Visual Design for the Web: S09E02

Colour and Contrast

Moving beyond broken math to perceptual truth.

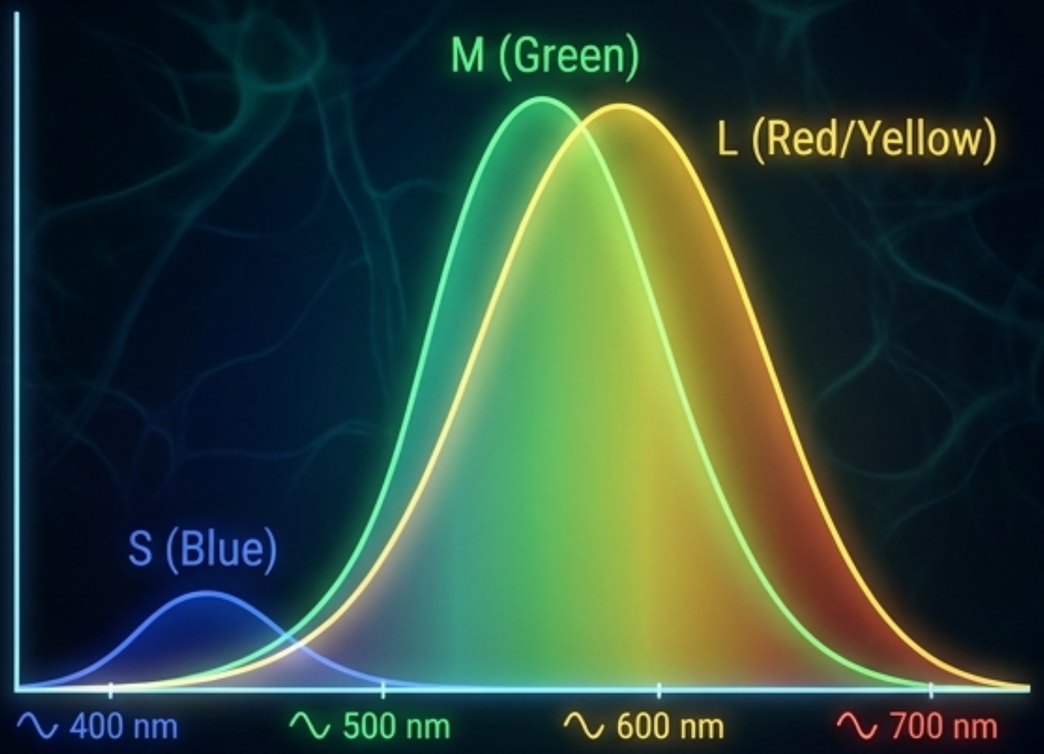
Previously in S09E01 (‘Visual Hierarchy and Composition’), we established that perceptual lightness preserves our grayscale hierarchy when hue finally arrives.

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Human Cone Physics vs. Broken RGB/HSL Math

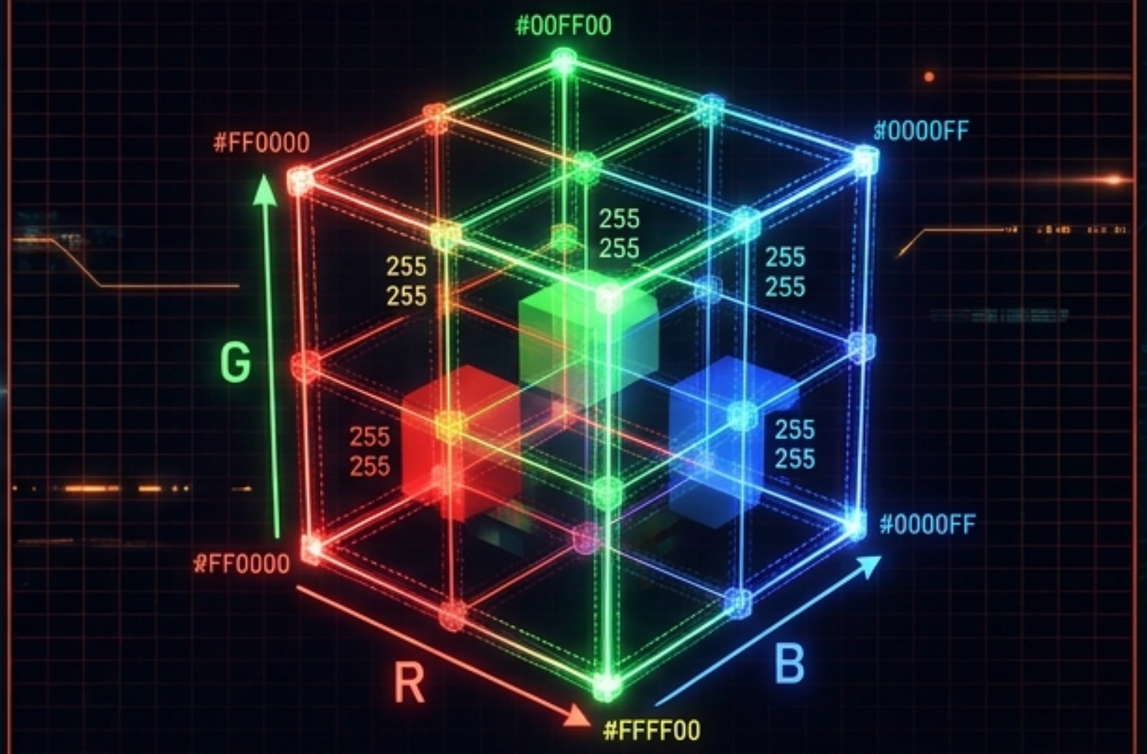
The Biological Hardware vs. The Legacy Code

The Biological Hardware



Humans possess an overwhelming density of L (red/yellow) and M (green) cones. Our S (blue) cones are incredibly sparse. We are biologically wired to perceive luminance primarily through green and yellow wavelengths.

