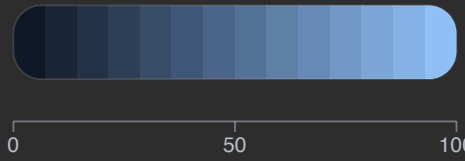
Qualitative

Categories

Blue Sky Green Orange Vermillion Purple

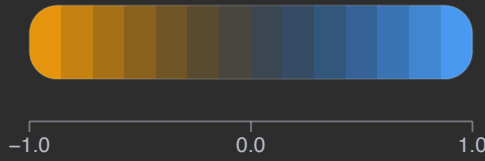
Sequential

Low → High

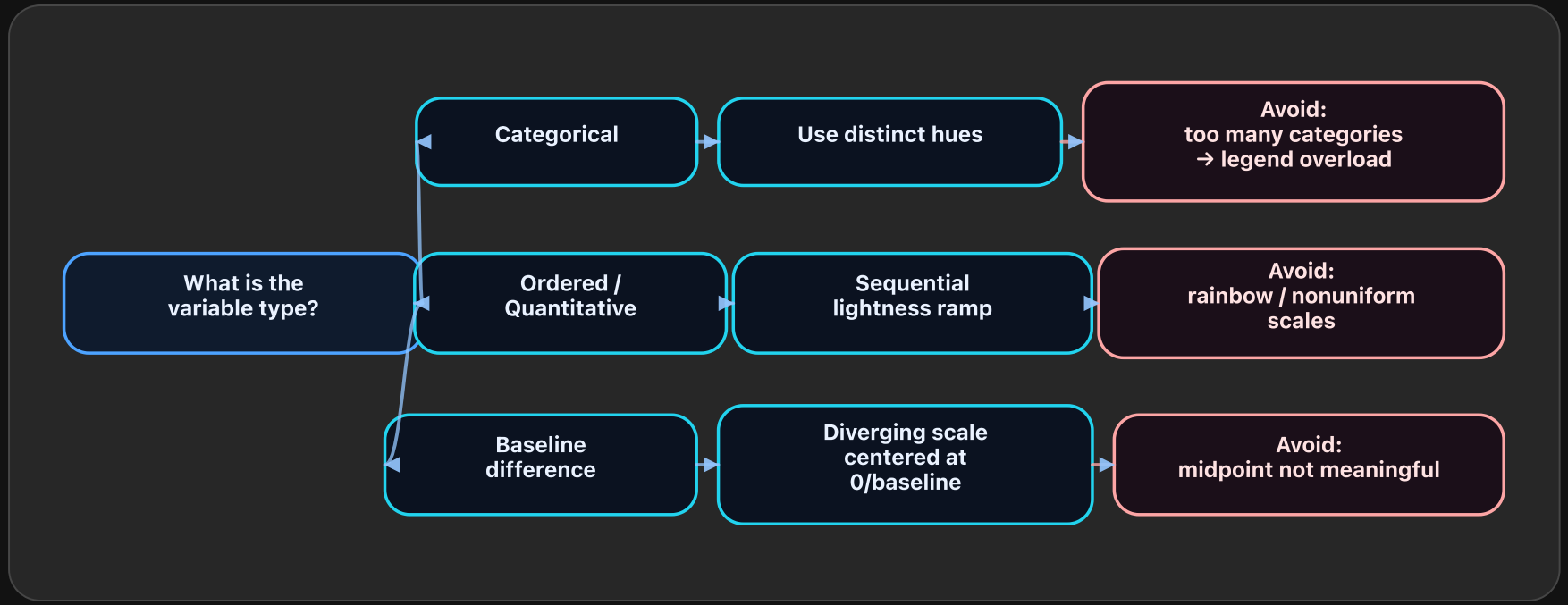


Diverging

Below ↔ Above



Match Color to Data Type + Task



Qualitative Palettes: Practical Rules

HOW MANY?

≤ 6 categories

Beyond that, use facets, grouping, or interaction.

HOW TO LABEL?

Direct labels > legends

Legends are fine, but don’t make them mandatory.

HOW TO HIGHLIGHT?

One accent

Gray everything else, highlight the point of interest.

