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New Colours for Autonomous Driving: An Evaluation of Chromaticities for the External Lighting Equipment of Autonomous Vehicles

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Abstract

Colour is an important medium of non-verbal communication in nature as well as in human civilisation. Colour signals are prominent in road-, railway- and air-traffic and lighting/light-signalling on vehicles is carefully regulated by international institutions (UNECE, SAE). The introduction of AI and autonomous mobility requires the identification of new colour regions for the labelling of autonomous vehicles (AVs). The present study evaluates colour regions for their suitability to that respect: Daimler proposal Turquoise, Selective Yellow, Mint-Green and Purple/Magenta. The evaluation takes into account physiological and psychological factors such as human chromatic sensitivity, colour vision deficiencies, attractiveness and expected uniqueness. The evaluation concludes that, overall, Turquoise receives higher ratings in most criteria than Selective Yellow, Mint-Green, and Purple/Magenta: Turquoise is therefore rated as the colour best suited for the identification of autonomous cars and human – automobile communication. A recommendation is given to adjust the chromaticities of the proposed Turquoise in order to optimise discrimination from standard daylight D65.

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Introduction

In the wake of introducing artificial intelligence (AI) and autonomous mobility, a reliable and intuitive human-machine communication will be of utmost importance. Colour will play an important role in this context, since it presents an additional dimension in our visual world, carrying crucial information about the environment. In crowded scenes like those often encountered in busy urban environments (Fig. 1), colour enables us to detect and recognise objects fast and reliably;[1] it significantly enhances their saliency and is a major factor for guiding our attention.[2] Self-luminous colour signals can be identified quickly even from far distances and are therefore employed in road-, railway- and air-traffic. Since colour can be quickly recognised independently of visual acuity, colour signals are also important indicators for people with impaired vision.

Fig. 1 New York street scenes. Photos: Max Whitfield; private collection, 2018

[1] James W. Tanaka, and Lynn M. Presnell. ‘Color diagnosticity in object recognition.’ *Perception & Psychophysics*, 61 (1999): 1140-1153; Cathrine Jansson, Nigel Marlow & Matthew Bristow. ‘The influence of colour on visual search times in cluttered environments’, *Journal of Marketing Communications*, 10, no. 3 (2004): 183-193. DOI: 10.1080/1352726042000207162; Werner, Annette ‘Robust Colour in Complex Scenes’, habilitation treatise, 2017. https://annettewerner.com.

[2] Jeremy M. Wolfe and Todd S. Horowitz. ‘What attributes guide the deployment of visual attention and how do they do it?,’ *Nature Reviews Neuroscience* 5, (2004): 495–501.

Not surprisingly, colour plays a major role in advertisement and, owing to its excellent memorability[3] and symbolic character, colour is often an integral part of logos for companies, parties, clubs, official institutions, etc. The fact that colour can evoke strong associations and emotions is a trait used in neuromarketing[4] since many years, whereby variations of colour preferences exist between cultures, gender and age of the observers.[5] .

Being non-verbal and intuitive, colour signals are already omnipresent in everyday life: for example, the universal markers for warm (red) and cold (blue) water on water-taps use an intuitive association of temperature and colour; in road-, shipping-, and air-traffic, signs for danger warning (typically yellow or red & black), prohibitive and mandatory signs (often red), as well as information signs (often blue or green) are reinforced by colours, which are either intuitive or are readily learnt.

Colour specifications for external colour signals on motor vehicles are controlled and regulated by standards set by the UNECE[6] (United Nations Economic Commission for Europe) and the SAE[7] (Society of

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[3] Felix Wichmann, Lindsay T. Sharpe, and Karl R. Gegenfurtner, 'The contributions of color to recognition memory for natural scenes,' *Journal of Experimental Psychology: Learning, Memory and Cognition* 28, (2002): 509-520.

[4] Li-Chen Ou, Luo M. Ronnier, Andrée Woodcock, and Angela Wright, 'A study of colour emotion and colour preference. Part I: Colour emotions for single colours,' *Color Research & Application* 29, no. 5, (2004): 381-389. https://doi.org/10.1002/col.20010; Patrick M. Georges, Anne-Sophie Bayle-Tourtoulou, and Michel Badoc, *Neuromarketing in Action: How to Talk and Sell to the Brain* (London, Philadelphia: Kogan page, 2014).

