



TEAM *of* ART

HOW TO ADAPT COLOURS FOR PEOPLE WITH VISUAL PROBLEM

General Objective

The aim of this practical sheet is to make works of art accessible to everyone.

- ✓ To promote individual and collective awareness of visual impairments.
- ✓ To enable social integration.
- ✓ To improve the quality of life for the visually impaired community.

You will need:

- ✓ A computer with internet access.

Challenges and issues

People that have colour blindness, or better said colour vision deficiency, suffer from a group of conditions that affect the perception of colour. Colour vision deficiency is inherited as it is usually passed on to a child by their parents and is present from birth, although sometimes it develops later in life.

There are many types of colour vision deficiency. The most severe one is colour blindness, also called monochromacy, and you cannot see colours at all and it is very uncommon.

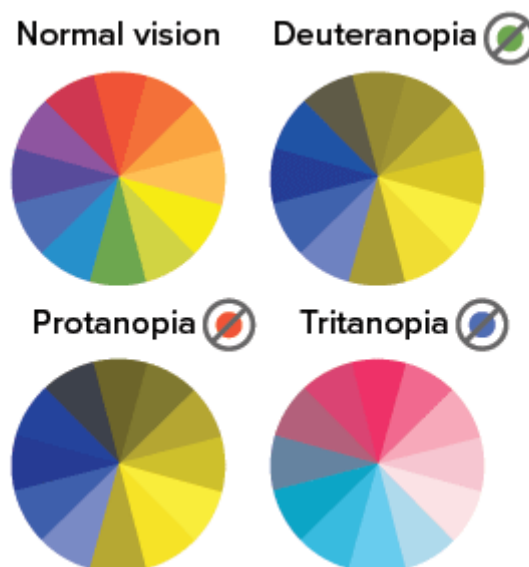


The most common type of color blindness is the red-green color blindness and makes it hard to tell the difference between these two colours. There are 4 types of red-green color blindness:

- Deuteranomaly is the most common one. It makes green look more red.
- Protanomaly makes red look more green and less bright.
- Protanopia and deuteranopia both make you unable to tell the difference between red and green at all.

This less-common type of color blindness makes it hard to distinguish blue and green, and yellow and red. There are 2 types of blue-yellow color blindness:

- Tritanomaly makes it hard to distinguish blue and green, and yellow and red.
- Tritanopia makes you unable to distinguish blue and green, purple and red, and yellow and pink. It also makes colors look less bright.



All six of these types of color vision deficiency stem from one of the three cone types not functioning to some degree. Though people with these problems may have some trouble selecting fruit, reading traffic lights... most people with color vision deficiency adapt to live normal lives. Sometimes with some

additional help, many things can be better as we are going to see in this practical sheet. Monochromacy, on the other hand, can be quite challenging.













Adaptation

Design systems are often thought of as a way to improve accessibility. But, first, it's important that we understand the disabilities that people may have. For users, these disabilities can be permanent, temporary, or situational.

For these reasons, it is important to:

✓ Accessible or inclusive design:

It focuses on making products consumable by people with disabilities.

	Permanent	Temporary	Situational
Touch	 One arm	 Arm injury	 New parent
See	 Blind	 Cataract	 Distracted driver
Hear	 Deaf	 Ear infection	 Bartender
Speak	 Non-verbal	 Laryngitis	 Heavy accent

Inclusive
A Microsoft Design Toolkit

✓ Focus on contrast

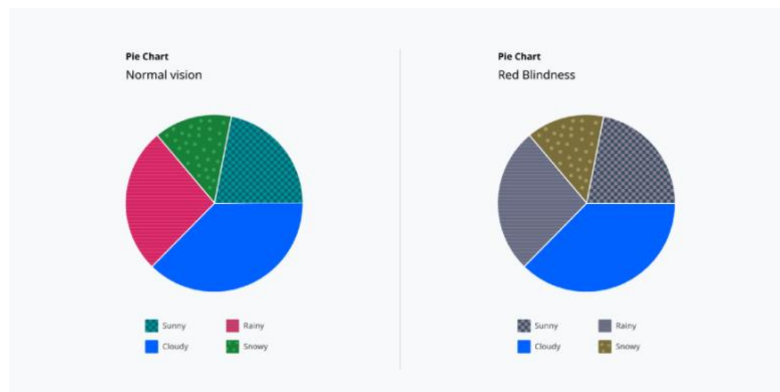
Contrast is a key factor in designing accessible interfaces.