CONSISTENCY

Same color = same meaning

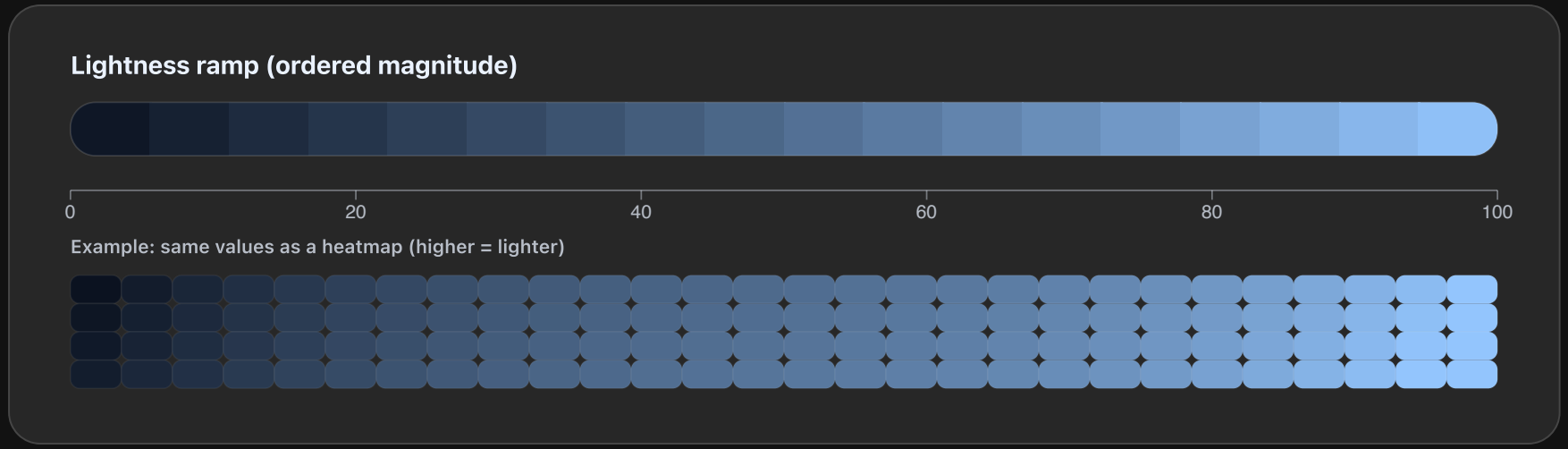
Across slides, charts, and the whole project.

A Colorblind-Safer Qualitative Palette (Example)

USE IT LIKE THIS

Pick 4–6 colors + keep one neutral for baseline/context.

Sequential Scales (Magnitude: Low → High)



GOOD SCALE PROPERTY

Lightness increases smoothly

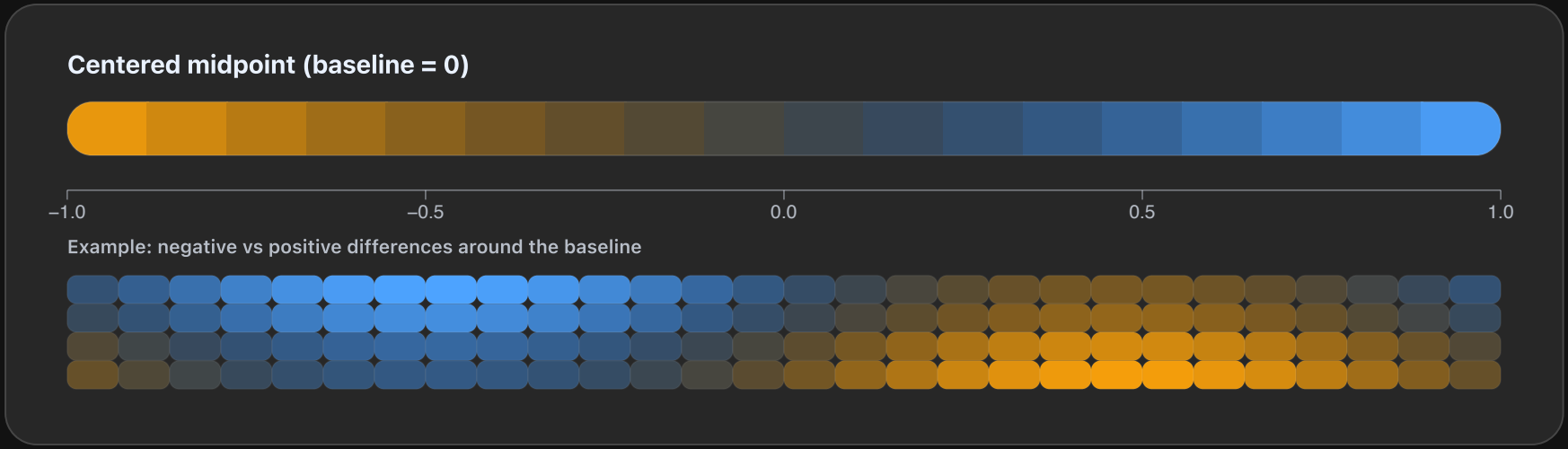
So order is visible even in grayscale.

COMMON FAILURE

Hue changes create false boundaries

Viewers “see” edges that aren’t real.

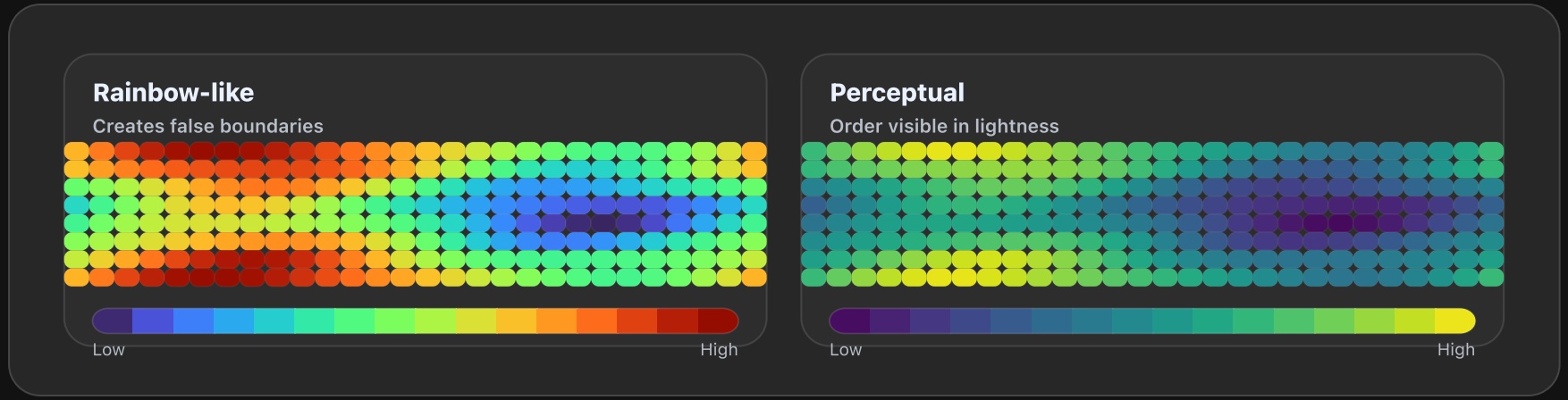
Diverging Scales (Difference Around a Baseline)