[5] Manuela Dittmar. 'Changing Colour Preferences with Ageing: A Comparative Study on Younger and Older Native Germans Aged 19–90 Years.' *Gerontology*, 47, (2001): 219–226. https: DOI:10.1159/000052802; Anya C. Hurlbert and Yazhu Ling. 'Biological components of sex differences in color preference,' *Current Biology*, 17 no. 16, (2007): R624. https:// doi.org/10.1016/j.cub.2007.06.022; Chloe Taylor, Alexandra Clifford, and Anna Franklin, 'Color preferences are not universal.' *Journal of Experimental Psychology: General* 142, no. 4, (2013): 1015-1027. http://dx.doi.org/10.1037/a0030273; Kazuhiko Yokosawa, Natsumi Yano, Karen B. Schloss, Lilia R. Prado-Leòn, Stephen, E. Palmer. 'Cross-Cultural Studies of Color Preferences: US, Japan, and Mexico.' *Journal of Vision* 10, no. 7, (2010): 408, 408a, DOI:10.1167/10.7.408; Erika Kumakura, Annette Werner, and Kazuhiko Yokosawa. 'Effect of imagining another culture on color preference.' *Journal of Vision* 18.10 (2018): 866-866.

[6] United Nations Economic Commission for Europe: www.unece.org.

[7] Society for Automotive Engineers: www.sae.org.

Automotive Engineers). Figure 2 shows the chromaticity limits for the specified colours *Red, Yellow (Amber), Selective Yellow*, and *Blue* (*Restricted/Signal Blue*) under the current SAE standards J578_201603[8] and UNECE regulations ece r-65[9].

New standards are also in the process to be developed for lighting and light-signalling of autonomous vehicles. For this purpose, the UNECEs World Forum for the Harmonization of Vehicle Regulations has recently established the new Working Party on Automated/Autonomous and Connected Vehicles (GRVA). Labelling of autonomous vehicles shall add to road and transport safety while also providing traffic participants (other motorists, cyclists and pedestrians alike) with more confidence in this new technology. In the past, the chromaticites of self-luminant colour signs was limited by the available light sources, such as incandescent lamps or fluorescent lamps, equipped with selectively transmitting (i.e. coloured) filters. Today, LEDs offer the opportunity to cover new colour regions for the identification and labelling of vehicles. An important goal will be therefore to identify a colour region suitable for signalling, i.e. a colour, which offers high visibility, is reliably and easily detectible, and can be well discriminated against other, already present signals.

The conceptualisation of according signals will have to take into account the properties of human visual perception as well as the impact of altered colour and contrast sensitivity (being a consequence of either inherited variations in sensitivity, ageing, pathological changes or medication). All of these aspects are important factors for the selection of a colour region suitable for the labelling and signalling of autonomous vehicles.

The present evaluation refers exclusively to the selection of a suitable colour region for labelling autonomous vehicle, not the other features of their presentation such as form, or positioning on the vehicle.

[8] See 'SAE J578_201603,' surface vehicle standard, color specification. SAE International, last modified March 11, 2016, http://www.sae.org/technical/standards/J578_201603.

[9] See 'UNECE regulations ece r-65,' UNECE, accessed December 7, 2011, https://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2011/r065r2e.pdf.

1. Goal of the study

1.1. The study shall provide information for selecting colours that are suitable for employment in autonomous cars, ensuring the traffic safety, i.e. exhibiting high visibility, reliable and quick detection and high discriminability against other existing signals (employed in other motor vehicles or present in the traffic environment).

1.2.The study focuses on physiological aspects and colourimetric considerations; it does not refer to the design and presentation of the colour signals. Characteristics of normal visual perception (spectral sensitivity across the visual field, contrast sensitivity) as well as altered chromatic sensitivity (inherited and acquired colour vision deficiencies) are taken into account.

1.3. For better comprehension, the perceptual colour names are used instead of a characterisation by wavelengths.

1.4. Colours are evaluated for application in external lighting equipment in motor vehicles, with respect to the following tasks:

- tell-tale lights for identification as autonomous car
- human-automobile communication (signalling by the vehicle).

