Visual customization

Diversity in color preferences in the automotive interior and implications for interior design

Wagner, Alexa-Sibylla; Kilincsoy, Umit; Vink, Peter

DOI
10.1002/col.22218

Publication date
2018

Document Version
Final published version

Published in
Color Research and Application

Citation (APA)
Wagner, A.-S., Kilincsoy, U., & Vink, P. (2018). Visual customization: Diversity in color preferences in the automotive interior and implications for interior design. *Color Research and Application*, *43*(4), 471-488. https://doi.org/10.1002/col.22218

Received: 13 January 2017 | Revised: 4 February 2018 | Accepted: 5 February 2018
DOI: 10.1002/col.22218

RESEARCH ARTICLE

WILEY

Visual customization: Diversity in color preferences in the automotive interior and implications for interior design

Alexa-Sibylla Wagner[1,2] | Ümit Kilincsoy[1,2] | Peter Vink[2]

[1] BMW Group Forschungs- und Innovationszentrum, Knorrstraße 147 Munich, Bavaria, DE 80788, Germany

[2] Faculty of Industrial Design Engineering, Delft University of Technology; Landbergstraat 15, Delft, CE 2628, The Netherlands

Correspondence
Alexa-Sibylla Wagner, BMW Group Forschungs- und Innovationszentrum, Knorrstraße 147 Munich, Bavaria, DE 80788, Germany.
Email: Alexa-Sibylla.Wagner@bmw.de

Abstract

Evolving multimodal mobility needs influences established human–product relationships and requires a deeper insight into color preferences for car interiors. Hence, a study was conducted in which 204 members of a web contest created 1,265 designs. After a peer-evaluation process, 53 most-appreciated and 34 least-preferred interior color compositions were identified and compared to identify patterns in color choices. Besides, visual lightweight design by layering of large interior components such as the seat, a modest use of color and patterns accompanied by repetition and the framing of the entire interior to create a feeling of spaciousness were found. Additionally, differences in the type of color between most and least favored color designs were found. Brown and beige occur more frequently among the top- than the worst-rated designs. Larger surfaces are favored in lighter hues and smaller components in darker hues.

KEYWORDS

color harmony, color preferences, interior car design, materialistic appearance, visual perception

1 | INTRODUCTION

Mobility needs are evolving due to an increasing demand for urban and multimodal mobility.[1] Simultaneously, a decrease in the use of cars is detected in studies of the IFMO institute among representatives of Generation Y[2,3] who prefer other modes of transport, for example, air travel, public transport, nonmotorized. Also, customer expectations are evolving toward individualization and sustainability, while new players from other sectors seek opportunities to play a role in the mobility market.[1]

The trend toward shared mobility both via peer-to-peer and business-to-consumer models is complementing conventional modes of transport.[1,2] Car-sharing business models with various car brand cooperation question the validity of owning a car for transportation reasons.[2] To understand these mobility trends and their effects on the car as a product per se, the interaction between product and user needs to be investigated. A product generally gets modified slightly during the human–product relationship as sort of an assimilation such as the users' customization of smartphones by protective covers in different colors or with additional functions.[4] Irrespective of ownership, apartments get painted and furnished in order for the inhabitants to feel at home; even unconventional items like car components can be turned into accessories for living rooms as furniture equipped with smart media interfaces (e.g., IKEA's Uppleva series). So, the eruption in the world of product categories leads to blurring boundaries. Even prestigious objects like tablet PCs or smartphones are only customized by their owners with personal settings, Apps, or additional protective covers. Therefore, a variety, which is not fulfilled by the product itself, can be added later on by users with purchases of colorful covers made from silicone or plastic.[4]

Since studies by the authors indicated that exterior and interior design are crucial motivators for buying or leasing cars, the respective product that should be studied further is the automotive interior with a focus on customization. Any interdependencies by exterior design aspects like form (body type, i.e., convertible, coupé, SUV, or sedan), shape (exterior design language created by stylistic elements), and color (painting) are excluded from the study. Given that the