CRITICAL REQUIREMENT

Only use diverging scales when the midpoint is meaningful (0, target, average).

The Rainbow Trap (Why It Misleads)



WHY IT MISLEADS

- Non-uniform perception: some hues “pop.”
- False boundaries: hue edges look categorical.
- Not robust: breaks in grayscale and for CVD viewers.

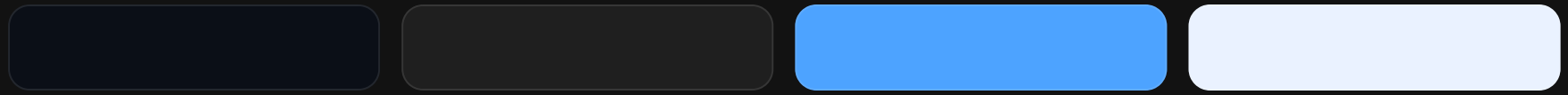
DO INSTEAD

Use lightness ramps (and label them)

Sequential for magnitude; diverging only with a meaningful midpoint.

Include units + min/max (+ midpoint for diverging).

Color + Contrast on Dark Backgrounds



Background | Surface | Accent | Text

CONTRAST FOR TEXT

Readable labels

Use off-white text; increase label size; avoid thin fonts.

CONTRAST FOR MARKS

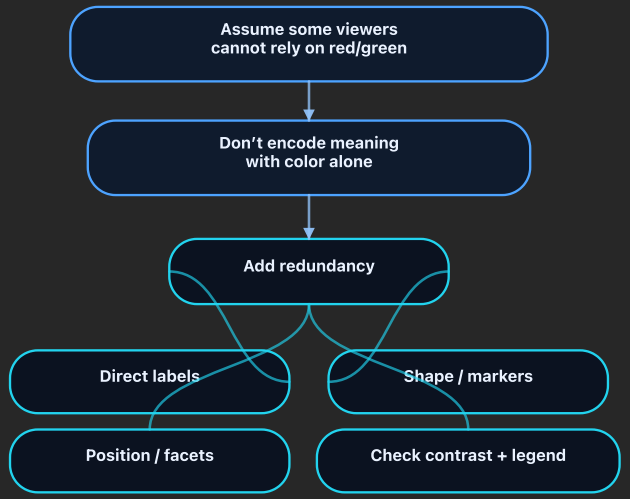
Visible data ink

Thicker strokes; subtle gridlines; keep one strong accent.

PRACTICAL CHECKLIST

Neutrals + one accent · off-white text · thicker lines · subtle gridlines

Accessibility: CVD + Redundant Encoding



DO

Design for robustness

Prefer blue/orange contrasts; use lightness ramps for magnitude; label directly.

AVOID

Color-only meaning

Red/green-only signals; unlabeled scales; too many hues; required legend hunting.

Legends Done Right (Small Details, Big Trust)

GOOD LEGEND

Has units + ordering

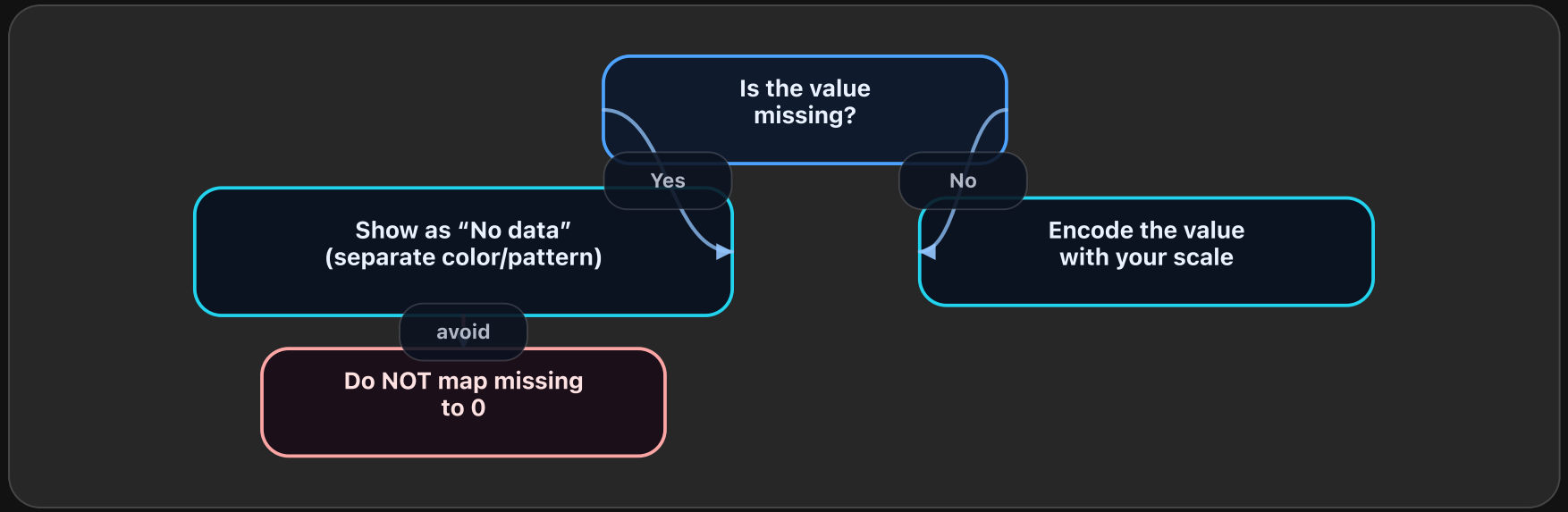
Includes midpoint for diverging scales.