1.5. The evaluation refers to a signalling system consisting of an array (width approx. 30 cm) of tunable LEDS (e.g. Red, Green, Blue, Yellow and White) which will produce static as well as dynamic signals (characteristics of the background are yet to be determined; the present expertise assumes a neutral background.

1.6. Criteria for the evaluation are:

- visibility/saliency
- discriminability against other light signals emitted by the car and traffic environment
- visibility and discriminability considering colour vision deficiencies
- attractiveness
- uniqueness

2. Choice of colours under consideration (Fig.2)

2.1. Colours already employed in mobile vehicles and/or reserved according to colour specification of SAE (J578)[10] and UNECE

[10] SAE, 'SAE J578_201603.'

(ece r-65)[11]: *Red, Yellow (Amber), Selective Yellow, Green, Restricted Blue, Signal Blue* and *White (Achromatic).*

2.2. Colours (colour regions) considered here for employment in autonomous cars: *Turquoise, Selective Yellow*, *Mint-Green*, and *Purple/Magenta.*

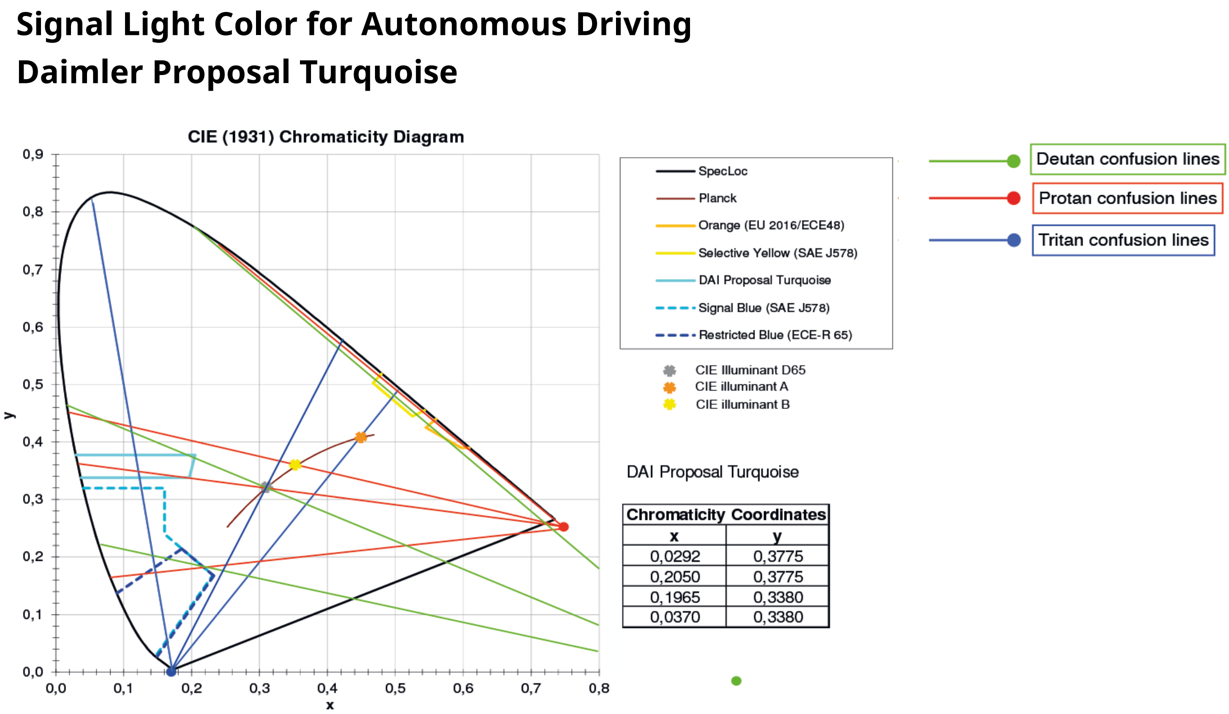

Figure 2. CIE[12] xy (1931) chromaticity diagram depicting colour regions under consideration.

