Analyzing a decade of Colors of the Year

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Abstract

The Color of the Year was first introduced by Pantone in 2000, and recently (the last decade) we saw the trend of introducing a Color of the Year being picked up by more and more companies. Paints and coatings companies typically select their colors of the year by extensive research by designers and trend experts, resulting in a plurality of colors being introduced as Color of the Year, every year. In this paper, we collated colors of the year of 15 different paints and coatings companies published in the past decade and we show that most colors of the year can be described as neutral or off-white color (i.e., the median value for NCS Chromaticness is low, 20%) although occasionally colors of the year have high NCS Chromaticness.

We demonstrate that the distribution of colors of the year follow a certain narrative from year to year: The average Lightness and Chroma (averaged over all companies, per year) appear to follow a wavelike pattern, where the average Lightness appears to repeat itself every ~8 years and the average Chroma approximately every 4.5 years. Similarly, we can see a cyclic pattern in the hue: From mostly yellowish red or greenish blue in 2015, towards predominantly blue in 2017, to a wide variation in hues in 2020 suggesting a fragmentation in colors of the year preferences. In addition, we demonstrate that the colors of the year differ significantly from what can be expected if the colors would have been selected randomly. This could reflect the fact that paint companies use similar raw data to identify their color trends.

Key words: Color, Color of the Year, color trends, color forecasting

1. INTRODUCTION

For many products there is strong focus on providing consumers with the right colors at the right time and at the right price. Achieving this goal would have economic benefits for manufacturers and retailers and may also lead to reduced waste and reduced environmental impact [1] [2]. The first color forecasting agency, the Textile Color Card Association of America was introduced in 1915 and produced colors for women's wear textile products [3] but the color forecasting industry that we are familiar with today came to prominence in the 1960s and 1970s [1]. Today, trend forecasting is a multi-billion dollar business [4] and color trend forecasting is at its heart with color forecasts being produced for different industries typically 18-24 months in advance of consumption. Indeed, it has become widely accepted that color is a physical manifestation of the mood of a certain era; a symbol of the Zeitgeist [3]. It is believed, for example, that color preferences can be influenced by cultural, economic and political trends [5] or the Zeitgeist [6].

Yet despite the importance of color trends, relatively little is known about the accuracy of color trend forecasting [7]. King found that in the textile industry a number of 'core' colors (e.g. white and black) were used season after season and achieved high sales but otherwise there was no evidence of any cyclic variation in color trends [7]. The relationship between color trends and the prevailing sociocultural lifestyle conditions of a society were questioned by Stansfield and Whitfield [8] who found no evidence to support the notion of color cycles or any tangible order to color consumption. Whitfield and Whelton [9] noted that not only have there been almost no evaluations of the accuracy of color forecasting but that it may not even be possible to evaluate accuracy; indeed, they note that it is not even clear whether the success of color forecasts are monitored (it appears sufficient that predictions simply are made).

Although color forecasting has a rather long history stretching back to at least the late 19th Century, the idea of a 'color of the year' is a more recent development in the 21st Century. Pantone announced a color of the year in 2000 to 'encapsulate the spirit of our times' [10]. Pantone's color of the year is intended to reflect a global perspective on the movement of color across current and future seasons; however, how can this be the case when many studies have demonstrated that color meanings often vary across and between cultures [11]? It has been suggested that global meaning and significance can be achieved by the association of a name or phrase along with the visual representation of the color of the year itself [12]; for example, in 2002 Pantone published the color of the year as 'True Red' in connection with the 9/11 attacks and in 2004 published the color of the year as 'Tigerlily' (a shade of orange) to inspire a warm mood in the context of armed conflicts in Afghanistan and Iraq. In 2019 the Pantone Color of the year was 'Living Coral' which Pantone described as 'an animating and life-affirming coral hue with a golden undertone that energizes and enlivens with a softer edge' [13]. The semiotic associations of the color of the year are also reflected in the stories that are associated with many color forecasts (the implication being that these stories are as important as the colors themselves). Today, not only Pantone, but a plethora of companies produce a color of the year and the idea of a single color that can be representative of the Zeitgeist is gaining ground. Curiously, different companies – even those in the same field – often produce different colors for the same year. The lack of literature, and underlying studies, on color forecasting in general and on color of the year (in particular) has recently been highlighted [13].

Typically, the color of the year is selected by extensive research by a group of designers and trend experts, in which trends in society, economy and design are considered and reviewed [14] [15]. By capturing the mood of the moment, the leading paint color is identified and complemented with additional colors to create versatile color palettes that help consumers, designers and DIY-ers select colors that feel trendy, fresh and cohesive. This study has collated every color of the year published by paint companies over the past decade and explores whether there is an inherent order or pattern in these selections. In Section 2, we will describe the data we collected. Then, in Section 3, we analyze the historic data using CIELAB and the Natural Color System (NCS). In Sections 4 and 5 we compare the various colors of the years with each other, and in Section 6 we come back to the historic data to analyze the trends that occurred throughout the years. Finally, in Section 7 we conclude with a summary and discussion.

2. DATA COLLECTION

Probably the best-known company regarding color is Pantone, especially known for its Pantone Matching System. This tool is primarily used for the printing industry, graphic design and fashion. For the paints and coatings industry, however, Pantone colors are often outside the gamut of colors that are offered, mainly because those colors are based on non-durable ink formulations. Hence, after Pantone introduced the first Color of the Year in 2000, paints and coatings companies followed shortly after with their own Color of the Year. First, in 2003 AkzoNobel launched their ColourFutures™ containing AkzoNobel's Color of the Year 2004, followed by Benjamin Moore (2006) and Sherwin-Williams (2011). After that, more and more companies followed suit: PPG, Beauti-tone and Jotun since 2014, Diamond Vogel, Behr, Asian Paints, Nippon Paint and Pratt & Lambert since 2015, and Kansai, Dutch Boy, Dunn-Edwards and Glidden since 2016. We collected all data for these colors via online sources and company websites, resulting in 99 sRGB colors (Figure 1). Note that Glidden discontinued their Color of the Year in 2020.

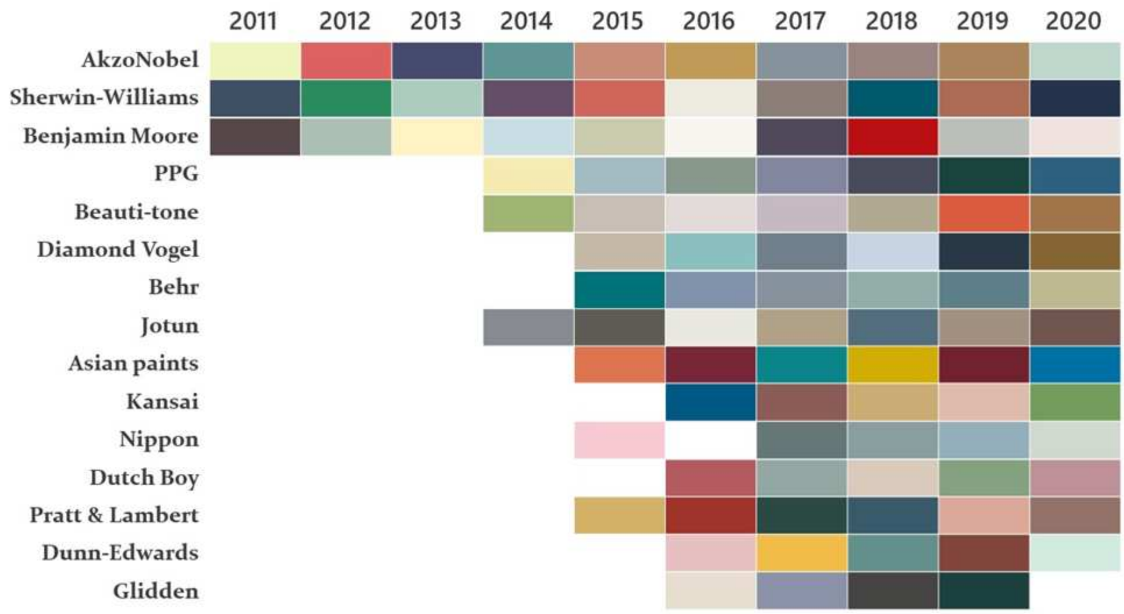


Figure 1 Colors of the Year of the past decade, as announced by 15 major paints and coating brands.