BAD LEGEND

Forces guesswork

Unlabeled bins, unclear min/max, missing “no data”.

Missing Data ≠ Zero (A Common Interpretation Bug)



Color for Emphasis (Highlight, Don’t Paint Everything)

BASELINE CONTEXT

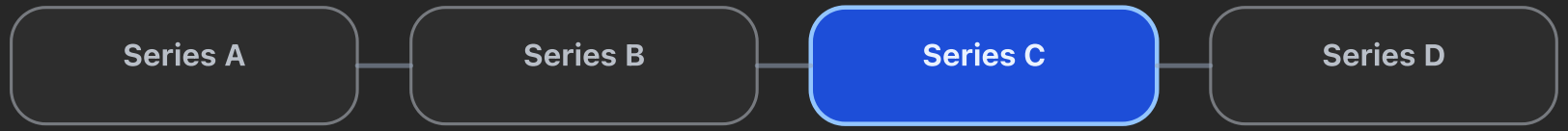
Neutral

Gray or low-saturation colors.

FOCUS

One accent

Use the accent only where you want attention.



When Color Is the Wrong Tool

TOO MANY CATEGORIES

Use small multiples

Facets + consistent scales beat 12-color legends.

PRECISE COMPARISON

Use position

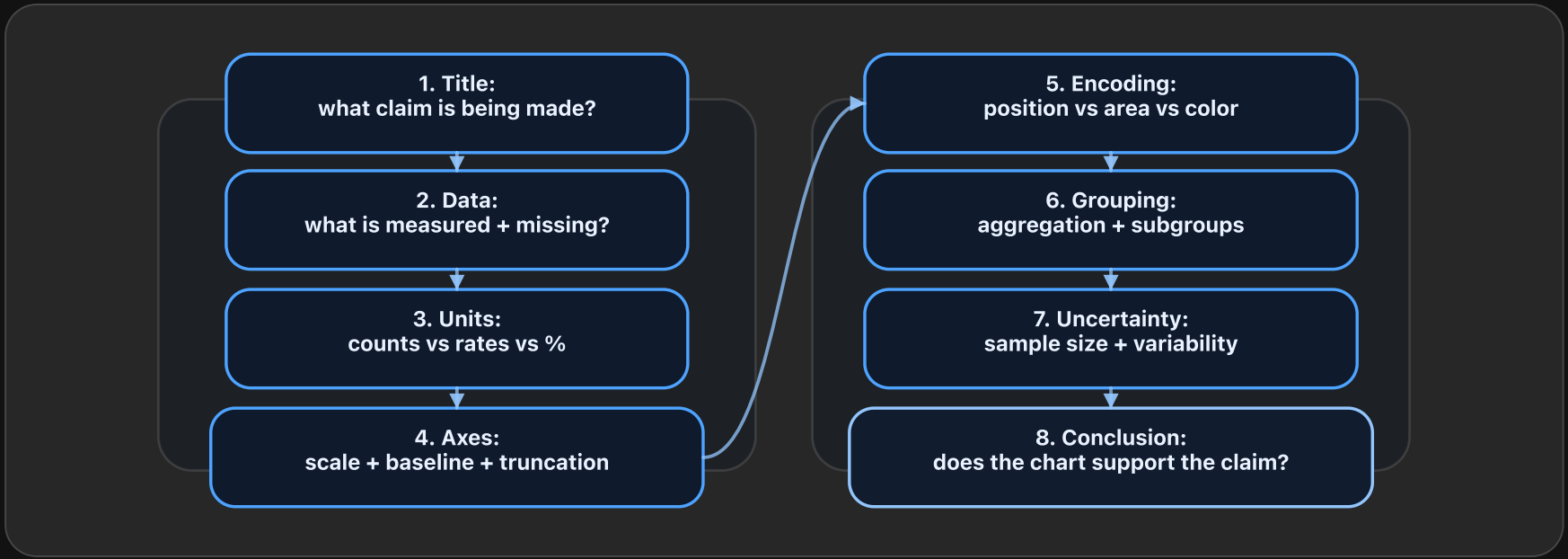
Dot plots and aligned bars are more accurate.

PART 3 · CHART READING

Read charts like a skeptic

Trust the data, but verify the encoding.