Figure legend 2. CIE xy (1931) chromaticity diagram depicting colour regions of colours currently defined by SAE and UNECE standards, plus additional colour regions under consideration, including the Daimler proposal Turquoise for labelling autonomous cars. Solid, straight lines (red, green, and blue) indicate colour confusion axes[13] (protan, deutan, and tritan deficiencies, respectively). The grey line indicates colour loci of daylight. The black line denotes the loci of spectral colours, corresponding to the wavelengths of monochromatic lights (380 nm – 770 nm).

[11] UNECE regulations ece r-65.

[12] CIE Commission Internationale de l'Eclairage, http://www.cie.co.at.

[13] Lindsay T. Sharpe, et al. 'Opsin genes, cone photopigments, color vision, and color blindness,' in *Color Vision: From Genes to Perception*, eds. Karl Gegenfurtner and Lindsay T. Sharpe (Cambridge, UK: Cambridge University Press,1999), Fig. 1.12, 28.

3. Evaluation

3.1. Visibility/saliency and discrimination

Visibility/saliency and discriminability of the signal colours are considered in the presence of other signals employed in the vehicles as well as in the traffic environment (e.g. traffic lights (red, amber yellow, green), lights on vehicles (*Selective Yellow, Yellow (Amber), Red, White, Signal Blue*) and reflexions of these lights on glossy surfaces such as car coating, wet pavement etc., see Figure 2). Weather conditions such as rain, fog, and snow will also influence visibility, e.g. by causing light scatter or reducing overall light intensity.

Scatter increases with shorter wavelengths and therefore visibility of longer wavelength lights (*Selective Yellow, Mint-Green*) will be less degraded by rain and fog than visibility of shorter wavelength lights (i.e. *Turquoise, Purple/Magenta*).

Given the frequency of yellow, orange, red, green, and white lights in the traffic environment, *Turquoise* and *Purple/Magenta* are expected to possess the highest saliency. This means that these two colours will stand out against the majority of other lights and reflections in the field of view and will make autonomous cars and their signalling better identifiable.

Physiologically, visibility and discriminability will depend on chromatic/achromatic sensitivity and contrast sensitivity, all of which vary across the human retina and thus the visual field. Therefore, characteristics of the perception in the central and peripheral visual field need to be considered separately. The physiological properties of the human visual system as described below are based on findings reported in *The Visual Neurosciences*[14] and *Color Vision: From Genes to Perception*[15].

3.1.1. Visibility in the central visual field (inner 30 deg.)

For normal colour vision and central fixation, the photopic (vision in bright light, $L > 10$ cd/m^2) sensitivity of the human visual system is highest for spectral lights around 555 nm wavelength, and around 507 nm

14 Leo M. Chalupa, and John S. Werner eds., *The Visual Neurosciences* (Cambridge, Mass: MIT Press, 2004).

15 Karl Gegenfurtner and Lindsay T. Sharpe eds., *Color Vision - From Genes to Perception* (Cambridge, UK: Cambridge University Press, 1999).

wavelength for scotopic conditions (vision in dim light, L < 0.01 cd/m²). For signalling by cars, the photopic range is considered to be relevant. Therefore, with respect to central, photopic vision, *Mint-Green* will have the highest luminosity, followed by *Selective Yellow*, and *Turquoise* (the latter two being approximately equal), whereas *Purple/Magenta* will have a lower luminosity.

3.1.2. Visibility in the peripheral visual field

Because of the characteristic distribution of photoreceptors in the human retina, sensitivity in the peripheral visual field differs for different colours: for white lights, detection limits (as measured by perimeter) are approx. at 90° temporal, for blue lights at 80° temporal, for red lights at 60° temporal, and for green lights at 50° temporal. It can be expected therefore that in the peripheral visual field, light with a high blue content (i.e. *Turquoise* or *Purple/Magenta*) will be detected more easily and at greater eccentricities than lights with a predominance of red, green or yellow.

3.2. Discriminability

3.2.1. Central visual field

Human colour discrimination (normal colour sensitivity, central vision) is best in spectral ranges around wavelengths 480 – 490 nm and 570 – 580 nm, respectively; this corresponds to an optimal discriminability in the colour regions blue-green and yellow/orange, favouring *Turquoise* and *Selective Yellow* over *Mint-Green* and *Purple/Magenta*.