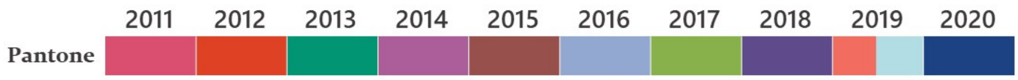


Figure 2 Pantone's Colors of the Year of the past decade.

3. ANALYSIS OF HISTORIC DATA

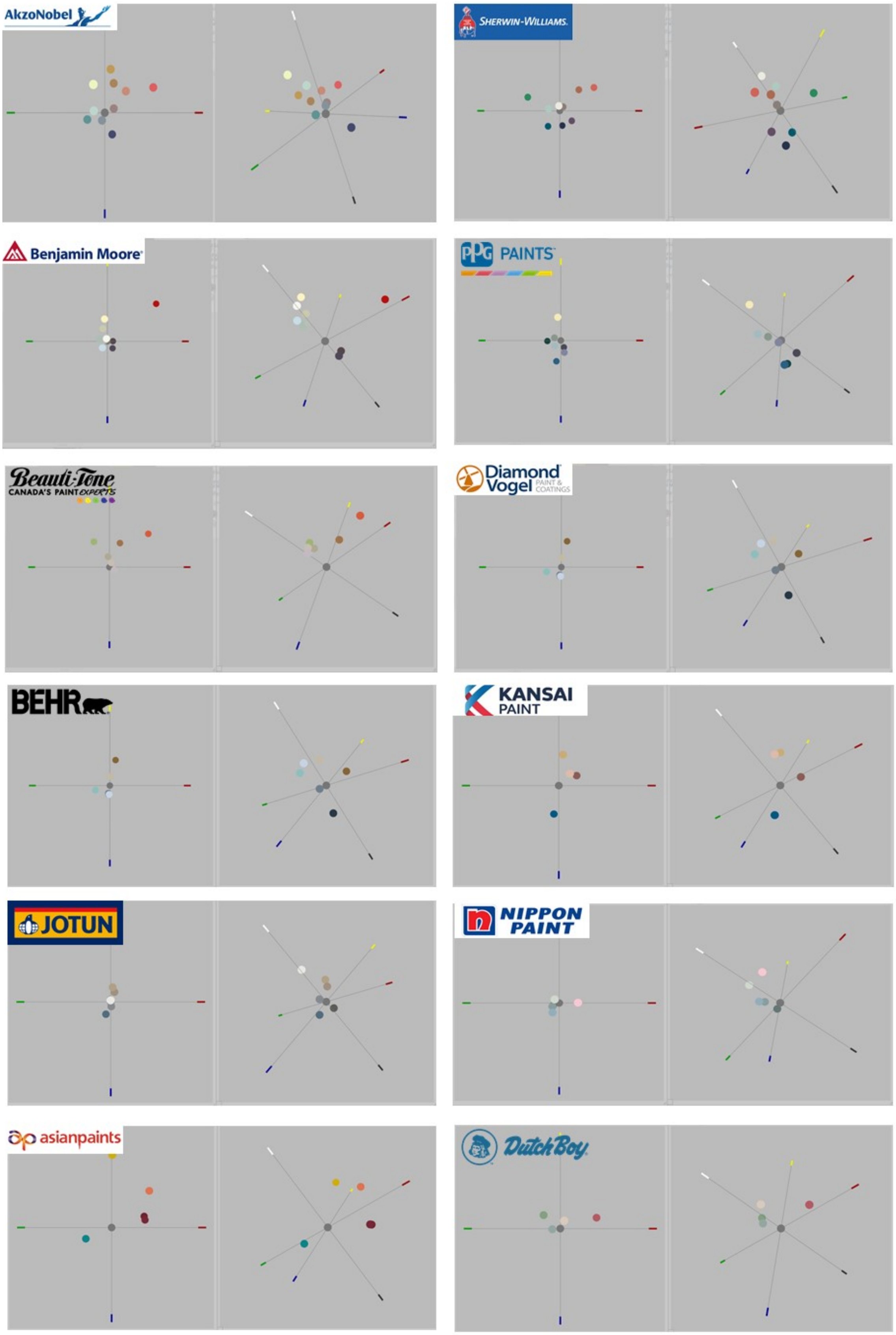
Every Color of the Year is likely to be selected independent of each other. However, when looking at the overview in Figure 1, the colors appear to have in common that they are not as chromatic as Pantone's Color of the Year shown in Figure 2. In this section, we investigate if the colors share any other properties with each other. For this, we use both the CIELAB color space, by converting the sRGB colors to CIELAB [16], and the Natural Color System (NCS), by converting to the NCS notations using the NCS Navigator tool [17] from NCS by finding the nearest NCS code for each Color of the Year (which are verified using other online conversion tools [18] [19]).

NCS is the most commonly used color system in architecture and design [20]. In the NCS system, colors are defined according to their degree of resemblance to the nearest elementary color (red, green, blue, yellow, black and white). An NCS color such as 4010-Y90R is easy to interpret. The last four characters give information on the hue. In this example, Y90R indicates a color between yellow and red, with a small contribution of yellow and a dominating 90% contribution from red. We use the parameter ϕ_{NCS} to denote the NCS hue, with values ranging from 0° (Red), via 90° (Blue) and 180° (Green) to 270° (Yellow) and 360° (Red). The first four characters of the NCS code (4010 in this example) are sometimes referred to as the *nuance*, which is composed of blackness S and chromaticness C ($S = 40\%$ and $C = 10\%$ in this example). The whiteness W can be calculated as $100 - S - C$. In this example, we would have $W = 50\%$. The values for hue, chromaticness, blackness and whiteness often give good indications of the character of a color.

CIELAB

In Figure 3, we show all colors per company, plotted in 2D (a/b-space) and 3D. Most colors are grouped together in the middle of the diagram, indicating most colors of the year are not very chromatic. The exception to this appears to be Asian Paints, who introduced the most chromatic colors of the year. In Figure 4 we show colors of all companies together organized by year. These graphs again confirm that most colors of the year are not very chromatic, except for a few chromatic reds and yellows.

In Figure 5 and Figure 6 the Chromaticity and Lightness, respectively, for all colors are plotted from year to year. The largest variation of chromaticity is observed in 2018: The chromaticity varies between $C^* = 0.99$ (Glidden) to $C^* = 77.0$ (Benjamin Moore). Similarly, the largest variation in lightness is observed in 2020, ranging between $L^* = 21.2$ (Sherwin-Williams) and $L^* = 94.1$ (AkzoNobel).


AkzoNobel
SHERWIN-WILLIAMS.
Benjamin Moore
PPG PAINTS
Beauti-Tone
CANADA'S PAINT EXPERTS
Diamond Vogel
PAINT & COATINGS
BEHR
KANSAI PAINT
JOTUN
NIPPON PAINT
asianpaints
Dutch Boy