An 8-Step Chart Reading Checklist



Pitfall: Truncated Axis (Especially for Bars)

WHY IT MISLEADS

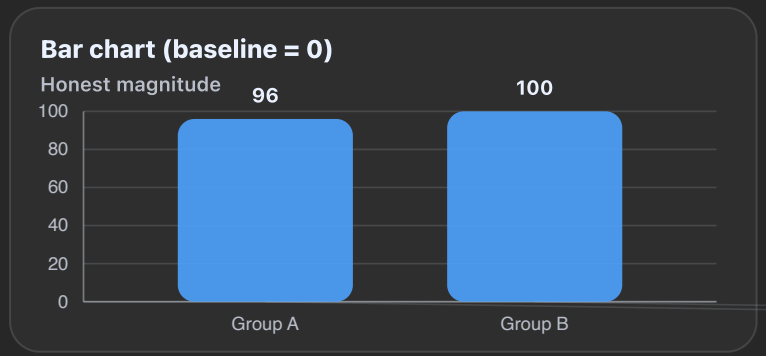
Bars encode length from a baseline

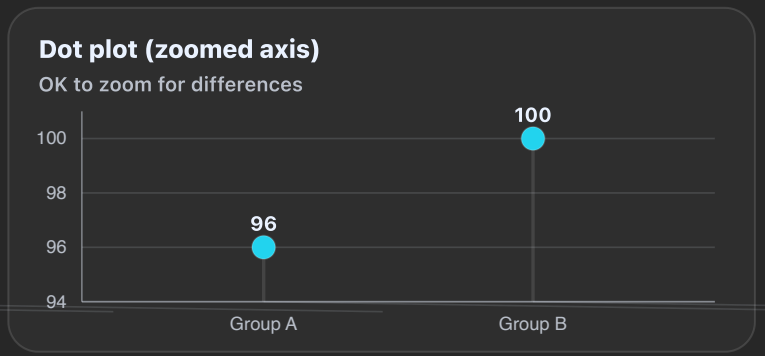
If the baseline is not zero, the visual difference is inflated.

WHEN ACCEPTABLE

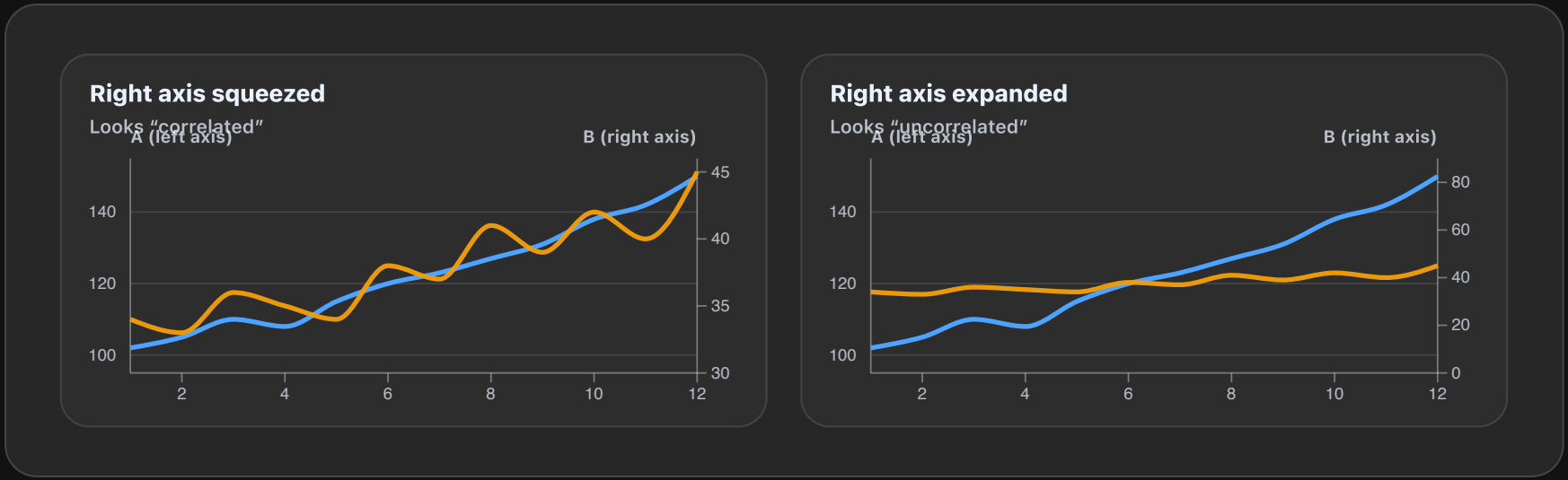
Use dots/lines for nonzero baselines

Or clearly mark axis breaks and explain them.





Pitfall: Dual Y-Axes (Two Stories in One Chart)



Pitfall: 3D and Perspective

PERCEPTION PROBLEM

3D turns accurate length comparisons into ambiguous area comparisons.

WHAT 3D ADDS

Decoration, not information

It makes the reading harder, not better.

PROFESSIONAL FIX

Use 2D with labels

Add annotation if you need emphasis.

Pitfall: Area Encodings (Bubbles, Pies, Stacked Areas)

DESIGN GUIDANCE

If comparison matters, avoid area-only charts. Use aligned position instead.

Pitfall: “Average” Hides Distribution

READER MOVE

Ask: what is the distribution?