Sufficient brightness contrast between elements allows people to distinguish them. This is especially important when placing text or icons on a background colour.

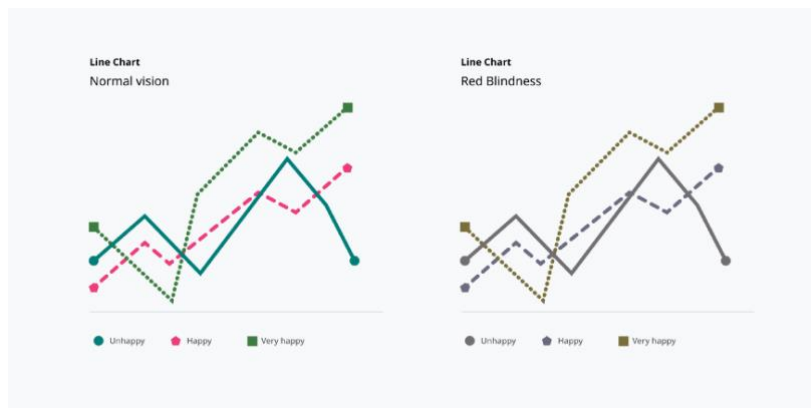
✓ Optimistic infographics

The main goal is to make lines and fills distinguishable. First, we need to choose colours with a high contrast for people with red-green colour blindness. But colours should not be the only difference.

For diagrams, you can use patterns in addition to coloured fills. This will make the diagrams distinguishable even when converted to greyscale.



For line charts we can use line styles like dotted, dashed and soft to differentiate them. Adding shapes to the start, end and intermediate points helps to associate lines with labels.



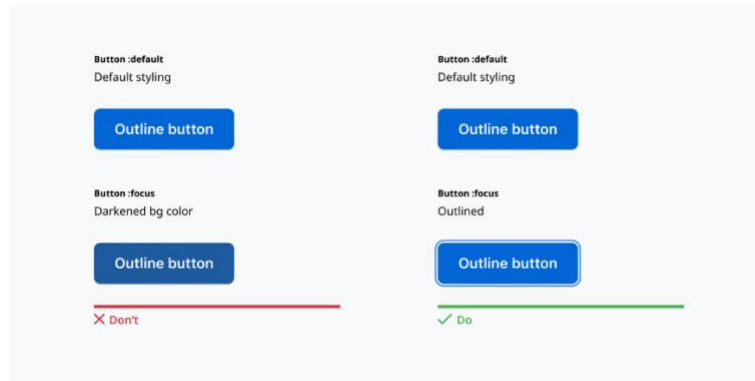
✓ Avoid bright colours

Bold combinations create what is called an «afterimage». This interferes with other colours and causes visual vibrations. The visual vibrations can be a problem for everyone.



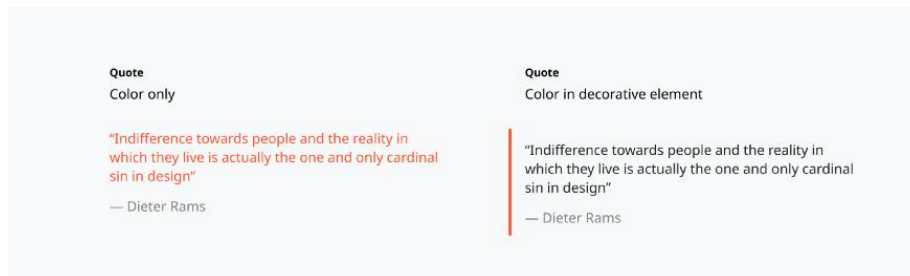
✓ State of focus

This is the element that users interact with when they press the return key. Navigating with the keyboard is basically like jumping between focus states. For this reason, it is important that the focus is clearly distinguishable. A colour alone is often not enough. It is also important to outline the focused element with a strong contour.