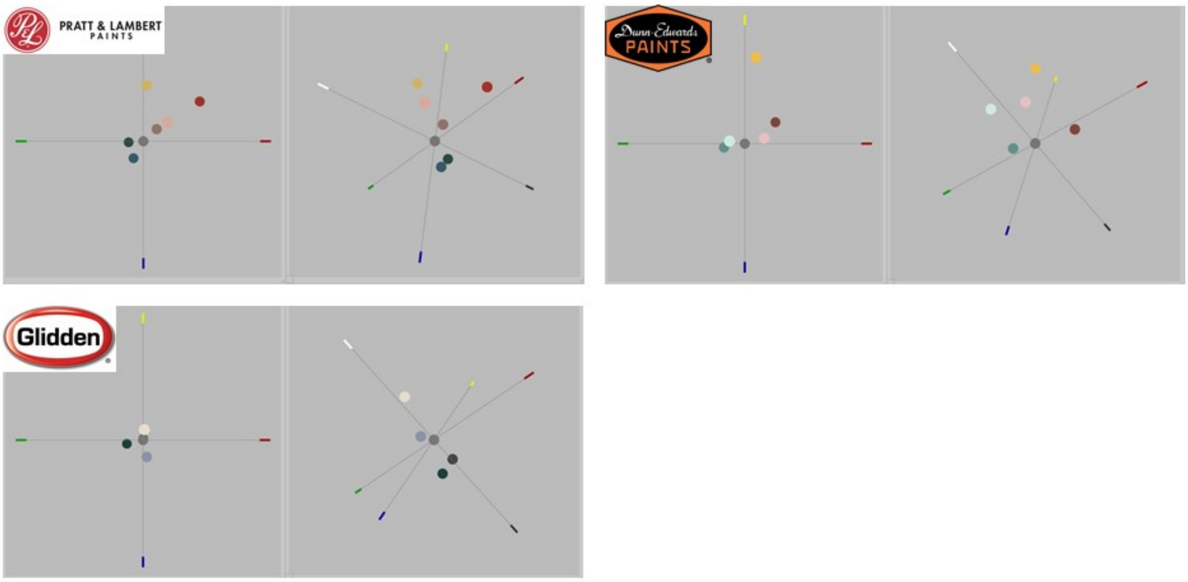


Figure 3 Colors of the Year of the past decade for 15 paint companies plotted in CIELAB space.

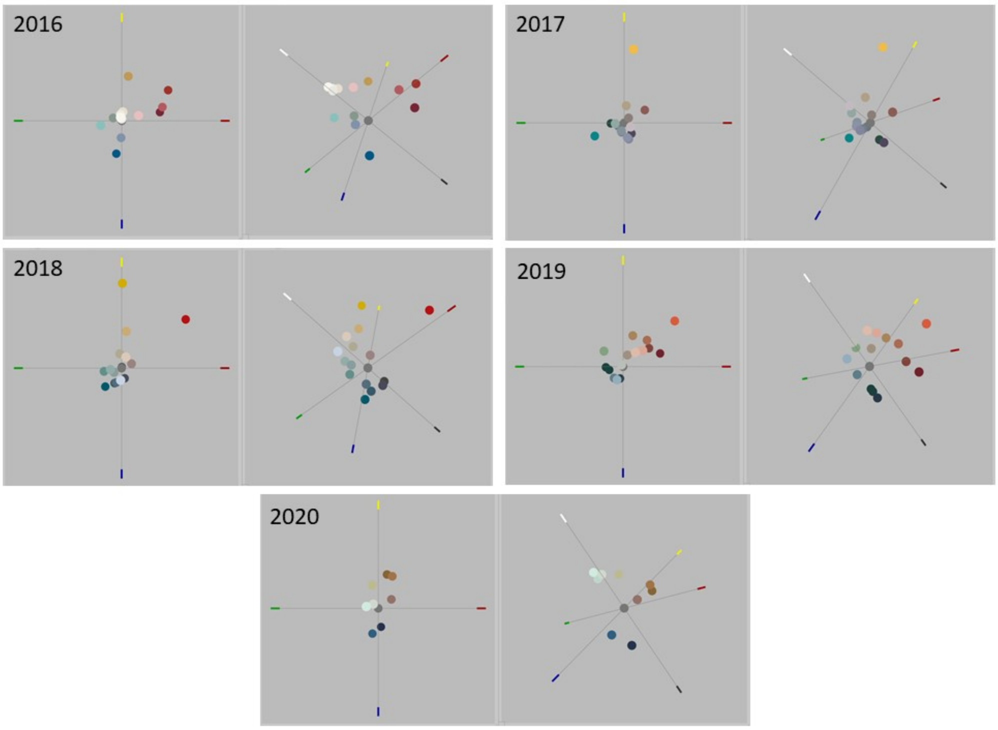


Figure 4 Colors of the Year from 15 paint companies since 2016 until present plotted in CIELAB space.

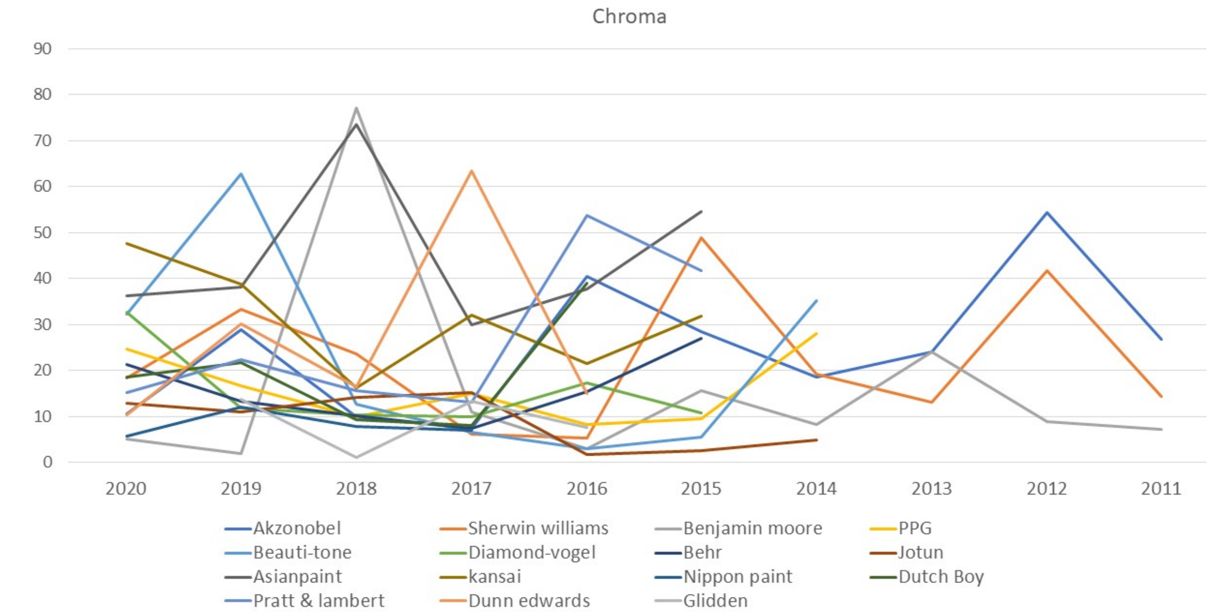


Figure 5 Chroma of Colors of the Year from 15 paint companies plotted per year.

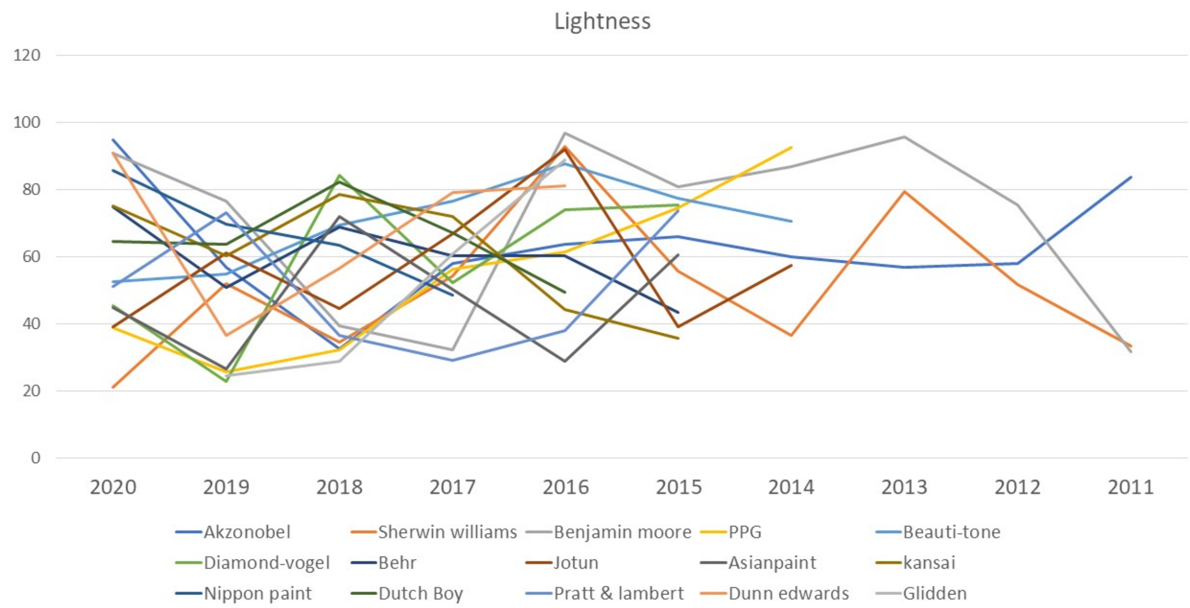


Figure 6 Lightness of Colors of the Year from 15 paint companies plotted per year.