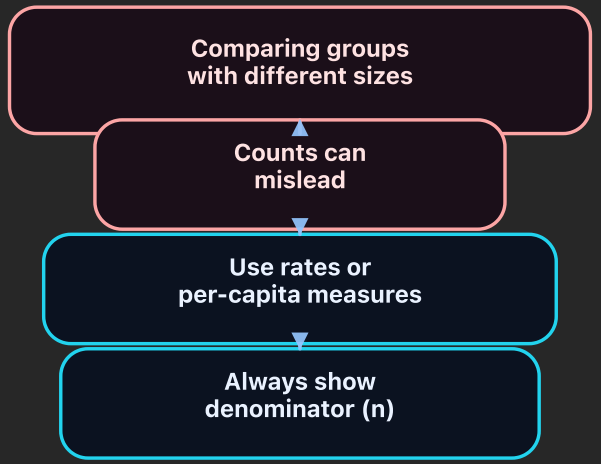
Outliers? bimodal? wide variance?

DESIGNER MOVE

Show uncertainty or spread

Box plots, intervals, or small multiples.

Pitfall: Counts vs Rates (Normalization Errors)



Pitfall: Binning and Scale Choices (Histograms, Heatmaps)

BINNING CHOICE

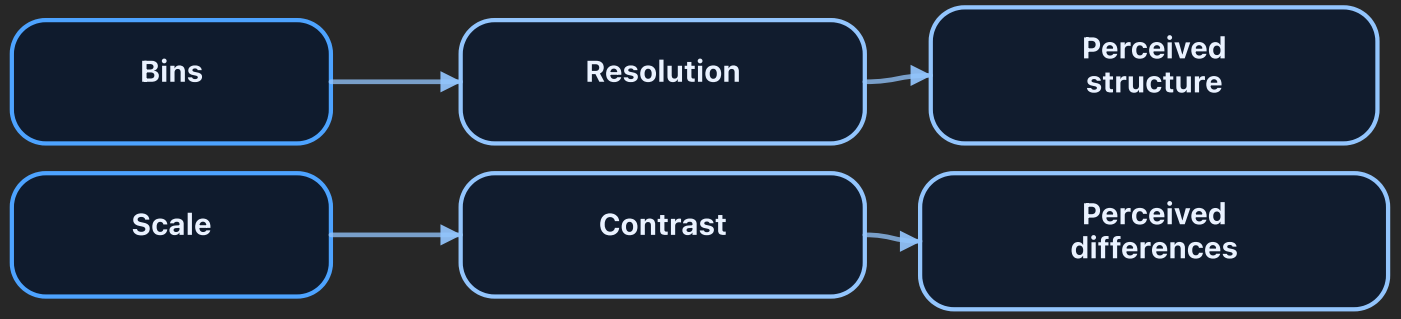
Controls what patterns appear

Too few bins hide structure; too many bins add noise.

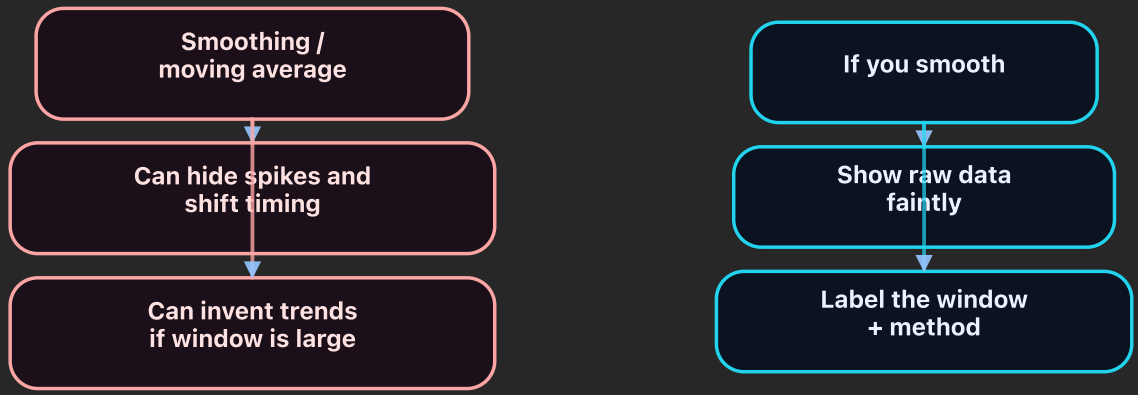
SCALE CHOICE

Controls contrast

Linear vs log can change perceived differences.



Pitfall: Smoothing (It Can Hide or Invent Changes)



Pitfall: Uncertainty Missing (False Precision)

READER MINDSET

If you see a single line, ask: how variable is it?