✓ Hierarchy

You need to use font size, style, capitalization, white space and indentation for different headings. The size can be helpful.



In conclusion, it is important to consider the next steps:

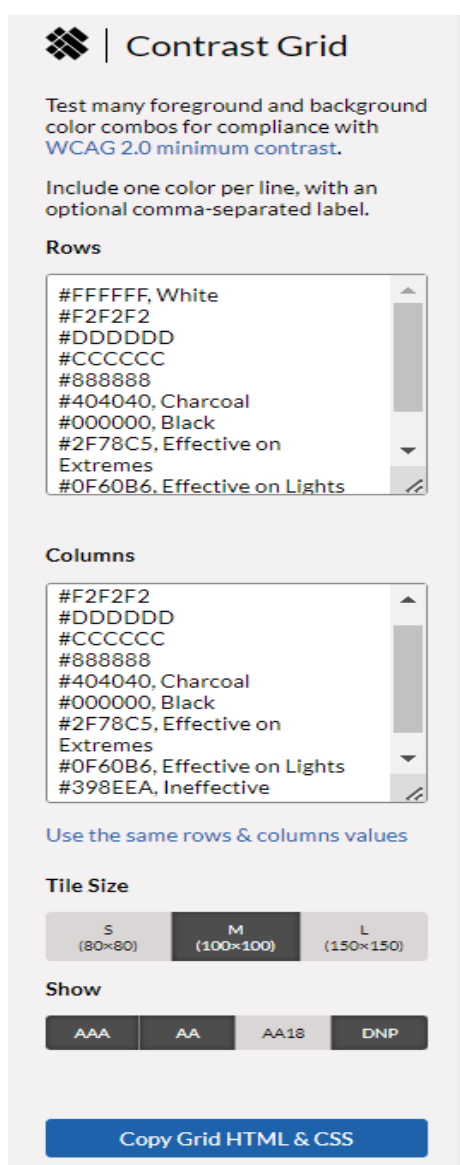
- Do not rely on colour alone to convey any meaning or function.
- Make sure there is enough contrast when choosing colours.
- Use patterns and shapes for infographics.
- Avoid bright colour combinations.
- Use alternative visual clues for states, interactive elements, and for pointing.

The following tools are a good start to working on inclusion, but we believe the, first step should be to try to humanise the people affected by the various disabilities.

You can also use accessible widgets: such as **The UserWay Accessibility Widget**.

Practical examples and inspiration

- **Contrast Grid:**



The screenshot shows the 'Contrast Grid' tool interface. It includes a title, a description of the tool's purpose (testing foreground and background color combos for WCAG 2.0 compliance), and instructions on how to use it (one color per line). There are two scrollable lists: 'Rows' and 'Columns'. The 'Rows' list contains: #FFFFFF, White; #F2F2F2; #DDDDDD; #CCCCCC; #888888; #404040, Charcoal; #000000, Black; #2F78C5, Effective on Extremes; #0F60B6, Effective on Lights. The 'Columns' list contains: #F2F2F2; #DDDDDD; #CCCCCC; #888888; #404040, Charcoal; #000000, Black; #2F78C5, Effective on Extremes; #0F60B6, Effective on Lights; #398EEA, Ineffective. Below the lists are options for 'Tile Size' (S: 80x80, M: 100x100, L: 150x150) and 'Show' (AAA, AA, AA18, DNP). A 'Copy Grid HTML & CSS' button is at the bottom.

The goal of this website is to create sufficient contrast between text and background so that it can be read by people with moderate vision.

Colour deficits may affect the luminance contrast somewhat. Therefore, the contrast is calculated so that colour does not matter, so that even people with colour vision deficiencies have sufficient contrast between text and background.