NCS Chromaticness

In Figure 7, we show how the colors of the year are distributed across the NCS space. Taking the full set of Colors of the Years from all 15 companies, the median value of NCS Chromaticness is only 20%. This confirms the previous observation that many of these colors are neutral or off-white colors, following the general trend in decorative paints. The most extreme example of this observation is Jotun: The median value for NCS Chromaticness for this company is only 5%. Other examples of a strong preference for neutrals and off-whites are colors of the year 2016, 2017 and 2019 by Benjamin Moore, the color of the year 2014 by Jotun and the color of the year 2018 by Glidden, which are all purely achromatic (0% NCS Chromaticness).

Other companies selected more chromatic colors as their Color of the Year during the past decade. Asian Paints and Kansai did so most consistently, resulting in a median value of 50% and 30%, respectively. Colors of the year with the highest NCS Chromaticness were selected by Asian Paints (70% in 2018), Benjamin Moore (80% in 2018) and Beauti-tone (70% in 2019). For those latter two companies, these high chromatic colors were exceptions to their usual selections since they typically select low-chromatic colors of the year (the median value for those companies is low). This results in a very high variation in NCS Chromaticness for these two companies: 80% and 65%, respectively. Companies with low variability, and hence are quite consistent in their selection of NSC Chromaticness, are Nippon Paint (10% variability), PPG, Diamond Vogel, Jotun and Glidden (all 20% variability).

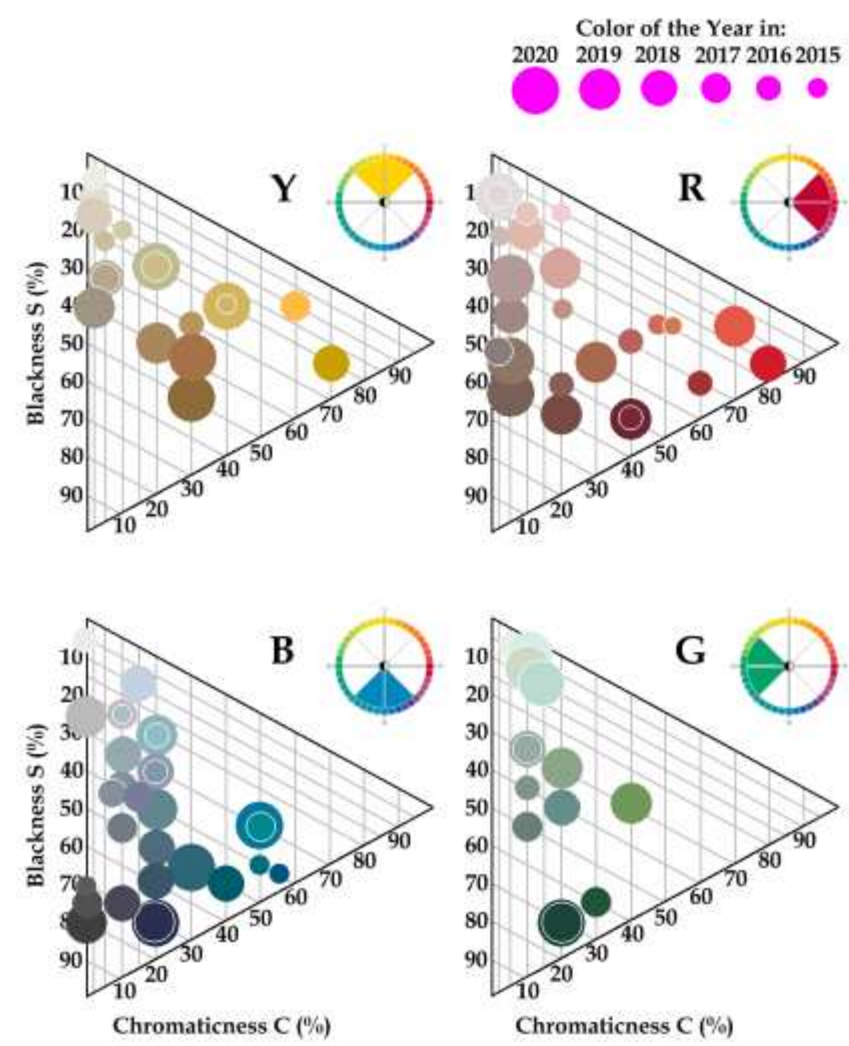


Figure 7 Representation of the Colors of the Year from 15 paint companies, 2015-2020, in the Natural Color System. Each figure refers to one quadrant of NCS hue space. The size of the circles refers to the year the color was launched as Color of the Year.

NCS Whiteness

The median value of the NCS Whiteness of all the Colors of the Year investigated here is 42.5%. However, there are large differences between the 15 companies: On one hand there are companies with a relatively high median value, e.g., Benjamin Moore (72.5%), Beautitone, Nippon Paint and Dutch Boy (all 60%), while on the other hand there are companies with a very low median value, e.g., Asian Paints (15%) and Sherwin-Williams (25%).

NCS Whiteness values of 90% or higher are only found for Benjamin Moore, Sherwin-Williams, and Jotun, while NCS Whiteness values as low as 5% are only found for Benjamin Moore and Kansai. Indeed, Benjamin Moore selected both colors on the high end as well as on the low end of the NCS Whiteness scale, resulting in the widest range of NCS Whiteness of all companies (90%). Other companies with a wide range are Sherwin-Williams (80%) and Glidden (75%). Companies that seemingly strive for consistency, are Asian Paints and Nippon Paint, with variation of 20% and 40% respectively.

NCS Blackness

In terms of the values for NCS Blackness for the colors of the year from the 15 companies investigated, we find large differences. For two companies, the median value of the NCS Blackness parameter remains as low as 15% or less (Benjamin Moore and Dunn-Edwards), indicating that generally the Color of the Year for these two companies are relatively bright compared to the median value of all companies' colors of the year (30%). Those same two companies also selected colors with the lowest NCS Blackness (5%), but half of the other companies also selected a color with such low NCS Blackness at least once.

Relatively high median values for NCS Blackness are found for Sherwin-Williams, Jotun and Glidden, with values of 45% and higher. The highest values for NCS Blackness, with values of 70% and higher, were found for six companies including the three just mentioned. The highest variation for NCS Blackness was found for Benjamin Moore and Glidden (70%), other companies seem to aim for more consistency in terms of NCS Blackness, e.g., the variation of Behr and Dutch Boy is only 20% or less, primarily caused by their preferences for colors with low NCS Blackness (consistently lower than 40%).

4. HOW UNIQUE ARE COLORS OF THE YEAR?

Most probably the 15 paint companies in this investigation conduct their color trend analyses independently from each other. But since they probably collect their data from similar sources, such as major trends in fashion, it is hardly surprising that similar colors of the year are launched by different companies. Our data shows that indeed in the past decade most colors of the year are not unique: For 85% of the colors, there is a similar color (within $dE_{00} < 8.0$) launched by a different company. Only fourteen colors are launched in the past decade where this was *not* the case, so called "unique" colors (see Figure 8). Arguably, these colors can be considered as successful, in the sense that they are new inspirational colors rather than reflecting existing color trends.

Interestingly, during the past decade some companies launched a unique Color of the Year twice (AkzoNobel, Sherwin-Williams, Beauti-tone) or even three times (Dutch Boy), whereas other companies never launched a unique color (Benjamin Moore, PPG, Behr, Asian Paints, Nippon, Pratt & Lambert). This may reflect different strategies between these companies, aiming for a different balance between launching unique new colors or reflecting existing color trends.