ADD UNCERTAINTY

Intervals or distributions

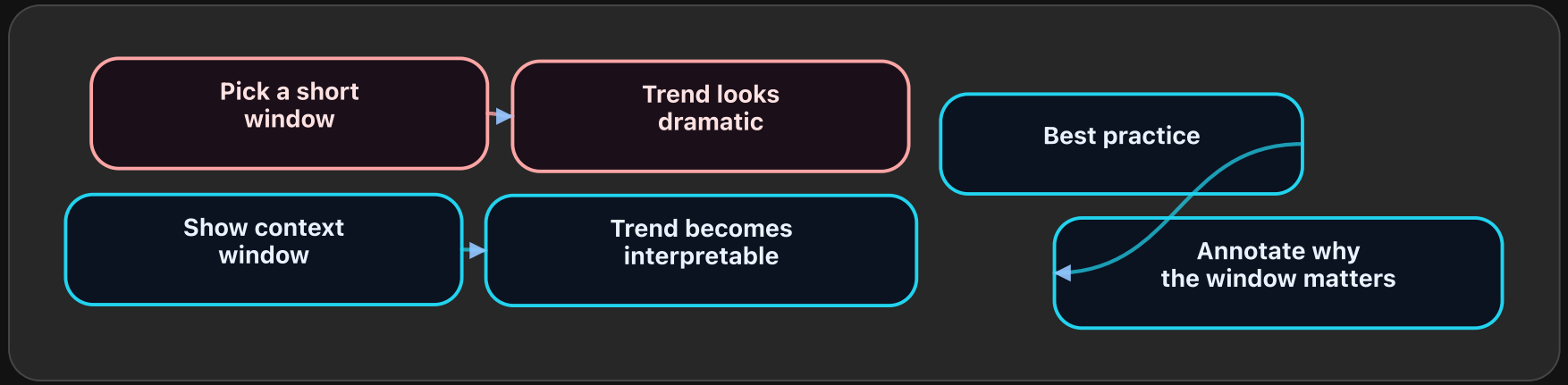
Error bars, bands, dot plots, or box plots.

AT MINIMUM

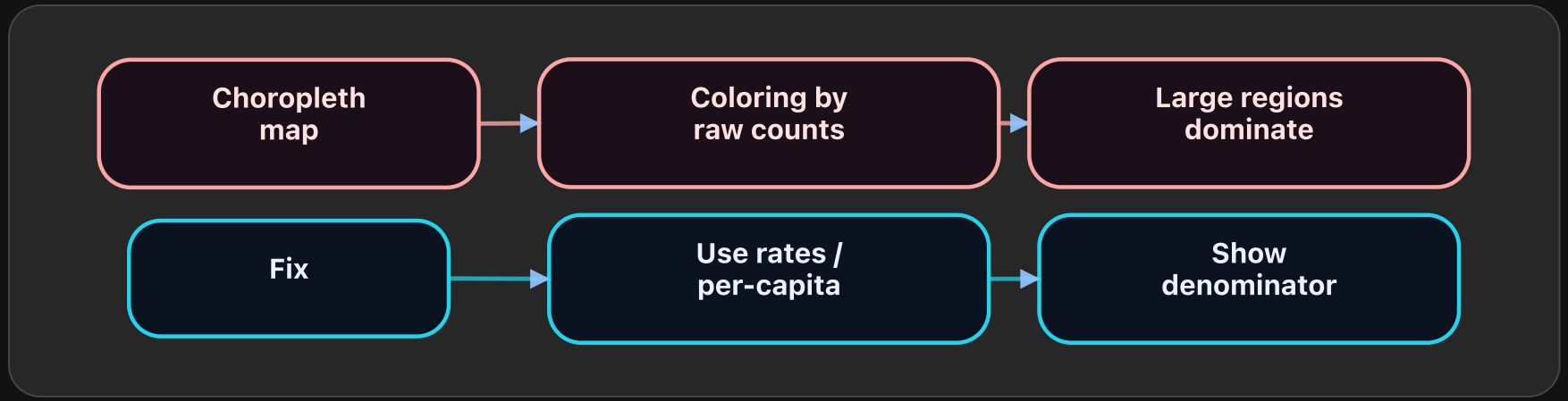
Show sample size

So viewers can judge stability.

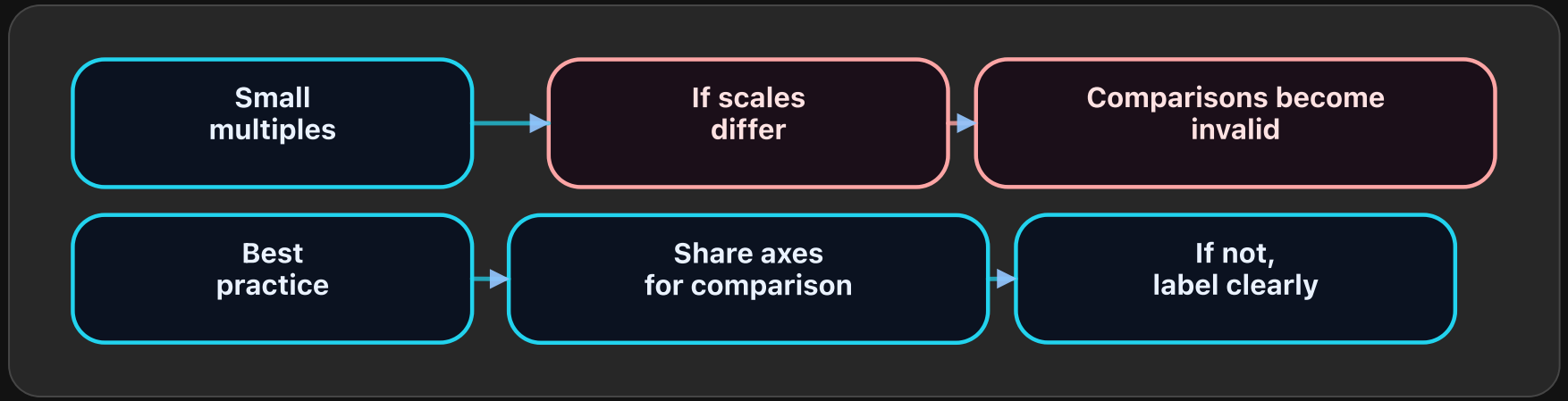
Pitfall: Cherry-Picked Time Windows



Pitfall: Choropleths of Counts (Map Misuse)



Pitfall: Inconsistent Scales Across Panels



Pitfall: Category Order and Sorting

UNSORTED CATEGORIES

Hide ranking patterns

Readers waste time scanning.