The Legacy Code

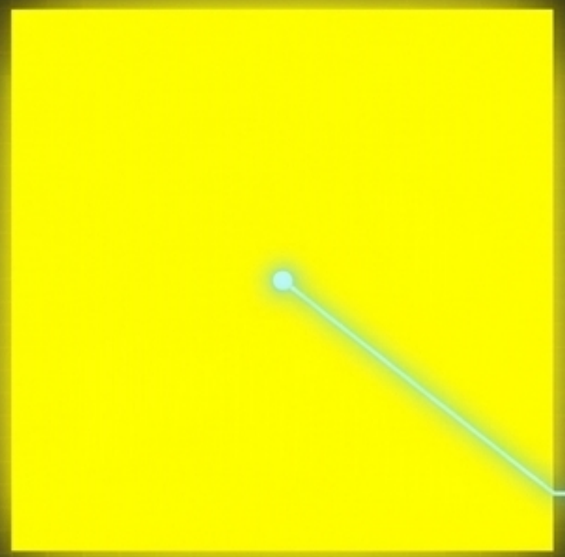


RGB and Hex code treat color as equal, linear mixtures of light output. They are entirely blind to human biology, treating a maximum-output blue pixel as mathematically equal to a maximum-output yellow pixel, ignoring how the eye's hardware actually absorbs that light.

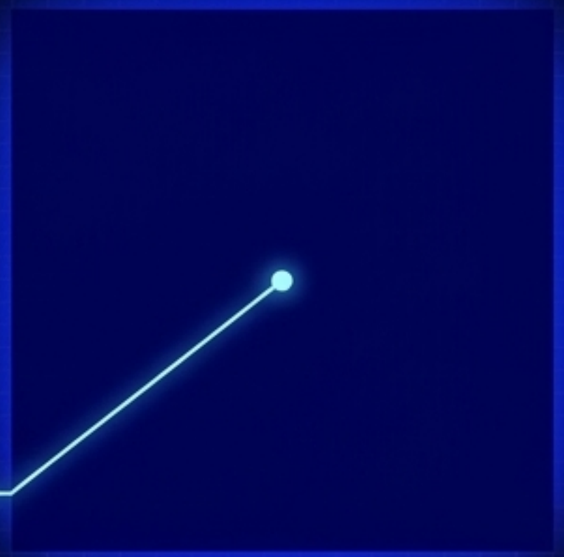
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The hsl() 50% Lightness Lie

hsl(H, 100%, 50%)

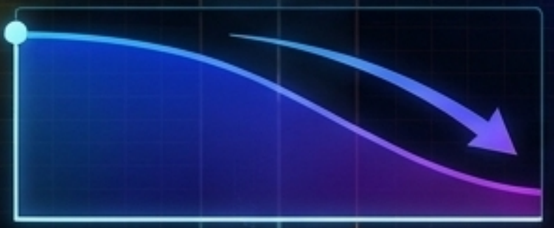


hsl(H, 100%, 50%)



OKLCH Inspector Overlay

Actual Perceptual Lightness: L: 45%



CIELAB shift:
Blue distorts toward Purple

The hsl() color space maps color to a uniform mathematical cylinder that wildly distorts biological reality. At identical 50% lightness values, pure yellow is blindingly bright while pure blue is intensely dark.

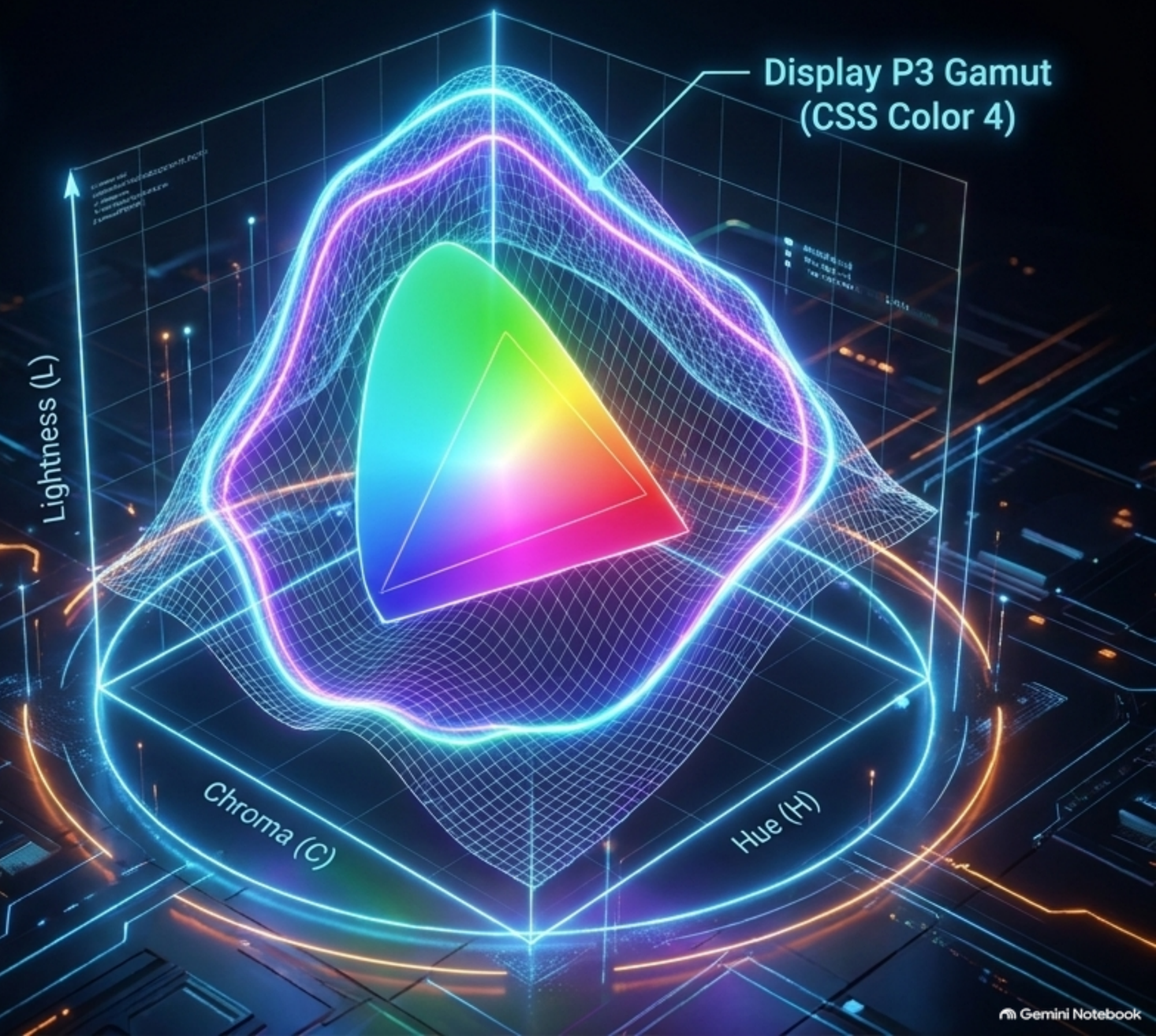
Takeaway: Building an accessible, systematic color palette using HSL is a guessing game because its lightness coordinate is completely untethered from human perception.