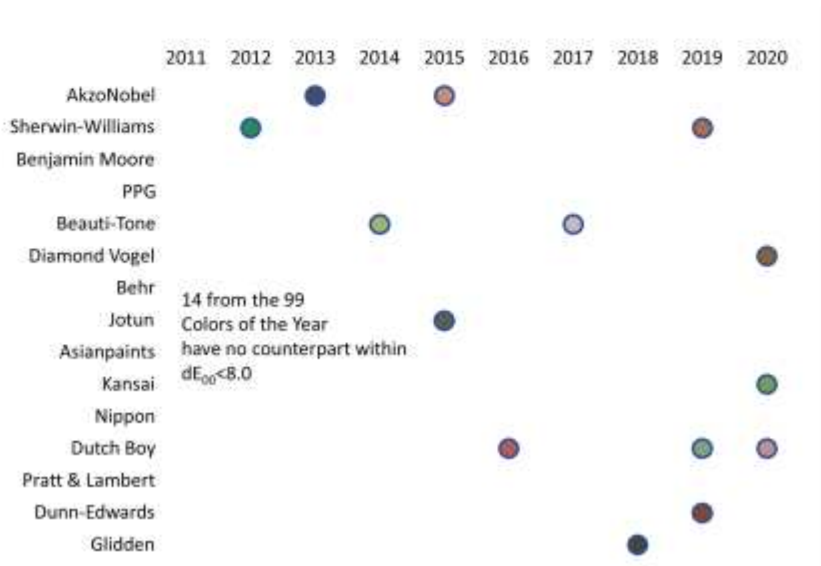


Figure 8 Diagram showing the only 14 Colors-of-the-Year with no counterpart within $dE_{00} < 8.0$.

From all the colors with a similar counterpart (within $dE_{00} < 8.0$), 24 of these were launched in the same year. During the past 6 years, there were always at least two companies launching a similar Color of the Year. If indeed the Color of the Year reflects trends in color popularity, Figure 9 shows trends that were identified by multiple paint companies in the same year.

Figure 10 shows that many colors of the year have relatively close counterparts from competitors launched in this decade. In 41% of the cases the similarity is better than $dE_{00} < 5.0$, and in 9% it is even better than $dE_{00} < 3.0$. We found that the most similar colors of the year are launched by AkzoNobel and Behr, both in 2017, with $dE_{00} = 0.42$.

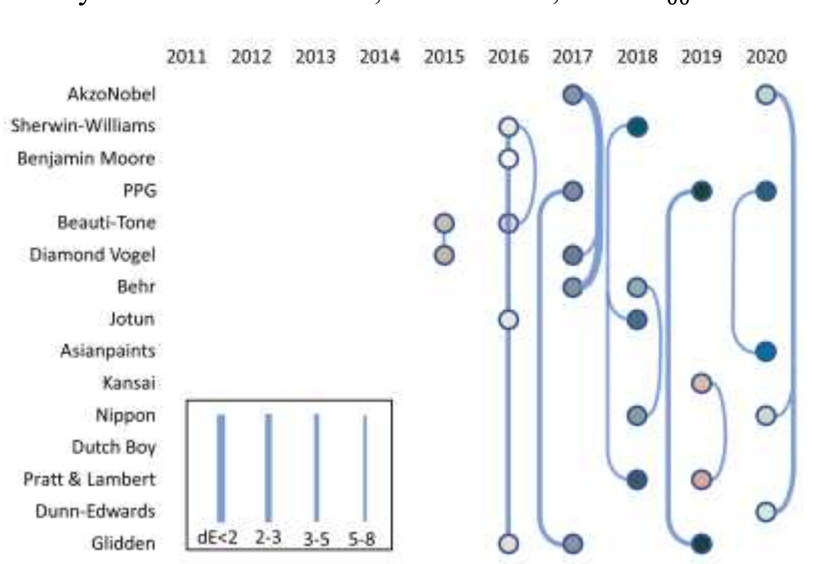


Figure 9 Diagram showing Colors-of-the-Year that were relatively close matches to other Colors-of-the-Year launched in the same year. Color differences (expressed as dE_{00}) are marked by thickness of lines.

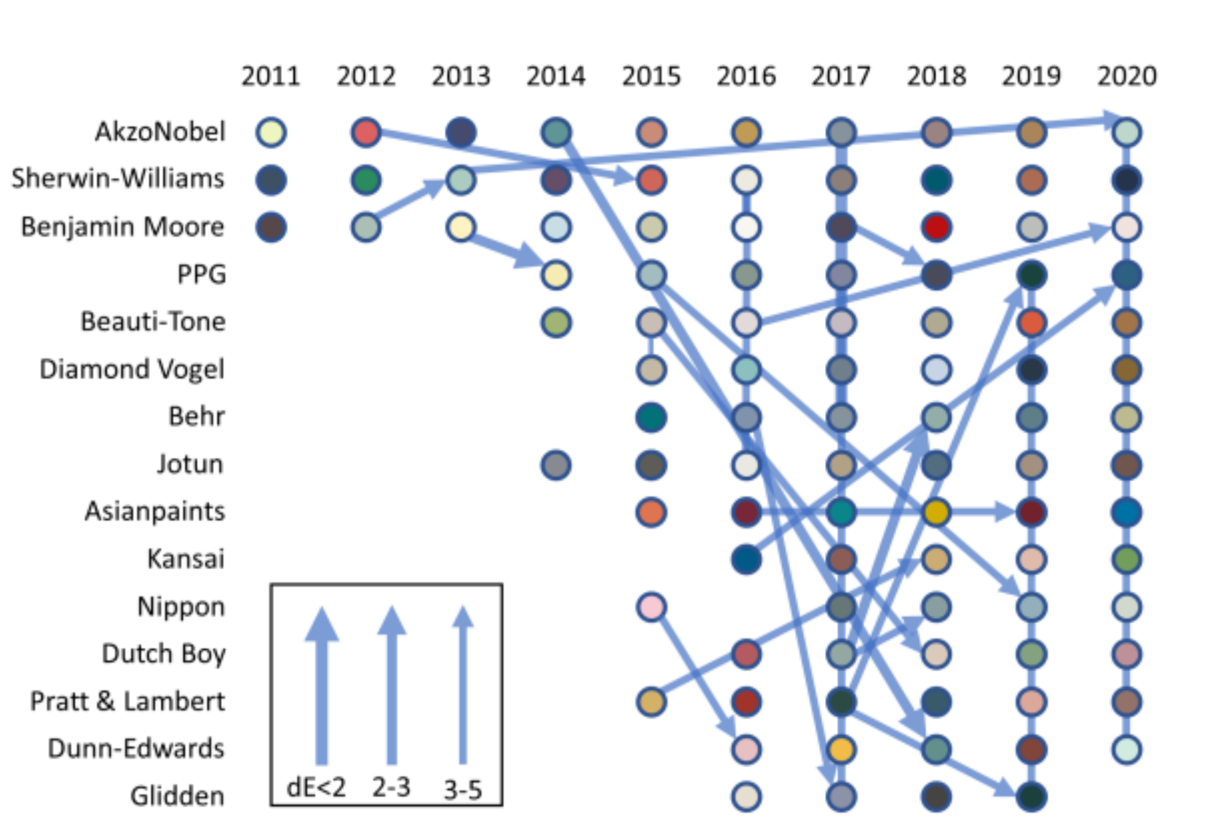


Figure 10 The color distances between different Colors-of-the-Year may show several underlying trends.

5. NUMBER OF COLOR NEIGHBORS AND SIGNIFICANCE

When looking at the observations of the previous section, we may wonder how likely they are to occur by chance. After all, selecting 99 colors of the year randomly from color space, we are likely to end up with *some* similar colors and *some* unique colors. In this section, we analyze the significance by running a series of Monte Carlo simulations: We randomly selected 99 colors and assigned a company and year to each generated color, and we repeated this simulation 100 times. The colors were not picked from the full gamut of possible object colors (the so-called Rösch-MacAdam color solid), but only from the gamut that is covered by the actual colors of the year. This gamut was determined by subdividing the Lightness axis into 5 equal slices, with $L^* = 0 \cdots 20, 20 \cdots 40$, etc. For each slice, the full range of hues was subdivided into four quadrants characterized by $h^* = 0^\circ \cdots 90^\circ, 90^\circ \cdots 180^\circ$, etc. For each quadrant in each hue, we determined the median value of the chromaticity C^* of the actual colors of the year. By calculating the value of $\sqrt{2}$ multiplied by this median C^* value we obtained a good estimate of the full range of chromaticities in each quadrant, without being affected too much by outliers.