SORTED CATEGORIES

Make comparisons effortless

Sort by value, by meaningful order, or by grouping.

Pitfall: Color Implies Meaning You Didn’t Intend

COMMON FAILURE

Sequential color on categories implies order.

READER CHECK

Is the color scale labeled?

If not, don’t assume magnitude.

DESIGNER FIX

Use qualitative hues for categories

Reserve sequential/diverging for ordered measures.

PART 4 · PRACTICE

Audit, then redesign

Build trust by catching problems early.

A Fast Audit Checklist (Before You Trust a Chart)

CLAIM

What is this chart trying to prove?

Is the claim specific and verifiable?

DATA

What is included/excluded?

Any missing values, filtering, or transformations?

ENCODING

Are channels appropriate?

Position vs area; color type matches data type.

SCALE

Baselines + axes correct?

Truncation, log scales, inconsistent panels.

UNCERTAINTY

Could noise or sample size change the story?

Look for n, intervals, or distributions.

Critique Drill (In Groups)

ACTIVITY

Find 3 problems and propose 3 fixes.

- Identify the *claim* the chart is making (1 sentence).
- List 3 potential issues (axes, color, encoding, aggregation, missingness).
- Propose 3 fixes (chart type, scale, palette, labels, transforms).
- Decide whether the original claim still holds after your fixes.

“Spot the Pitfall” (Quick Check)

SCENARIO

A bar chart shows a tiny change as a huge jump.

What do you check first?

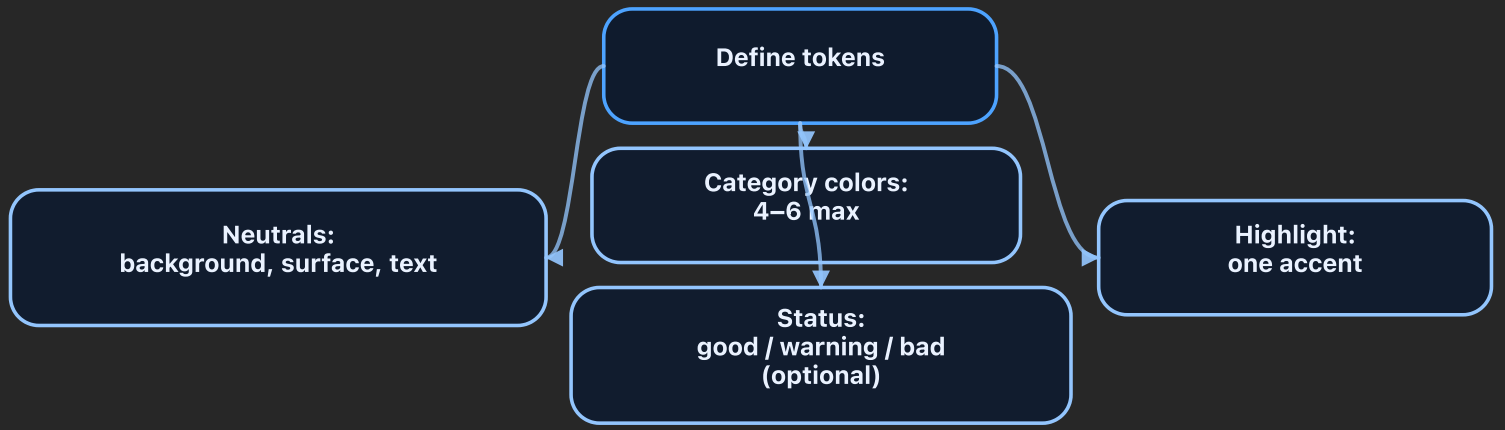
SCENARIO

A heatmap looks like it has “bands.”

What do you check first?

- Bar chart: check the y-axis minimum and baseline.
- Heatmap: check the color scale type (sequential? labeled?) and whether it’s uniform in lightness.
- Both: check if the claim matches the data + transformations.

Build a Simple Color System for Your Project



OUTCOME

Your charts look cohesive because your colors are consistent.

Wrap-up + Practice

TAKEAWAYS

- Use **position/length** for accurate comparisons; avoid area for precision tasks.
- Use **hue** for categories, **lightness** for magnitude, **diverging** for baseline differences.
- Design accessibly: **contrast + redundancy + labeled scales**.
- Read charts with a checklist: claim → data → units → axes → encoding → aggregation → uncertainty.

Ethics: Be persuasive by being clear — not by manipulating perception.

WHAT TO PRACTICE

- Critique one real chart (write the claim + 3 issues + 3 fixes).
- Redesign one misleading choice (axis, encoding, palette, aggregation).
- Apply accessibility basics (contrast, direct labels, “no data” handling).
- Reuse a consistent palette system across your project.

References (Recommended)

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Color Universal Design (palette guidance)

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