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The Perceptual Vanguard (OKLCH, HCT, P3)

To design systematically, we must use color models built on human perception. Enter Björn Ottosson's OKLCH, Material Design's HCT, and CSS Color 4's Display P3 mapping.

The Superpower: OKLCH guarantees predictable, uniform lightness adjustments. A 60% Lightness blue and a 60% Lightness yellow will finally look identically light to the human eye. It also effortlessly maps modern, wide-gamut P3 colors without distorting hues (fixing the legacy CIELAB blue-to-purple shift).



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Annotated Comparison — WCAG 2.2 vs. APCA

The Math of Legibility

Elements | Computed | 1

Relative Luminance

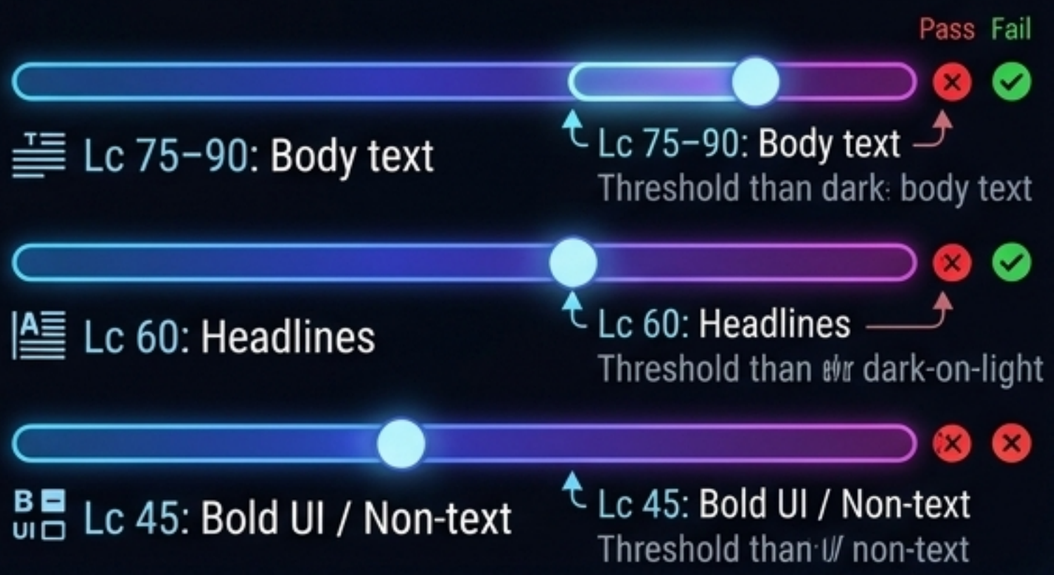
1.4.3 Contrast (Minimum):
4.5:1 (normal text) / 3:1 (large text)

1.4.6 Contrast (Enhanced):
7:1 (AAA)

1.4.11 Non-text Contrast:
3:1 (UI input borders, icons)

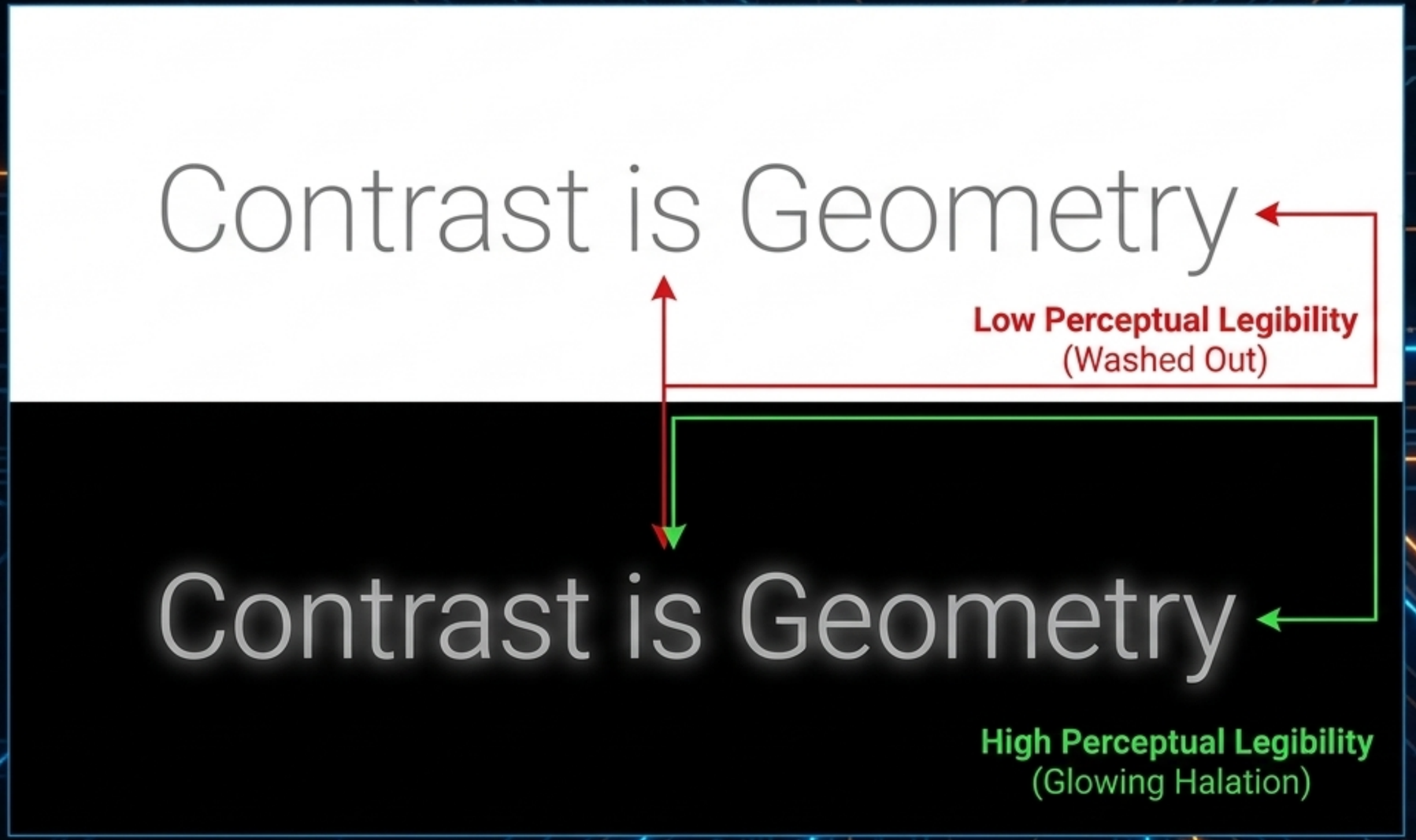
Accessible Perceptual Contrast Algorithm (Andrew Somers)

Polarity-aware (treats light-on-dark differently than dark-on-light) and explicitly font-weight-aware.