Contrast Grid

Test many foreground and background color combos for compliance with WCAG 2.0 minimum contrast.

Include one color per line, with an optional comma-separated label.

Rows & Columns

#FFFFFF, White
#F2F2F2
#DDDDDD
#CCCCCC
#888888
#404040, Charcoal
#000000, Black
#2F78C5, Effective on Extremes
#0F60B6, Effective on Lights
#398EEA, Ineffective

Use distinct rows & columns values

Tile Size

S (80x80) M (100x100) L (150x150)

Show

AAA AA AA18 DNP

Copy Grid HTML & CSS

Tweet My Grid

By Eightshapes • On Github

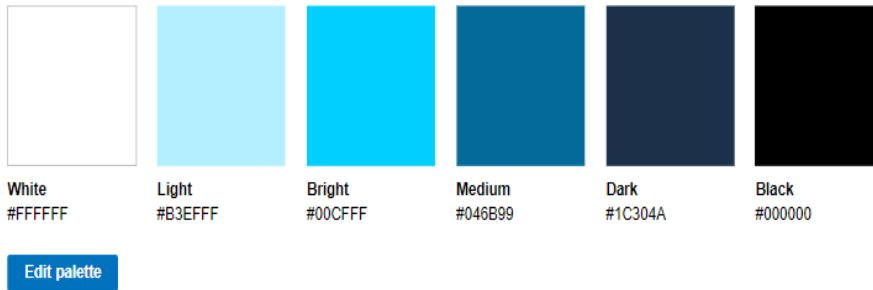
Background \ Text	#FFFFFF	#F2F2F2	#DDDDDD	#CCCCCC	#888888	#404040	#000000	#2F78C5	#0F60B6	#398EEA
White #FFFFFF	Text	DNP 1.1	DNP 1.3	DNP 1.6	AA18 3.5	AAA 10	AAA 21	AA 4.5	AA 6.2	AA18 3.3
#F2F2F2	DNP 1.1	Text	DNP 1.2	DNP 1.4	AA18 3.1	AAA 9.2	AAA 18.7	AA18 4	AA 5.5	AA18 3
#DDDDDD	DNP 1.3	DNP 1.2	Text	DNP 1.1	DNP 2.6	AAA 7.6	AAA 15.4	AA18 3.3	AA 4.5	DNP 2.4
#CCCCCC	DNP 1.6	DNP 1.4	DNP 1.1	Text	DNP 2.2	AA 6.4	AAA 13	DNP 2.8	AA18 3.8	DNP 2.1
#888888	AA18 3.5	AA18 3.1	DNP 2.6	DNP 2.2	Text	DNP 2.9	AA 5.9	DNP 1.2	DNP 1.7	DNP 1
Charcoal #404040	AAA 10	AAA 9.2	AAA 7.6	AA 6.4	DNP 2.9	Text	DNP 2	DNP 2.2	DNP 1.6	AA18 3
Black #000000	AAA 21	AAA 18.7	AAA 15.4	AAA 13	AA 5.9	DNP 2	Text	AA 4.6	AA18 3.3	AA 6.2
Effective on Extremes #2F78C5	AA 4.5	AA18 4	AA18 3.3	DNP 2.8	DNP 1.2	DNP 2.2	AA 4.6	Text	DNP 1.3	DNP 1.3
Effective on Lights #0F60B6	AA 6.2	AA 5.5	AA 4.5	AA18 3.8	DNP 1.7	DNP 1.6	AA18 3.3	DNP 1.3	Text	DNP 1.8
Ineffective #398EEA	AA18 3.3	AA18 3	DNP 2.4	DNP 2.1	DNP 1	AA18 3	AA 6.2	DNP 1.3	DNP 1.8	Text

In the left part you can specify a colour for each line, optionally separated by a comma. Then, you can choose the rows and columns. Then, you can change the size and show.

- **Accessible palette builder:**

Accessible platform allows to know the levels of compliance with the ADA and levels and accessibility levels. In addition, to assess needs and adapt them.