Using this simulation, we obtained data on the distribution of nearest neighbors in color space that one may expect when colors of the year would have been picked randomly from the typical color range of such colors. For example, from the 100 simulations we find that on average 6 of the 99 colors have a counterpart within $dE_{00} < 2.0$. The 10^{th} percentile and the 90^{th} percentile values for these simulations are 2 and 10, respectively. Therefore, the fact that the actual colors of the year have 2 colors which indeed have a counterpart within $dE_{00} <$ 2.0 means that this result is just at the border of significance (80% confidence interval).

In the same way, we find that the average number of counterparts within 2.0 $< dE_{00} <$ 3.0 would be 12 if picked randomly, with 10%-90% confidence intervals from 7 to 17. In reality, we only found 6 such colors of the year, which would make it (just) significant according to this analysis.

In Table 1, we show that for several characteristics, the actual colors of the year indeed differ significantly from what can be expected if colors of the year would be selected randomly. For instance, we may conclude that at 80% confidence interval there are fewer *actual* colors of the year that highly similar ($dE_{00} <$ 3.0) than one would expect when selecting the colors *at random*. This can be explained by the fact that paint companies are likely to prefer avoiding picking colors of the year that are almost identical to colors of the year picked by competitors before.

On the other hand, we also find that there are significantly more colors of the year that are moderately similar (3.0 $< dE_{00} <$ 8.0), many even launched in the same year. One possible explanation for this could be that apparently paint companies succeed in recognizing similar color trends in the outside world, which then contributes to them picking similar but not identical colors of the year.

Number of colors with …	**Actual Colors of the Year**	**Simulation Average**	**Simulation 10^{th} … 90^{th} percentile**
… no counterpart within $dE_{00} < 8$	14	11	7 … 15
… a counterpart at $dE_{00} < 2$	2	6	2 … 10
… a counterpart at $2 < dE_{00} < 3$	6	12	7 … 17
… a counterpart at $3 < dE_{00} < 5$	32	34	27 … 42
… a counterpart at $5 < dE_{00} < 8$	44	36	28 … 43
… a counterpart at $dE_{00} < 2$ in same year	1	0.4	0 … 1
… a counterpart at $2 < dE_{00} < 3$ in same year	0	0.7	0 … 2
… a counterpart at $3 < dE_{00} < 5$ in same year	8	3.2	1 … 6
… a counterpart at $5 < dE_{00} < 8$ in same year	15	12	8 … 15
… a counterpart at $dE_{00} < 8$ in same year	24	16	11 … 21

Table 1 Statistics on neighboring colors of the year, as found as among actual Colors of the Year, versus results from Monte Carlo simulations.

6. TREND ANALYSES

Finally, in this section we analyze whether we can identify trends in the data over time period. First, we calculated the average CIELAB coordinates for each of the colors of the year from 2011 to 2020, averaged over all companies per year (see Figure 11). The blue circles in this graph depict the average lightness L^*, chromaticity coordinates a^* and b^*, and chroma C^* from year to year (averaging over all colors in that particular year). Arguably, looking at these blue circles, a wave-like pattern can be identified in the data. To quantify this effect, we fitted the data with simple sine functions. The chroma $C^*$and chromaticity coordinates a^* and b^* are fitted with Eq. (1), the data for lightness L^* are fitted with a slightly more complex form, Eq. (2).

$$f(x) = a\sin(bx + c) + d \quad (1)$$

$$f(x) = a\cos(bx) - c\sin(dx) \quad (2)$$

Fitting the data with these functions resulted in the red lines in Figure 11: The red lines show the modeled trends for the respective color property (L^*, a^*, b^* and C^*). The coefficient of determination, the R^2-value, provides a measure of how well the observed data are replicated by the calculated model, in other words how good the model (the red line) fits the yearly averages (the blue dots), where a value of 1.0 indicates a perfect match between the model and the observed data. In this case, the R^2-values are 0.84, 0.58, 0.77 and 0.80 respectively for L^*, a^*, b^* and C^*, implying that the wave-like pattern is strongest in the Lightness and the Chroma dimensions.

Hence, from these values we could conclude that there is some weak evidence of a wave-like pattern. However, it is unclear how statistically significant these results are. To investigate this, we again use a Monte-Carlo simulation: By randomly generating numerous sets of colors (say N sets of colors, simulating N sets of "colors of the year"), we can calculate how likely the chance is that we observe the data in Figure 11, statistically speaking. For this experiment, we randomly generated 99 new "colors of the year", ensuring that each generated color falls within the gamut of the original 99 colors of the year (which is modeled by the convex hull of the original 99 color coordinates). Next, we used the same approach for this simulated set of colors as before, fitting Eq. (1) and (2) to the average color coordinates and calculating the R^2-values. By repeating these steps 100 times (and thus generating 100 sets of 99 "colors of the year"), we obtain a distribution of R^2-values that we can then use to compare our original R^2-values with. By looking at the 5^{th} and 95^{th} percentiles of the distributions of R^2-values, we can say whether our observed true R^2-values are statistically significant or now. The R^2-values for the simulated values for L^*, a^*, b^* and C^*span the range of 0.09 – 0.74 (actual R^2: 0.84), 0.13 – 0.75 (actual R^2: 0.58), 0.12 – 0.76 (actual R^2: 0.77) and 0.13 – 0.76 (actual R^2: 0.80), respectively. This implies that the wave-like pattern found for L^* and C^* are most significant (at the 90% confidence-level) and that the pattern is less significant for the individual chromaticity values for a^* and b^*.

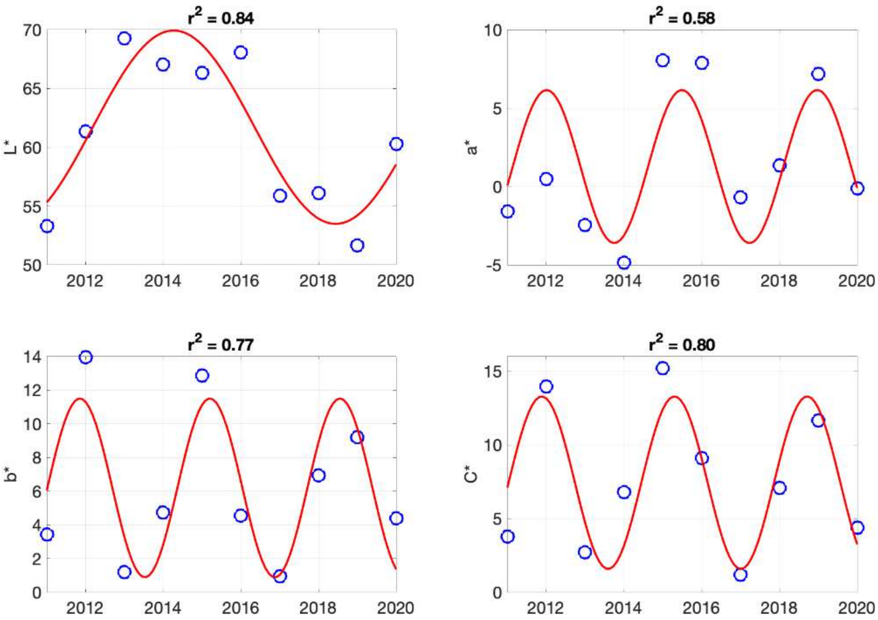


Figure 11 Average CIELAB values for each year (blue symbols) fitted with models (red lines). The blue circles show the average lightness L^*, chromaticity coordinates a^* and b^*, and chroma C^*, from year to year, averaged over all colors in that particular year. The red lines indicate the model that is fitted to these data points according to Eq. (1) and (2), showing that the corresponding color properties follow a wave-like pattern.