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Spatial Features and Polarity

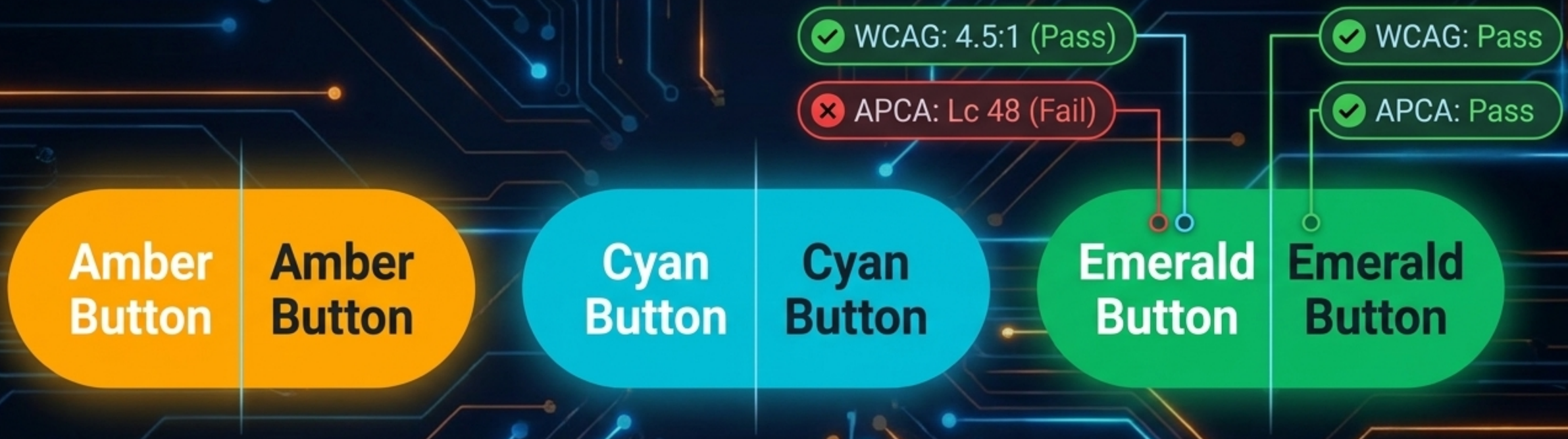


Contrast is not just about color; it is about geometry and environment. WCAG's simple relative luminance math creates false passes for thin text on light backgrounds and false failures for dark modes.

The APCA Standard: APCA scales mathematically based on font weight and size, demanding significantly higher baseline contrast for thinner fonts to achieve the same perceptual legibility.

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The Mid-Tone Button Dilemma



High-chroma mid-tones (cyan, emerald, amber) routinely expose the flaws in WCAG 2.2. White text on an emerald button technically passes WCAG math, but fails human perception (and APCA's strict Lc 60 UI threshold).

The Rule: Because of actual perceptual lightness scaling, dark ink consistently beats white text on mid-tone hues, requiring less visual strain to parse the geometry of the characters.

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Never Use Pure #000000 or Dead #808080

Irradiation and Halation Fatigue



On digital displays, bright pixels bleed into adjacent dark pixels—a physical effect known as irradiation or halation.

The Danger: Staring at pure white text on a pure #000000 background forces the eye to constantly refocus to correct this physical blur, causing severe astigmatism-like visual fatigue.

The Fix: Soften absolute black to a deep, rich tinted charcoal to reduce display vibration and ease optical strain.

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Tinting Neutrals (The 0.015 Chroma Rule)



OKLCH: L: 53%
C: **0** H: 0



OKLCH: L: 75%
C: **0.005** H: 80



OKLCH: L: 60%
C: **0.015** H: 240



OKLCH: L: 30%
C: **0.020** H: 120

Pure 0-chroma greys do not exist in nature; on digital displays, they look lifeless, dull, and artificial.

The Formula: To bring neutrals to life without breaking background neutrality, use OKLCH to inject a subtle Chroma (C: 0.005–0.02) that matches the exact Hue (H) of your primary brand signal color.

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The Gray Dead Zone



sRGB

RGB Yellow
FFFF00

RGB Blue
0000FF

When standard sRGB math interpolates between two highly saturated opposite colors, the channels converge toward their middle values (127.5), completely stripping out saturation.

OKLCH

STABLE CHROMA

OKLCH
Yellow

OKLCH
Blue

The Fix: OKLCH interpolates around the perceptual color wheel, preserving chroma mathematically and entirely eliminating the muddy gray dead zone.

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Contrasting Style Matrix

Tinted Neutral Personalities

Warm Editorial

Canvas: OKLCH(95%, 0.02, 65°)

Editorial content with a gentle, sophisticated character.
OKLCH(20%, 0.005, 65°)

Accent Button

OKLCH(50%, 0.1, 40°)

High sophistication, low fatigue.

Crisp Swiss / Technical Utility

Canvas: OKLCH(92%, 0.02, 250°)

Technical and precise interface. Clinical focus.
OKLCH(15%, 0.002, 250°)

Signal Button

OKLCH(45%, 0.15, 260°)

Clinical, precise, developer-focused.