Accessible color palette builder



White #FFFFFF

Light #B3EFFF

Bright #00CFFF

Medium #046B99

Dark #1C304A

Black #000000

Edit palette

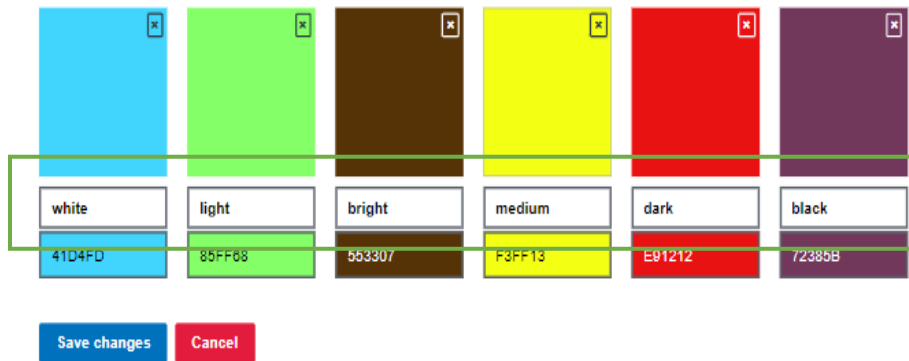
Accessible color combinations

Please don't use these color combinations; they do not meet a color contrast ratio of 4.5:1, so they do not conform with the standards of Section 508 for body text. This means that some people would have difficulty reading the text. Employing accessibility best practices improves the user experience for all users.

	White text #FFFFFF Aa	Light text #B3EFFF Aa	Bright text #00CFFF Aa	Medium text #046B99 Aa	Dark text #1C304A Aa	Black text #000000 Aa
Black background #000000	Aa	Aa	Aa			
Dark background #1C304A	Aa	Aa	Aa			
Medium background #046B99	Aa	Aa				
Bright background #00CFFF					Aa	Aa
Light background #B3EFFF				Aa	Aa	Aa
White background #FFFFFF				Aa	Aa	Aa

You can change the white, lightness, brightness, size, darkness and black in the palette builder. Then, the combination will change.

Accessible color palette builder



It is important to save the changes by clicking here:

Accessible color palette builder



Below are the accessible colour combinations:

Accessible color combinations

Please don't use these color combinations; they do not meet a color contrast ratio of 4.5:1, so they do not conform with the standards of Section 508 for body text. This means that some people would have difficulty reading the text. Employing accessibility best practices improves the user experience for all users.

	White text #41D4FD Aa	Light text #85FF68 Aa	Bright text #553307 Aa	Medium text #F3FF13 Aa	Dark text #E91212 Aa	Black text #72385B Aa
Black background #72385B	Aa	Aa		Aa		
Dark background #E91212						
Medium background #F3FF13			Aa			Aa
Bright background #553307	Aa	Aa		Aa		
Light background #85FF68			Aa			Aa
White background #41D4FD			Aa			Aa

- **Whocanuse:**

It's a tool that brings attention and understanding to how colour contrast can affect different people with visual impairments.

First, they figure out the contrast between two HEX values. For this they are using a plugin called *Chroma.js* - this does the heavy lifting for them. Once they have the ratio (and using font size and font-weight), they can apply a grade to that specific colour combo.

For the colour blindness options, they are using another plugin aptly called *Color-blind*. It converts their HEX codes into ones that would be seen by people with different impairments. Then they can apply the same process to obtain the colour ratios and determine the grade of people with this disability. Then, you can see different cases.

Depending on the levels you choose in the colour palette, the contrast ratio and the WCAG rating will vary. In the example below, you can see that the chosen colours have a good level as "AAA" appears as a result of the evaluation. In addition, this website also allows you to see the percentage of

impairment according to visual impairment. Furthermore, you can see how the affected person sees the original colour tone.

Who can use this color combination?