FIGURE 1 Car interior colors of the last century: BMW 502 convertible with green leather seats and light green exterior, wooden dashboard and trims, and ivory-colored steering wheel (left); BMW Z8 roadster with black leather seats, blue dashboard, and trims, the number of interior colors is limited to black and blue[17] [Color figure can be viewed at wileyonlinelibrary.com]

interior serves as an interaction threshold for driver and passenger, the importance of the interior car design for functional and aesthetic customization is a plausible conclusion.[4]

Color is considered to be an important element of environmental design and is related to psychological, physiological, and social reactions of humans, and aspects of environments both aesthetic and technical,[5] and thus color is an element worth studying for aesthetic customization.

1.1 | Color vision and color classification

The literature about color ranges from the definition of color vision by the human visual cortex[6,7] influenced by individual experiences[8] to diverse color classification systems.[6,7,9–14] However, the interaction of color with a specific object seems to change the viewer's preferences.

1.2 | Color preferences

The physical environment influences the performance and mood of people.[15] Color plays a role in the environment, but there are doubts about the exact effects on human beings and their behavior in relation to specific colors.[16] Additionally, colors are related to decision processes on what customers like and dislike.[17] Human color preferences are classifiable into three types: phenomenological (i.e., experience-based), biological (i.e., neural activity to distinct colors), and ecological (i.e., affective responses to colors).[18] In Bakker's study of 1095 Dutch people[19] about color preferences significant relationships were found relating to gender,[20,21] education, age,[22–24] culture,[25,26] and personality traits.[22,27] For instance, males preferred the color blue, while most females had no color preference. Nonetheless, there are also studies in literature with no distinct relationships between gender.[17,28] This changed slightly when the respective object was considered as well, for example, black was identified by Bakker as the overall favorite color for clothing for females and blue for males, but no preference was given for yellow in the sample[22]; the preference for building interiors was white. This was also proven by Kwallek.[29] Additionally, the low chroma colors of light blue, light aqua green and off white were favored for workspace interiors[27,30] inclining toward a dependency on the lightness of color.[31,32] Brown is never named as a favorite color, yet it is favored as a color for carpets and sofas,[33] due to culturally imprinted preferences for material to have a natural, or elegant appearance.[34,35] Historically, wood is a common interior material,[36] which was also used for dashboards and trims in car interiors (cf. Figure 1 left).[17]

Red and black as clothing colors are attributed with higher attractiveness, indicating a psychological influence on wearers and raters.[37] The influence of hue, tone, and texture were proven to be significant in fashion fabrics with colors like yellow-red, and red hues, or light, or dark grayish tones regarded as elegant,[38] whereas saturated reds were identified to be generally disharmonious in combination with other colors in studies.[18] But color perception per se is influenced beyond saturation, chroma, and hue by the respective viewing angle, amount and type of ambient light, and the presence of other colors or further environmental conditions.[39–42]

Since the car interior represents an interior with large surfaces, and is also a workspace with driving being the work task and the seat as furniture, the color preferences could be similar and are therefore investigated further.

1.3 | Test methods for color preferences and the translation to car interiors

The psychological domain of color perception offers a broad field of different research techniques. The very diverse test methods for color preferences[22,24,27,29,31,43–45] cannot easily be applied to car interiors (cf. Figure 1) as it is a specific environment with specific individual demands. Additionally, as shown in the literature, the interaction between the colored object and the color itself is decisive. Bakker stated that because of the differences in applied test materials, methods and models and different contexts in color research studies, a comparison of the results is not easy. Also, experiments in artificial settings and a sample consisting of students might neglect the situational context of color and therefore bias the results.[15,46]