Tactile Craft Brand

Canvas: OKLCH(88%, 0.03, 45°)

Handcrafted, natural, and grounded feeling.
OKLCH(12%, 0.01, 45°)

Accent Button

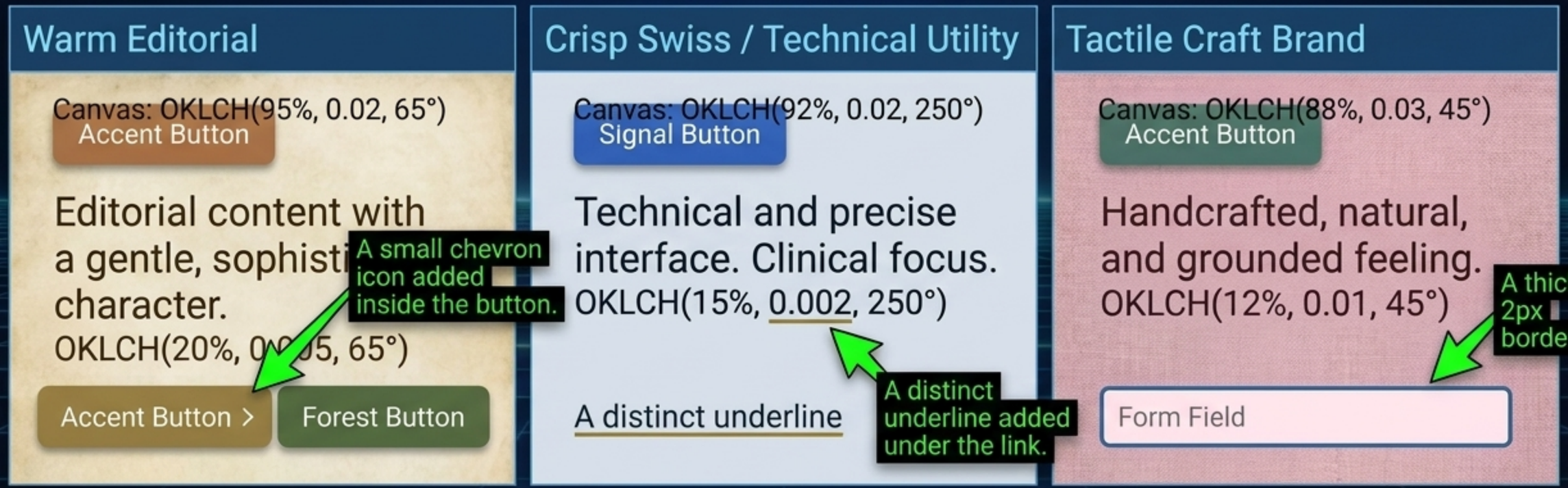
OKLCH(40%, 0.08, 110°)
OKLCH(55%, 0.06, 70°)

Earthy, grounded, physical.

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Daltonism Safety & Signifiers

Protanopia View | Deuteranopia View | Tritanopia View



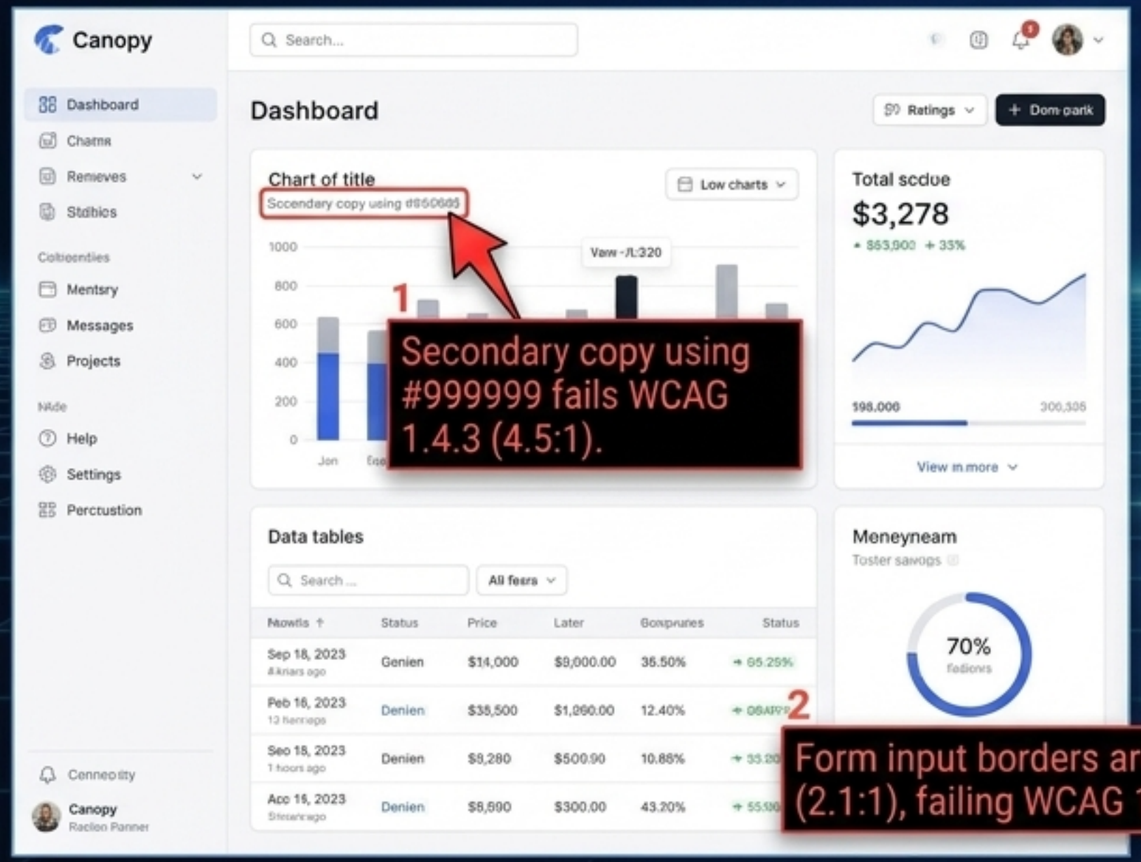
Even perfectly mapped perceptual palettes are vulnerable to Daltonism. Red/green confusion lines will instantly destroy the meaning of purely color-based UI signals.