CONTRAST RATIO: **8.41:1** WCAG GRADING: **AAA**

POPULATION	VISION TYPE	SIMULATION
68%	Regular Vision (Trichromatic) AA Can distinguish all three primary colors (due to no blindness)	Text
1.3%	Protanomaly AA Trouble distinguishing reds	Text
1.5%	Protanopia AA Red blind - Can't see reds at all	Text
5.3%	Deuteranomaly AA Trouble distinguishing greens	Text
1.2%	Deuteranopia AA Green blind - Can't see greens at all	Text
0.02%	Tritanomaly AA Trouble distinguishing blues	Text
<0.03%	Tritanopia AA Blue blind - Can't see blues at all	Text
<0.1%	Achromatomaly AA Partial color blindness: sees the absence of most colors	Text
<0.1%	Achromatopsia AA Complete color blindness: can only see shades	Text
33%	Cataracts AA Clouding of the lens in the eye that affects vision	Text
2%	Glaucoma AA Sight/vision loss	Text
31%	Low Vision AA Decreased and/or blurry vision (not fixable by usual means such as glasses)	Text

In this case, the colours change and the percentage and evaluation too. Now we have "AA" in the WCAG grading.

Who can use this color combination?

CONTRAST RATIO: **5.66:1** WCAG GRADING: **AA**

POPULATION	VISION TYPE	SIMULATION
68%	Regular Vision (Trichromatic) AA Can distinguish all three primary color (due to no blindness)	Text
1.3%	Protanomaly AA Trouble distinguishing reds	Text
1.5%	Protanopia AA Red blind - Can't see reds at all	Text
5.3%	Deuteranomaly AA Trouble distinguishing greens	Text
1.2%	Deuteranopia AA Green blind - Can't see greens at all	Text
0.02%	Tritanomaly AA Trouble distinguishing blues	Text
<0.03%	Tritanopia AA Blue blind - Can't see blues at all	Text
<0.1%	Achromatomaly AA Partial color blindness: sees the absence of most colors	Text
<0.1%	Achromatopsia AA Complete color blindness: can only see shades	Text
33%	Cataracts AA Clouding of the lens in the eye that affects vision	Text
2%	Glaucoma AA Sight/vision loss	Text
31%	Low Vision AA Decreased and/or blurry vision (not fixable by usual means such as glasses)	Text

Finally, we find a fail case.

The screenshot shows the 'who can use' tool interface. On the left is a preview of a website with a green background and white text. On the right, a table titled 'Who can use this color combination?' displays the results for a 2.21:1 ratio. The table is categorized by 'POPULATION' and 'VISION TYPE'. The overall result is a 'FAIL'.

POPULATION	VISION TYPE	PERCENTAGE	DESCRIPTION	SIMULATION
68%	Regular Vision (Trichromatic)	Can distinguish all three primary color. Able to see business.	Test	
1.3%	Protanomaly	Trouble distinguishing reds.	Test	
1.5%	Protanopia	Red blind - Can't see reds at all.	Test	
5.3%	Deuteranomaly	Trouble distinguishing greens.	Test	
1.2%	Deuteranopia	Green blind - Can't see greens at all.	Test	
0.02%	Tritanomaly	Trouble distinguishing blues.	Test	
<0.03%	Tritanopia	Blue blind - Can't see blues at all.	Test	
<0.1%	Achromatomaly	Partial color blindness. Lacks the essence of most colors.	Test	
<0.1%	Achromatopsia	Complete color blindness. Can only see shades.	Test	
33%	Cataracts	Clouding of the lens in the eye that affects vision.	Test	
2%	Glaucoma	Sight vision loss.	Test	
31%	Low Vision	Decreased and/or blurry vision that results by visual means such as glasses.	Test	

The grading uses a combination of colour contrast, text size and text weight. A fail simply means that the colour combination offers some visual strain to the person seeing it and should be avoided if possible.

Additional resources

<https://uxdesign.cc/design-system-accessibility-color-26834083a3a2>

<https://accessibility.blog.gov.uk/2016/06/17/colour-contrast-why-does-it-matter/>

<https://whocanuse.com/>

<https://toolness.github.io/accessible-color-matrix/>