3.2.2. Peripheral Visual Field

Because of the increasing size of neuronal receptive fields from the fovea to the periphery of the human retina, contrast sensitivity and visual acuity decrease with eccentricity, i.e. in the peripheral field of view; this is in particular the case for red/green contrasts. Consequently, colour vision becomes increasingly dichromatic and, in the peripheral retina, corresponds to a deutan/protan deficit (see below). In effect this means that, in the peripheral field of view, *Turquoise* and *Purple/Magenta* will be better identified amongst other lights than *Selective Yellow* or *Mint-Green*.

3.3. Visibility and Discriminability considering colour vision deficiencies (cvds)

Almost 10% of the Caucasian population (incidence varies across regions of the world) are affected by inherited colour vision deficiencies,[16] impairing the discriminability of specific colours; often, bearers of colour vision deficiencies are not aware of their abnormal colour vision. The majority of these deficiencies are related to green sensitivity (deutan cvd, 7% of males, 0.4% of females), and red sensitivity (protan cvd, 2% of males and 0.01% of females), less than 1% are related to the blue sensitivity (tritan cvd, less than 1% in both sexes). In addition, degenerative diseases (e.g. age-related macula degeneration, diabetes) or medications may impact colour vision. Complete colour blindness (achromatopsia, monochromasia), on the other hand, is very rare (incidence < 0.1%). Because of their high incidence, colour vision deficiencies must therefore be considered when designing new colour signals.

Discriminability of two lights can be estimated from colourimetric considerations, i.e. their proximity to or position on the respective confusion lines in the CIE chromaticity diagram (see Figure 2). Colours along those lines will be confused by observers with specific cvds. In the following, the discriminability of the potential signalling colours against other lights already present on vehicles and/or traffic environment will be considered in detail:

Turquoise

Turquoise vs. *White lights* (CIE illuminants A and B, according to SAE specification) is ensured for all classes of cvds;

Turquoise vs. *D65 lights* (CIE standard daylight illuminant): discrimination is good for tritan cvds, but can be impaired for protan cvds; deutan cvds are affected only for the least saturated *Turquoise*); in order to prevent reduced discriminability of desaturated *Turquoise* for these cvds it is recommended to restrict the range of *Turquoise* colour region to higher chroma as given at present and shift its range slightly towards green.

[16] Sharpe, et al. 'Opsin genes,' Tables 1.5 and 1.6, 30.

Turquoise vs. *Yellow (Amber and Selective Yellow), Red, Green* lights: good discrimination is expected for all cvds (except *Red* lights for severe protan deficiencies);
Turquoise vs. *Blue* lights (*Signal Blue, Restricted Blue*): good discrimination is expected for protan and deutan cvds, and reduced for tritan cvds.

Selective Yellow
Selective Yellow vs. *White lights* (CIE illuminants A and B, according to SAE specification) discrimination is good for protan and deutan cvds, discrimination against Standard Illuminant A may be reduced for tritan cvds.
Selective Yellow vs. *D65* (CIE standard daylight illuminant): Discrimination is good for all cvds.
Selective Yellow vs. *Yellow (Amber), Red, Green* lights: probability for confusion is high in the case of protan and deutan cvds, not impaired for tritan cvds.
Selective Yellow vs. *Blue* (*Signal Blue, Restricted Blue*): Discrimination is good for all cvds.

Mint-Green
Mint-Green vs. *White lights* (CIE illuminants D65, A and B, according to SAE specification) discrimination is good for all cvds.
Mint-Green vs. *Yellow (Amber and Selective Yellow), Green, Red* lights: confusion probability is high for protan and deutan cvds; no confusion for tritan cvds.
Mint-Green vs. *Blue* (*Signal Blue, Restricted Blue*): Discrimination can be impaired for tritan cvds.

Purple/Magenta
Purple/Magenta vs. *White lights* (CIE illuminants D65, A and B, according to SAE specification) good discriminability given for all classes of cvds.
Purple/Magenta vs. *Yellow (Amber and Selective Yellow), Green, Red* lights: propability for confusion is high in the case of *Red* for protan cvds, not impaired for deutan and tritan cvds.
Purple/Magenta vs. *Blue* (*Signal Blue, Restricted Blue*): discriminability can be reduced for deutan and protan cvds.