Year-to-year trends in NCS Whiteness and Blackness

Next, we analyze year-to-year trends using the NCS system. In terms of NCS Whiteness, AkzoNobel was the first to select a Color of the Year with NCS Whiteness as high as 75% in 2011. It would take several years before other companies would select a Color of the Year with at least that level of NCS Whiteness, e.g., PPG (3 years), Jotun (5 years) and Nippon Paint (4 years). Benjamin Moore followed with that level of NCS Whiteness in 2 years and selected colors with even higher NCS Whiteness in 2013 (80%) and 2016 (95%).

A similar analysis for NCS Blackness shows that Benjamin Moore was the first to choose a Color of the Year with NCS Blackness as high as 70% in 2011. Other companies followed much later, e.g., PPG in 2018 and Sherwin-Williams in 2020. The lowest level of NCS Blackness possible (5%) was already selected in 2011 by AkzoNobel, followed by Benjamin Moore in 2013, PPG in 2014 and Sherwin-Williams in 2016.

We already mentioned in Section 3 that some of the companies appear to prefer consistency throughout the years, e.g., Nippon Paint with consistently small variations in both NCS Whiteness and Chromaticness, and Asian Paints, PPG, Diamond Vogel, Jotun, Glidden, Behr and Dutch Boy with a small variation in either of the three NCS color parameters. On the other hand, some companies might prefer to explore the boundaries of the color space with their selection of Color of the Year. By calculating the average number of years it takes a company to select a color with maximum or minimum levels of NCS Whiteness, Blackness or Chromaticness, we can identify such companies. For Benjamin Moore, the average is 0.9 years, followed by Sherwin-Williams (3.0 years) and AkzoNobel (3.3 years). After that, Jotun (4.4 years) and PPG (4.8) and the other companies follow.

Year-to-year trends in NCS hue

Since hue refers to an angle that can take any value on the hue circle, its range is 360° by definition. For the analysis of NCS hue, we only look at data from 2015 and more recent, since up to 2014 only seven companies or less launched a Color of the Year. The data is summarized in Table 2 and visualized in Figure 12.

In 2015, for 42% of all colors of the year, the dominant color was red, i.e., a value of ϕ_{NCS} ranging between -45°° (Y50R) and 45° (R50B), and another 33% were predominantly blue with a small green tint, i.e. between B and B50G, $90^{\circ} < \phi_{NCS} < 135^{\circ}$. In 2016, even more dominantly red colors were selected (46%), but their hues slightly shifted towards blue. The other colors in 2016 are more evenly spread over all hues.

In 2017, the shift in hue from red to blue continued, with 46% of the colors of the year being bluish with either a minor contribution from red (still the majority case) or from green. The yellow component had disappeared from most reddish colors of the year. Again, the other colors of the year spread uniformly across different hues, with a small preference for yellow colors.

The shift towards bluish reds reached its end point in 2018. In that year, 46% of the colors of the year were predominantly blue, and the bluish colors with a minor contribution from red now formed a minority with respect to bluish colors with a greenish contribution. The proportion of yellow colors grew to 20%, being dominated by yellow while having a small green or (more commonly) red component. Another 20% of the colors were mainly red colors with a small contribution from yellow.

In 2019, we finally saw a reduction of bluish colors with respect to the year before: 34% of the colors of the year had a predominantly blue color component and a smaller contribution from either red or green. Another 40% of the colors were composed of both yellow and red, with still the majority red. In 2020, the shift away from red continues, and the 33% of the colors of the year that are mixtures of blue and green are more often dominated by green than by blue. The 33% of the colors of the year that are composed of both yellow and red are not often dominated by yellow so also this group of colors shifts away from red. The hues of the colors of the year in 2020 are further characterized by their widespread variation. This fragmentation is also recognized in trends becoming less pronounced, as indicated by the decreasing percentages following the main trends.

	G50Y - Y	Y - Y50R	Y50R - R	R - R50B	R50B - B	B - B50G	B50G - G	G - G50Y
	225°-270°	270°-315°	315°-360°	0°-45°	45°-90°	90°-135°	135°-180°	180°-225°
2015	8	17	33	8	0	33	0	0
2016	8	8	23	23	8	15	0	15
2017	7	20	7	0	33	13	13	7
2018	7	13	20	0	20	27	13	0
2019	0	13	27	7	7	27	7	13
2020	7	20	13	13	7	13	20	7

Table 2 Percentages of Color of the Year for eight different categories of NCS hue.

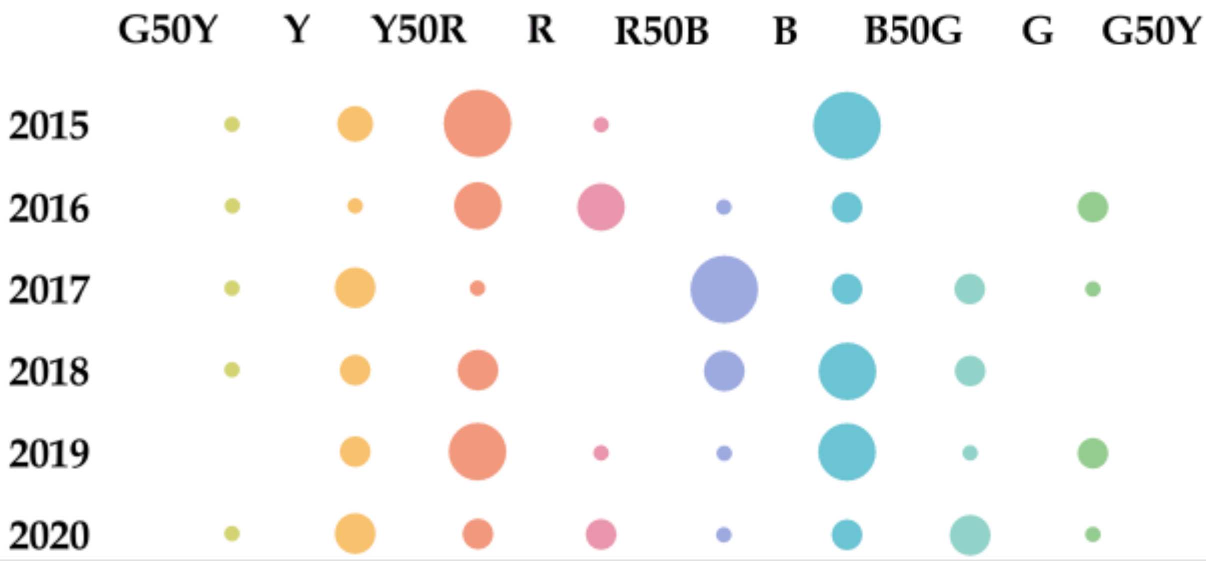


Figure 12 Illustration of Table 2. The diameter of each circle scales linearly with the percentages of Color of the Year for eight different categories of NCS hue.

7. SUMMARY AND DISCUSSION

In this article, we collected and analyzed colors of the year for 15 paint companies of the last decade. Although in general we see that the colors of the year are best described as off-white colors (demonstrated by the low median value of NCS Chromaticness of 20%), most companies *occasionally* select a Color of the Year with high NCS Chromaticness. Furthermore, every year we see quite high variation in chromaticity and lightness, up to ranges of $C^* = 0.99 \ldots 77.0$ for chromaticity in 2018 and ranges of $L^* = 21.2 \ldots 94.1$ for lightness in 2020. Looking at individual companies, we see a pattern that some companies more than others appear to appreciate consistency throughout the years. For instance, looking at NCS Whiteness, companies like Benjamin Moore, Sherwin-Williams and Glidden selected colors on both the high end as well as on the low end of the NCS Whiteness scale, while companies like Asian Paints and Nippon Paint are more consistent in their NCS Whiteness levels with variations of 20% and 40%, respectively.

Based on these examples, where variation in NCS Whiteness is highest for US-based companies Benjamin Moore, Sherwin-Williams and Glidden, and lowest for Asia-based companies Asian Paints and Nippon Paint, it may be tempting to associate the geographical origin of the paint companies to the choice of colors of the year. However, the current set of data seems to be too limited for such an analysis. Indeed, the deviations in this data set are too large to draw any statistically sound conclusions about this, e.g., Kansai and PPG with a variation of 65%. Moreover, other factors play an important role in the color selection too. For instance, different paint companies serve different geographical mixtures of paint markets, and color preferences in architectural wall paints differ substantially from, e.g., DIY wall paints.