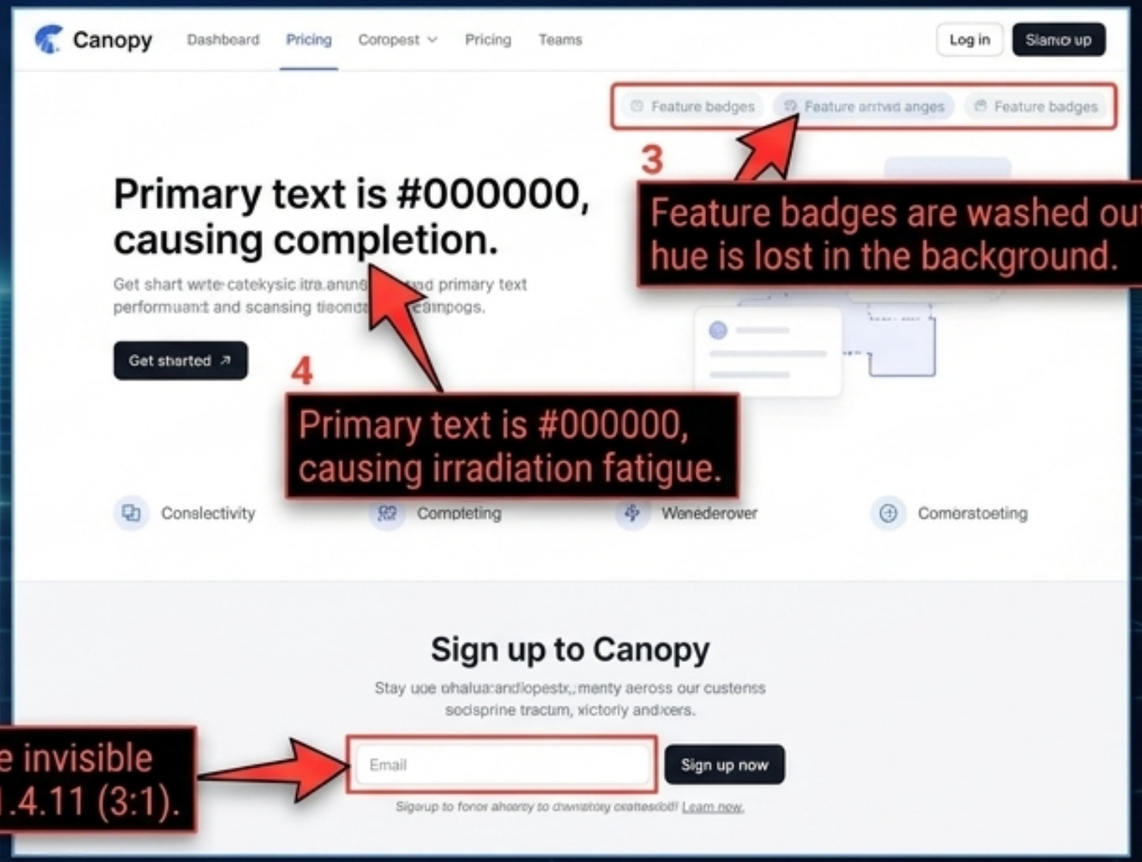
WCAG 1.4.1 Use of Color: Never rely on color alone. Map out non-color signifiers—icons, underlines, patterns, and border weights—so the UI survives perfectly regardless of retinal hardware.