3.4. Attractiveness

The subjective attractiveness of colours can be an important factor with respect to the acceptance of autonomous cars by the public. Studies on colour preferences reveal bluish colours to be the most positively rated worldwide, whereby the ratings vary slightly between cultures and genders: for example, a study testing colour preferences of British Caucasians and Chinese found that amongst the Caucasian group, men tended to prefer blue-greens, whereas women preferred reddish-purple; amongst the Chinese group, on the other hand, the gender difference was less pronounced, both genders showing more weight to reddish colours[17]. In other studies, all using the Berkley colour set, US citizens showed the highest preferences for blue, cyan, purple, and dark red, whereas Japanese preferred cyan over blue, green and light reds[18]; in comparison, Germans preferred most cyan, blue and dark reds[19]. Yellows, in particular dark or greenish yellow, appear to be the least favoured colour, often associated with danger (when bright) or dirt (when dark), in all three cultures. Greens are most often rated as neutral. Therefore, with respect to their emotional associations, *Turquoise* and *Purple/Magenta* are more favourable in comparison to *Mint-Green*, and in particular to *Selective Yellow*.

3.5. Uniqueness

Selective Yellow is already employed in motor vehicles, other yellow/orange and green lights are present in street lighting, traffic lights. *Turquoise, Purple/Magenta*, on the other hand, are not used in the context of traffic and thus are unique in this environment. Therefore, *Turquoise* and *Purple/Magenta* possess a high recognition factor and are suitable as unique features for the identification of autonomous vehicles.

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17 Anya Hurlbert and Yazhu Ling, 'Biological components of sex differences in color preference,' *Current biology* 17, R624;

18 Kazuhiko Yokosawa, Natsumi Yano, Karen B. Schloss, Lilia R. Prado-Leòn, Stephen E. Palmer 'Cross-Cultural Studies of Color Preferences: US, Japan, and Mexico,' *Journal of Vision* 10, no. 7 (2010): 408, 408a, DOI:10.1167/10.7.408.

19 Erika Kumakura, Annette Werner, Kazuhiko Yokosawa. 'The effect of imagining another culture on color preferences', *Journal of Vision* 18, no. 10 (2018): 866–866.

colour	visibility central	visibility peripheral	discriminability normal / CVD	uniqueness	attractivity	rank order
Turquoise	++	+++	+++ / ++	+++	+++	1
*Selective Yellow**	++	+	+++ / -	-	-	4
Purple/Magenta	+	+++	+++ / -	+++	+/-	3
Mint-Green	+++	+	+++ / -	++	+	2

CVD - colour vision deficiency

* already present as signal on vehicle

+/- positive/negative evaluation

Table1. Evaluation results for colours under consideration.

4. Summary of the evaluation

The results are summarised in Table 1 (see above). With respect to central vision, visibility of all colours under consideration (except *Purple/Magenta*) is comparable. With respect to peripheral vision, perception and identification of *Turquoise* and *Purple/Magenta* can be expected to be superior to that of *Selective Yellow*, and *Mint-Green*.

Turquoise, *Purple/Magenta* and *Mint-Green* can be expected to be better (faster and more reliably) distinguished from lights emitted by other cars and those frequently present in the urban visual environment (e.g. traffic lights, street lights, reflexions on wet pavement surface, car coating).

The uniqueness of *Turquoise* and *Purple/Magenta* as signalling colours on the car as well as the visual environment will allow for a fast and reliable identification of the autonomous vehicles.

Furthermore, there is a universal preference for colours in the blue/ blue-green region of colour space whereas yellows are in general less positively evaluated; thus acceptance and attractiveness of autonomous vehicles should profit from *Turquoise* signalling lights.

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5. Remarks concerning *White*

White had also been proposed as possible signalling colour. Although highly visible in general, white lights appear less suitable as signalling lights for autonomous cars, because of low saliency amongst other lights in the traffic environment, including reflections from the sky light; furthermore, discriminability against sunlight and the sky will be low. *White* can therefore not be recommended for application for autonomous vehicles.

Conclusion and Recommendation

Results are summarised in Table 1. Overall, *Turquois* receives higher ratings in most criteria than *Selective Yellow, Mint-Green and Purple/ Magenta: Turquoise* is therefore recommended as colour best suitable for the identification of autonomous cars and human - automobile communication.

