Colourblind-friendly communication

Checklist, guidelines and resources

Checklist

- Is the communication relying upon the contrast between colours?
  Certain colour combinations can undermine accessibility, check if the communication relies upon the contrast between colours.

- Are these colours accessible for all colour vision deficiency (CVD) types?
  If the communication relies upon the contrast between colours, check if these are accessible to all the CVD types using a colourblind simulator.

- Can the inaccessible colour combinations be replaced with an accessible colour scheme?
  Accessible colour schemes can be picked using ColourBrewer, iWantHue or other resources.

- Do symbols and patterns have to be used in combination with colour schemes?
  If some colour combinations cannot be replaced, use symbols and/or patterns to guarantee accessibility.

Awareness

Around 1 in 200 women and 1 in 12 men worldwide are affected by some type of colour vision deficiency (CVD) or colour blindness. This means that roughly 8% of the population can perceive visual communication differently than it was intended to be and experience discomfort when important information is communicated through certain colour combinations.

There are four main types of CVD. Deuteranopia is a red-green type of colourblindness that affects around 6% of the population. Protanopia is another form of red-green type of colourblindness that affects roughly 1% of the population. Tritanopia is a very rare type of colourblindness that generally makes greens and blues hard to be distinguished. The complete inability to distinguish different colour is called monochromacy, or total colour blindness, and it is extremely rare. The following table shows a simulation of the effect of these four main types of CVD, obtained using Color Oracle.

<table>
<thead>
<tr>
<th>Trichromacy</th>
<th>Deuteranopia</th>
<th>Protanopia</th>
<th>Tritanopia</th>
<th>Monochromacy</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Trichromacy" /></td>
<td><img src="image" alt="Deuteranopia" /></td>
<td><img src="image" alt="Protanopia" /></td>
<td><img src="image" alt="Tritanopia" /></td>
<td><img src="image" alt="Monochromacy" /></td>
</tr>
</tbody>
</table>
There are a few simple things that we can do to make sure that our communication is inclusive, such as choosing accessible colour schemes and palettes and relying on symbols and patterns. This does not mean that inclusive communication cannot be colourful, but rather that we should make sure that important information is available and easily accessible also to those affected by colourblindness.

This document provides a concise summary of the things that we can do to make sure that our communication is inclusive, together with some useful resources to help in the process and list of references for further readings on colourblindness and colour perception.

**Guidelines**

Avoiding certain colour combination is often the most important step to do to guarantee accessibility. The following colour combinations are generally bad for at least one type of CVD.

<table>
<thead>
<tr>
<th>Colour Combination</th>
<th>Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green - Red</td>
<td>Deuteranopia, Monochromacy</td>
</tr>
<tr>
<td>Green - Brown</td>
<td>Deuteranopia, Protanopia, Monochromacy</td>
</tr>
<tr>
<td>Green - Blue</td>
<td>Tritanopia, Monochromacy</td>
</tr>
<tr>
<td>Light Green - Yellow</td>
<td>Prostanopia, Monochromacy</td>
</tr>
<tr>
<td>Blue - Purple</td>
<td>Deuteranopia, Protanopia, Monochromacy</td>
</tr>
<tr>
<td>Blue - Grey</td>
<td>Monochromacy</td>
</tr>
<tr>
<td>Green - Grey</td>
<td>Monochromacy</td>
</tr>
<tr>
<td>Blue - Black</td>
<td>Monochromacy</td>
</tr>
</tbody>
</table>

It's hard to keeping track of all the possible bad colour combinations, so it is often more convenient to pick a palette from a colourblind friendly colour scheme collection or generator. A great tool to test colour schemes is ColorBrewer, a web utility originally developed for cartography by Cynthia Brewer and Mark Harrower (Pennsylvania State University).

Relying on symbols and patterns is a great way to guarantee accessibility when certain colour combinations cannot be avoided, especially because it is often difficult to obtain a colour scheme that is universally accessible across all the different CVD types.

A great example of colourful yet inclusive communication is given by the Exciton Science minigame Power Match from the "It’s on like Excitont" series. In this matching game, the relevant information required to win is encoded in the colour and in the symbols used to represents the quantum dots. The following figure shows an original game screen frame.
The table below shows a simulation of the same game screen for the main different CVD types. If the quantum dots were only differentiated by the use of different colours it would be very hard to tell them apart for people affected by Deuteranopia, and virtually impossible for those affected by Protanopia. Using different symbols allows for the game to be played by everyone.
Resources

Colourblind Simulators

Colourblind simulation is a very useful and widespread tool to check if visual communication is inclusive. While the simulation does not represent the way the images are perceived by someone affected by CVD, it provides a good representation of the information that is accessible to that individual. There are plenty of colourblind simulation software solutions, and most of them are free. Firefox browser, for example, already has an integrated colourblind simulator that can be found in its accessibility menu.

- **Color Oracle**: Free multiplatform software to simulate the four main types of colourblindness, available for Mac OS, Windows and Linux.
- **Colorblinding**: Free browser extension to simulate colourblindness.
- **Dalton**: Colorblind - Dalton is a Google Chrome browser extension to simulate colourblindness, by colorblind.tech.
- **Let's get color blind**: Firefox browser extension to simulate colourblindness, by Nullbrains.

Further readings on colour blindness

Colblindor - color-blindness.com
Colour Blind Awareness

Colour perception and human-friendly colour spaces

Beyond inclusive practices, a better understanding of colour perception can improve visual communication. The following links include general information about colour perception, colour maps for data visualisation, and different choices for human-friendly colour spaces.
- **Color Universal Design**
- **iWantHue** - Colour scheme generator optimized for data visualisation, with colourblind-friendly settings.
- **Perceptually accurate colour maps**
- A collection of perceptually accurate colour maps is available on [Matplotlib](https://matplotlib.org) for Python
- Human-friendly colourspace alternatives: HSLuv ([HSLuv comparison sheet](https://matplotlib.org/3.1.1/users/colormaps.html))
- **Colour palette generator**
- [Book] Edward Tufte, *The visual display of quantitative information* ([link](https://www.edwardtufte.com))

**References**

Colblindor - [color-blindness.com](http://color-blindness.com)
National Eye Institute - Color Blindness
[Colour Blind Awareness](https://www.colour-blind.com)

**Acknowledgments**

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