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Live Canopy Transformation

Canopy UI — The Audit



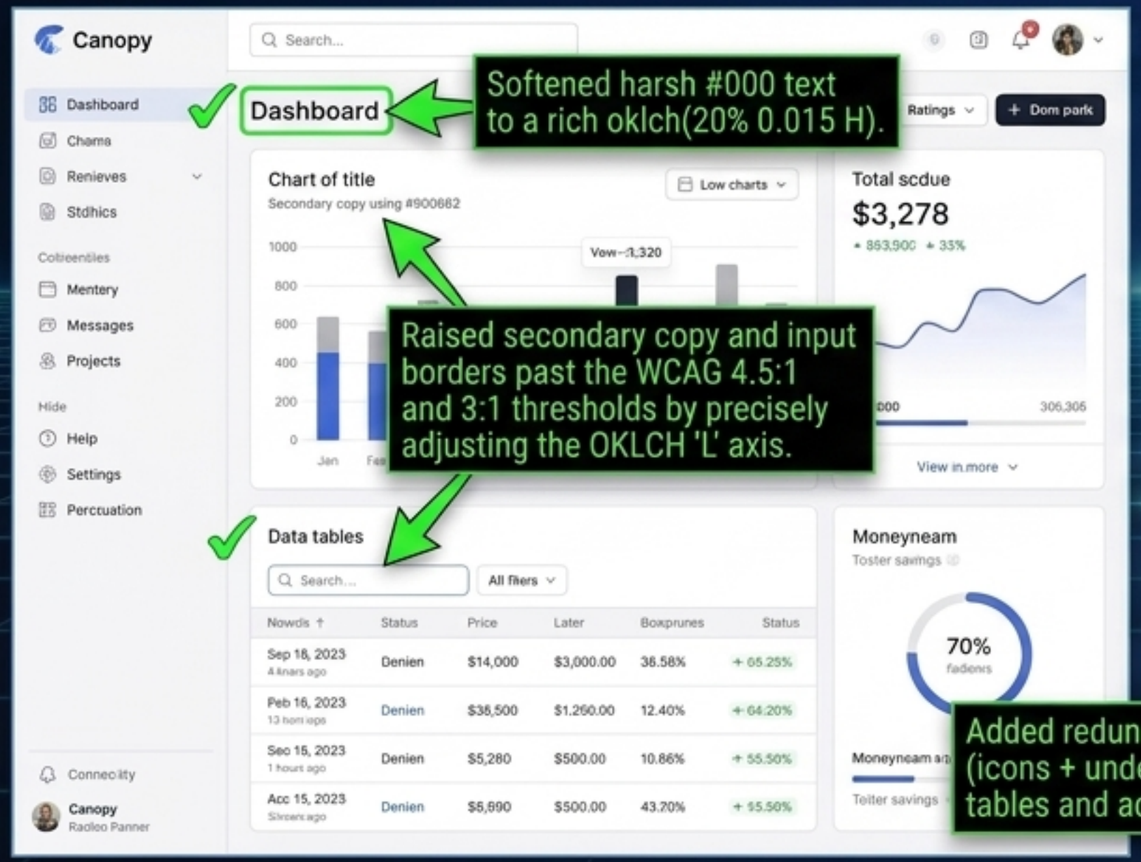


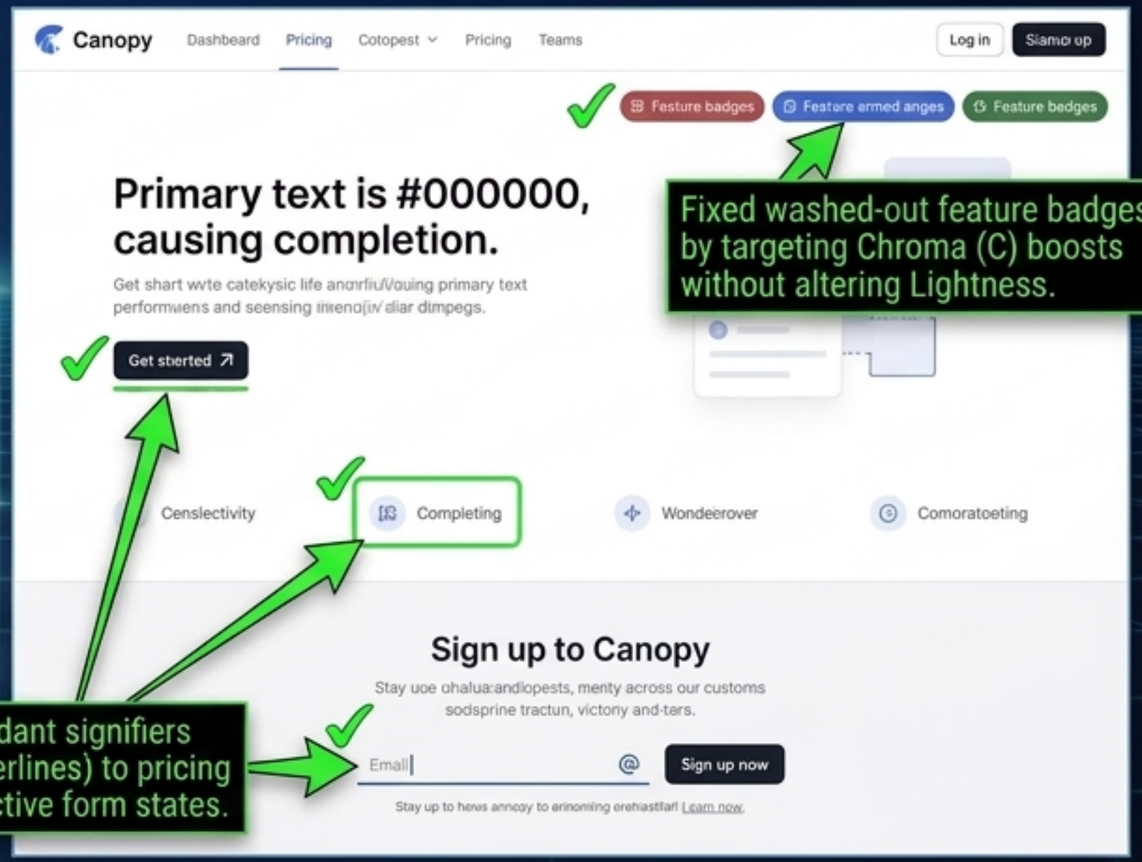
The layout, spacing, and typography of Canopy are **excellent**. The failures are entirely perceptual and mathematical.

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Canopy UI — The Perceptual Pass

Canopy UI — Perfect In.





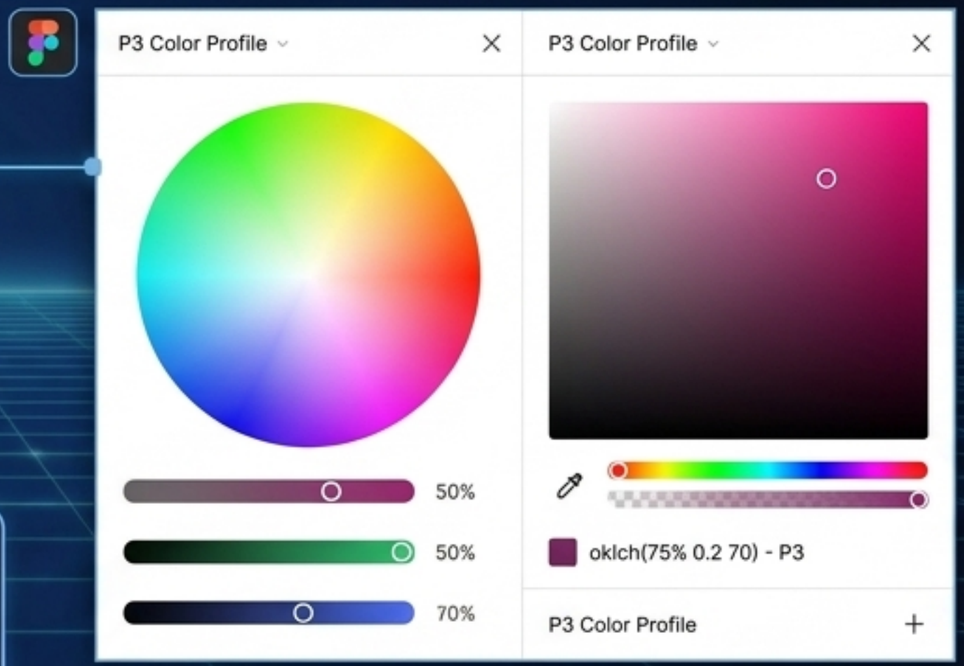
The layout, spacing, and typography of Canopy are **excellent**. The failures are entirely perceptual and mathematical.

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Focused 15-Minute Hands-On Exercise

The Builders & oklch() Challenge

```css
.button-primary {
    background-color: oklch(75% 0.2 70);
    color: white;
}
.badge-subtle {
    background-color: oklch(90% 0.1 140);
    color: oklch(50% 0.2 140);
}
```



The Recipe Card



The Exercise: Open oklch.com, Figma, Webflow, or your CSS editor. Take raw yellow/amber, emerald, and cobalt hues.

The Goal: Craft three primary button & subtle-badge pairs that have identical perceived lightness across all three hues.

The Validation Checklist:

- ☐ Passes WCAG 2.2 AA (4.5:1 background contrast)
- ☐ Hits APCA Lc >= 60 for the button label
- ☐ Survives Chrome DevTools Deuteranopia and Protanopia emulation perfectly.