It is recommended to adjust the chromaticities of the proposed turquoise in order to optimise discrimination from standard daylight D65 (restriction to higher chroma and small shift towards green (or blue, should this region of colour space be 'available')).

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References

Chalupa, Leo M., and John S. Werner, eds. *The Visual Neurosciences*. Cambridge, Mass: MIT Press, 2004.

Dittmar, Manuela. 'Changing Colour Preferences with Ageing: A Comparative Study on Younger and Older Native Germans Aged 19–90 Years.' *Gerontology* 47 (2001): 219–226. DOI:10.1159/000052802.

Georges, Patrick M., Anne-Sophie Bayle-Tourtoulou, and Michel Badoc. *Neuromarketing in Action: How to Talk and Sell to the Brain*. London, Philadelphia: Kogan Page, 2014.

Hurlbert, Anya C. and Yazhu Ling. 'Biological components of sex differences in color preference.' *Current Biology* 17, no 16 (2007).

Jansson, Cathrine, Nigel Marlow, and Matthew Bristow. 'The influence of colour on visual search times in cluttered environments.' *Journal of Marketing Communications* 10, no. 3 (2004): 183–193. DOI: 10.1080/1352726042000207162.

Kumakura, Erika, Annette Werner, and Kazuhiko Yokosawa. 'Effect of imagining another culture on color preference.' *Journal of Vision* 18, no. 10 (2018): 866–866.

Ou, Li-Chen, Luo M. Ronnier, Andree Woodcock, and Angela Wright. 'A study of colour emotion and colour preference. Part I: Colour emotions for single colours.' *Color Research & Application* 29, no. 5, (2004): 381–389. https://doi.org/10.1002/col.20010.

UNECE. 'Report of the Working Party on Automated/Autonomous and Connected Vehicles on its first session.' Accessed Document ECE/TRANS/WP.29/GRVA/1. http://www.unece.org/fileadmin/DAM/trans/doc/2018/wp1/ECE-TRANS-WP1-165e_01.pdf.

SAE International. 'SAE J578_201603.' Last modified March 11, 2016. http://www.sae.org/technical/standards/J578_201603.

Sharpe, Lindsay T., Andrew Stockman, Herbert Jaegle, and Jeremy Nathans. 'Opsin genes, cone photopigments, color vision, and color blindness.' in *Color Vision: From Genes to Perception*, eds. Karl Gegenfurtner and Lindsay T. Sharpe, 3–51, Cambridge, UK: Cambridge University Press, 1999.

Tanaka, James W. and Lynn M. Presnell. 'Color diagnosticity in object recognition.' *Perception & Psychophysics* 61, (1999): 1140–1153.

Taylor, Chloe, Alexandra Clifford, and Anna Franklin. 'Color preferences are not universal.' *Journal of Experimental Psychology: General* 142, no. 4 (2013): 1015–1027. http://dx.doi.org/10.1037/a0030273.

UNECE. 'Agreement Concerning the adoption of uniform technical prescriptions for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles and the conditions for reciprocal recognition of approvals granted on the basis of these prescriptions.' Addendum 64: Regulation No. 65 Revision 2. Last modified December 7, 2011. https://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2011/r065r2e.pdf.

Werner, Annette. 'Robust Colour in Complex Scenes.' habilitation treatise, Eberhard Karls Universität Tübingen, 2017.

Wichmann, Felix A., and Lindsay T. Sharpe, and Karl R. Gegenfurtner, 'The contributions of color to recognition memory for natural scenes.' *Journal of Experimental Psychology: Learning, Memory and Cognition* 28, (2002): 509–520.

Wolfe, Jeremy M., and Todd S. Horowitz, 'What attributes guide the deployment of visual attention and how do they do it?' *Nature Reviews Neuroscience* 5, (2004): 495–501.

Yokosawa, Kazuhiko, Natsumi Yano, Karen B. Schloss, Lilia R. Prado-Leòn, and Stephen E. Palmer, 'Cross-Cultural Studies of Color Preferences: US, Japan, and Mexico.' *Journal of Vision* 10, no. 7, (2010): 408, 408a, DOI:10.1167/10.7.408.