We demonstrated that the distribution of colors of the year appears to follow a cyclic pattern: The average Lightness and Chroma (averaged over all companies, per year) appears to follow a wavelike pattern, where the average Lightness appears to repeat itself every ~8 years and the average Chroma approximately every 4.5 years. Similarly, if we look at the individual NCS hue components of the colors of the year, we can see a shift from mostly yellowish red or greenish blue (in 2015), towards predominantly bluish (in 2017), towards a wide variation in hues in 2020 suggesting a fragmentation in color preferences. We might even argue that we can see a cyclic pattern when looking at the individual hue components from year to year. For instance, the contribution of the red component first diminishes, then increases, and then diminishes again; the same observation holds for the blue component. However, the limited chronological range of data, combined with the fact that he individual hue components are not independent from each other, prevents us from validating this assertion.

Additionally, our results show that colors of the year differ significantly from what can be expected if colors of the year would be selected randomly. For instance, there are significantly less colors of the year that are highly similar ($dE_{00} < 3.0$) than one would expect when the colors of the year would be select at random. One possible explanation for this is the fact that companies would prefer avoiding selecting a Color of the Year that we previously launched by a different company. In addition, we found that there are significantly more colors than one would expect if the colors are selected at random, that are moderately similar to each other ($3.0 < dE_{00} < 8.0$), many even launched in the same year. This could reflect the fact that paint companies use similar raw data to identify color trends: Apparently, independent research by different parties pointed towards similar colors of the year, which hints at a certain *level of accuracy*.

Unfortunately, it is impossible to further quantify this *level of accuracy*. We can only determine how accurate the colors of the year are, if we have some form of agreement of what we are aiming for. One could argue that paint companies are aiming for increased sales, but correlating sales figures with corresponding colors of the year would only show which company is better in marketing their Color of the Year. Indeed, the very nature of the concept "Color of the Year" implies more attention in marketing campaigns of the respective paint companies, as well as attention from trend setting websites, magazines, etc. Another goal for paint companies could be to reduce their slow moving and obsolete inventory: Less left-over products directly reflects in the profitability of the company. However, the shelf life of most paint products exceeds the time span of a Color of the Year. In addition, there are much more reasons why excess paint becomes obsolete than color, e.g., changing regulations resulting in new formulations, improved product quality rendering older products out of fashion, and changing market demands regarding types of products.

To conclude, in this article we gathered and analyzed colors of the year of the last decade. However, most companies accompany their colors of the year with specially created trend collections in which the Color of the Year takes a prominent place. Moreover, some companies don't introduce one Color of the Year but rather introduce several colors of the year at the same time, resembling a trend collection but without one dominant color. For instance, the 2020 ColourFutures™ by AkzoNobel featuring the grey / blue / green Color of the Year "Tranquil Dawn" also includes a color palette of 37 different colors, which are subdivided into four smaller trendy colors palettes containing 9 colors (+ the Color of the Year) each, focused around four different themes: Care, play, meaning and creativity. Similarly, PPG introduced three so-called "color stories" around their Color of the Year, with the themes "in the know", "at the core" and "on the move", containing 20 colors (+ the Color of the Year) each. Valspar, on the other hand, introduced not one but twelve colors of the year in 2020. For future work, it would be very interesting to analyze these yearly trend palettes rather than the individual colors of the year.

BIOGRAPHIES

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REFERENCES

[1] T. D. Cassidy, "Colour Forecasting," *Textile Progress,* vol. 51, no. 1, pp. 1-139, 2019.

[2] T. Diane and T. Cassidy, Colour Forecasting, John Wiley & Sons, 2009.

[3] A. Kirberg, "Forecasting, Standardization, and the Americanization of Color," *Dress,* vol. 41, no. 2, pp. 81-94, 2015.

[4] Telegraph.co.uk, [Online]. Available: https://www.telegraph.co.uk/finance/newsbysector/mediatechnologyandtelecoms/8482964/Trend-spotting-is-the-new-36bn-growth-business.html. [Accessed 15 4 2020].

[5] K. Scully and D. J. Cobb, Color Forecasting for Fashion: Portfolio Skills, Laurence King, 2012.

[6] E. L. Brannon and L. Divita, Fashion Forecasting, 4th Ed., Bloomsbury, 2015, p. 166.

[7] J. King, Colour forecasting: an investigation into how its development and use impacts on accuracy, PhD Thesis, University of the Arts London, 2011.

[8] J. Stansfield and T. Whitfield, "Can Future Colour Trends Be Predicted on the Basis of Past Colour Trends? An Empirical Investigation.," *Color Research and Application,* vol. 30, no. 3, pp. 235-242, 2005.

[9] T. Whitfield and J. Whelton, ". The Arcane Roots of Colour Psychology, Chromatherapy, and Colour Forecasting," *Color Research and Application,* vol. 40, no. 1, pp. 99-106, 2015.

[10] L. Eiseman and E. Cutler, Pantone on fashion: A century of color in design, Chronicle Books, 2013.

[11] Y. Chen, J. Wang, Q. Pan, M. Vazirian and S. Westland, "A method of exploring word-colour associations," *Color Research and Application,* vol. 45, no. 1, pp. 85-94, 2020.

[12] K. S. Lee, *The Color of the Year: A Textual Analysis of Pantone's Color Communication Techniques through the Application of Barthes' Semiotic,* Masters thesis 378: https://digitalcommons.liberty.edu/masters/378, 2015.

[13] R. Heidari-Moghadam, A. Mortezapour, S. Mosaferchi and I. Dianat, "Colour and ergonomics: On the selection of a "colour of the year"," *Color Research and Application,* vol. 44, no. 6, pp. 1042-1044, 2019.

[14] Elle Decoration, [Online]. Available: https://www.elledecoration.co.uk/decorating/colours/a27742526/making-of-a-colour-trend-dulux/. [Accessed 08 05 2020].

[15] Architectural Digest, [Online]. Available: https://www.architecturaldigest.com/story/how-ppg-paints-much-debated-upon-color-of-the-year-was-crowned. [Accessed 08 05 2020].

[16] IEC 61966-2-1:1999/AMD1:2003, "Multimedia systems and equipment - Colour measurement and management - Part 2-1: Colour management - Default RGB colour space - sRGB," IEC, International Standard, 1999. Amendment 1: 2003.

[17] NCS Navigator online tool, [Online]. Available: https://ncscolour.com/design-old/work-digitally-with-ncs/colouring-to-a-new-level/. [Accessed 17 March 2020].

[18] W3schools online tool to convert from RGB to NCS., [Online]. Available: https://www.w3schools.com/colors/colors_converter.asp?color=ncs(6030-R90B. [Accessed 17 March 2020].

[19] E-Paint online tool to convert from CIE-Lab to NCS., [Online]. Available: https://www.e-paint.co.uk/NCS_1950_colour_chart.asp. [Accessed 17 March 2020].

[20] J. L. Caivano, "Research on color in architecture and environmental design: brief history, current developments and possible future," *Color Research Application,* vol. 31, no. 4, pp. 350-363, 2006.

[21] N. Smith, T. Whitfield and T. Wiltshire, "The accuracy of the NCS, DIN and OSA-UCS colour atlases," *Color Research and Application,* vol. 15, no. 2, pp. 111-116, 1990.

[22] G. Döring, "Color notation by visual interpolation in colour order systems: how accurate is it," *Color Research and Application,* vol. 15, no. 2, pp. 99-110, 1990.

[23] R. Choudhury, "Colour order systems," *Rev. Prog. Coloration,* vol. 26, no. 1, pp. 54-62, 1996.
[24] N. Smith, T. Whitfield and T. Wiltshire, "Research note on the accuracy of the NCS, DIN, and OSA-UCS colour atlases," *Color Research and Application,* vol. 15, no. 5, pp. 297-299, 1990.
[25] G. Moon, "Conflict Colors," *Design and Culture,* vol. 10, no. 3, pp. 369-377, 2018.