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Quantified Reference Sheet & Next Up

The Master Data Matrix

Color Function / Token	Lightness (L): OKLCH Coordinate Ranges	Chroma (C): & Context / Rationale
Canvas/Backgrounds	Lightness (L): 95–99%	Chroma (C): 0.005–0.015
UI Borders / Dividers	Lightness (L): 80–85%	(Ensures 3:1 WCAG 1.4.11 pass against Canvas)
Muted / Secondary Copy	Lightness (L): 45–55%	(Ensures 4.5:1 WCAG pass against Canvas)
Ink Text / Primary	Lightness (L): 15–25%	(Reduces halation fatigue, avoids pure 0%)

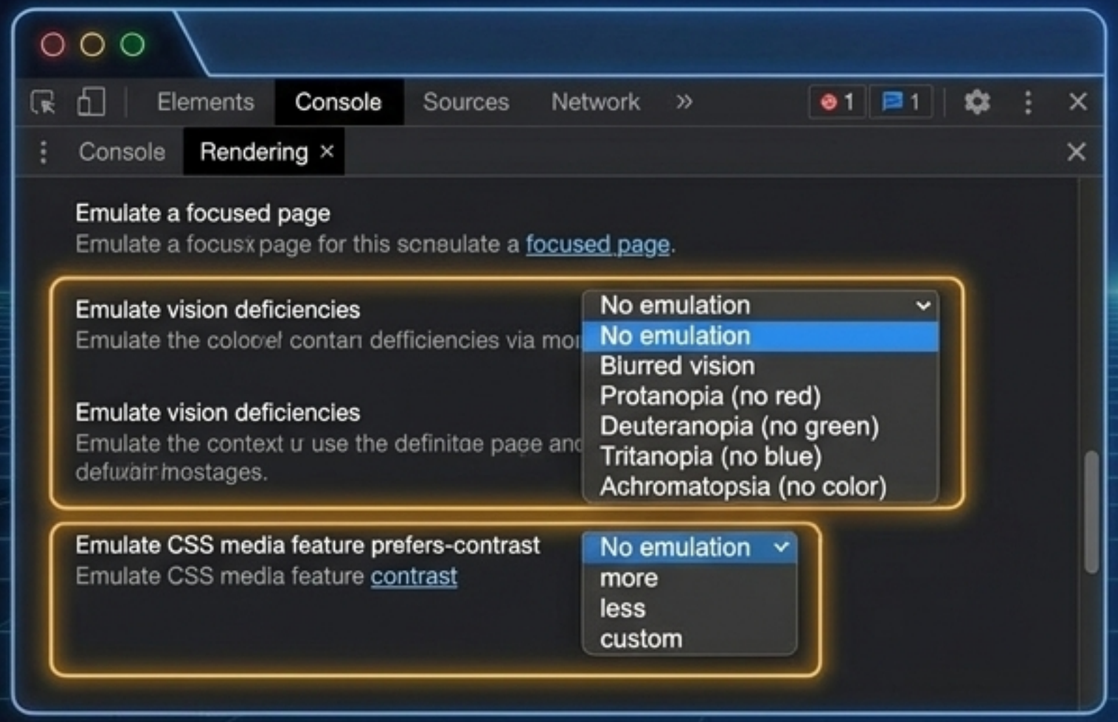
Quick-reference lookup floors

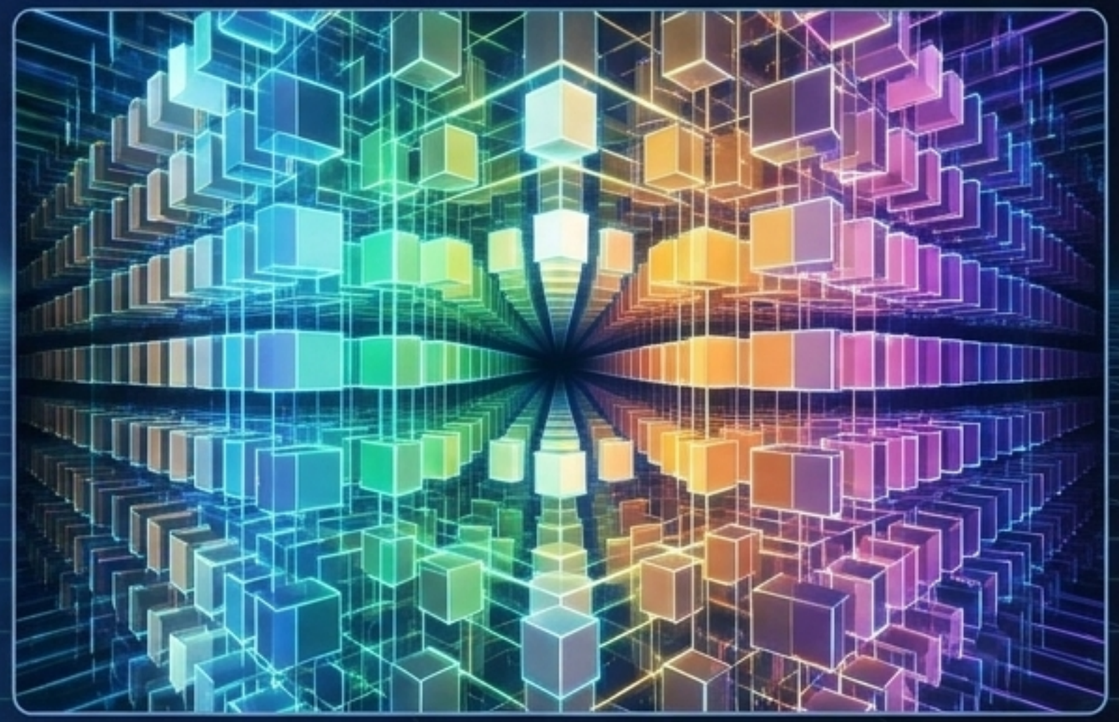
APCA targets: Lc 90 (Body) / Lc 60 (Headlines) / Lc 45 (UI) | **WCAG 2.2 targets:** 4.5:1 (Normal Text) / 3:1 (Large Text / UI)

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Developer Shortcuts & Next Up

The Spectrum Laboratory Global style





The Tooling: Don’t guess. Use Chrome DevTools (Rendering Tab) to natively audit contrast curves, emulate Daltonism, and test prefers-color-scheme in real-time on your DOM.

Coming in S09E03: We take these perceptual truths and architect a fully automated, semantic 50–950 theme scale and resilient Dark Mode architecture. Building a Colour Scheme.

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