Bakker found no preferences for yellow in her studies of workspace interiors, whereas Cubukcu's results showed a strong inclination to yellow exterior façades of buildings explained by the frequency of yellow buildings of the sample's home country (Cubukcu's description of buildings in Turkey, 2008).[31] The contextual influence on the color preference of humans regarding their affective responses is assumed to play an important role in car interiors (cf. building exterior study of Cubukcu).[31] Preferences also can vary as a function of lightness, for example, color preferences for most objects increased as the colors became darker, as opposed to the color preferences for walls and trims, which showed an inclination for being lighter.[32] There is also an "appropriate" color for objects varying from object to object or even types among objects (e.g., different types of automobiles) accompanied by other dimensions such as wall colors giving the impression of space or luxuriousness of cars.[32] The interaction of color and spaciousness of large surfaces such as walls is interesting. Considering the large surfaces of the car interior such as seats, floor carpet, roof lining, and so on versus trims, the color could evoke a specific feeling like spaciousness or crampedness. Thus, the components are visually segmented. By a first overview of major differences between the best-, and worst-rated interior designs, the authors established the following hypotheses:

1. According to Poldma,[47] interior environments along with their designs are profoundly influenced by a combination of color and light with form and space (2009). The human perception is a result of the interaction with light and its color effects on the surrounding environment.[48] In case of an adequately lit environment, a mediation of the use of space can be reached.[49] Aside from spaces modulated by light and color[50] in a dynamic way (e.g., by projections or lighting), a simple color change is a rather static approach. The term a "visual lightweight design" by the authors describes a design of a more lightweight appearance by subdividing interior components by color coordination (Hypothesis 1). For instance, interior components like the seat, door trims or dashboard can be mostly characterized as large surfaces. By using different hues, saturation, or patterns, subcomponents of those parts can be clustered and therefore appear visually more lightweight (cf. Figure 1). Harmonious impressions are reached by the layering of colors due to the constant underlying color which influences the entire composition.[51]

2. Modest use of color and pattern variety (Hypothesis 2): in accordance with the literature on color preferences[17,18,27,30,31,33,38,52] and common fashion trends of car interiors the researchers did not expect a wide variety of colors and patterns among the most-appreciated designs. Brown, black, or beige are estimated to be typical colors of car seats comparable to furniture or sofas.[33] Tofle stated that harmony principles could help to create a pleasing ambience of interiors, but individual taste varies among people and changes over time.[5] However, the question arises whether this particular color choice results from having future resale in mind rather than actual preference, and whether representatives of Generation Y would favor the same colorings.

3. Repetition as a design discipline to achieve harmony is applied by color as the most common and important means for repetition.[51] So, the researchers expect a certain repetition of colors and grouping of elements (Hypothesis 3). The interior design is expected to be categorized by repeating colors. Parts of the seats, door trims, and dashboard can be grouped by the same or very similar colors. Considering car interior colors in consumer choices, Figure 1 shows the similar choices of interior colors compared to the exterior color of the car. For instance, the Z8 interior repeats the blue color in the dashboard, parts of the center console, door trims, and seat back panel.

4. Framing of the interior (Hypothesis 4): The automotive interior is framed by either floor carpet or roof lining; therefore, the researchers assumed a distinct pattern in the use of colors and the resulting evaluation of the community members comparable to the color preferences of building interiors.[22,27,30–32]

1.4 | Crowd sourcing by communities

An interesting way to innovate is described by von Hippel.[53] His approach suggested individual users as additional sources of innovation beyond producers and managers from within the car manufacturing company.[53,54] Crowdsourcing represents a part of this open innovation paradigm in which customers, suppliers, or universities are actively integrated in the value-added process.[55] User involvement in product innovation and design by toolkits can create value in the business-to-consumer relationship by heterogeneous customer preferences.[56] Both authors describe toolkits as a design interface which enables trial-and-error experimentation and gives simulated feedback on the respective outcome to users. In the case of clothing, user involvement addresses individual needs and preferences caused either by fashion or business niches.[57] As a result, the users' willingness to purchase increases (Kamali & Loker, 2002) due to the

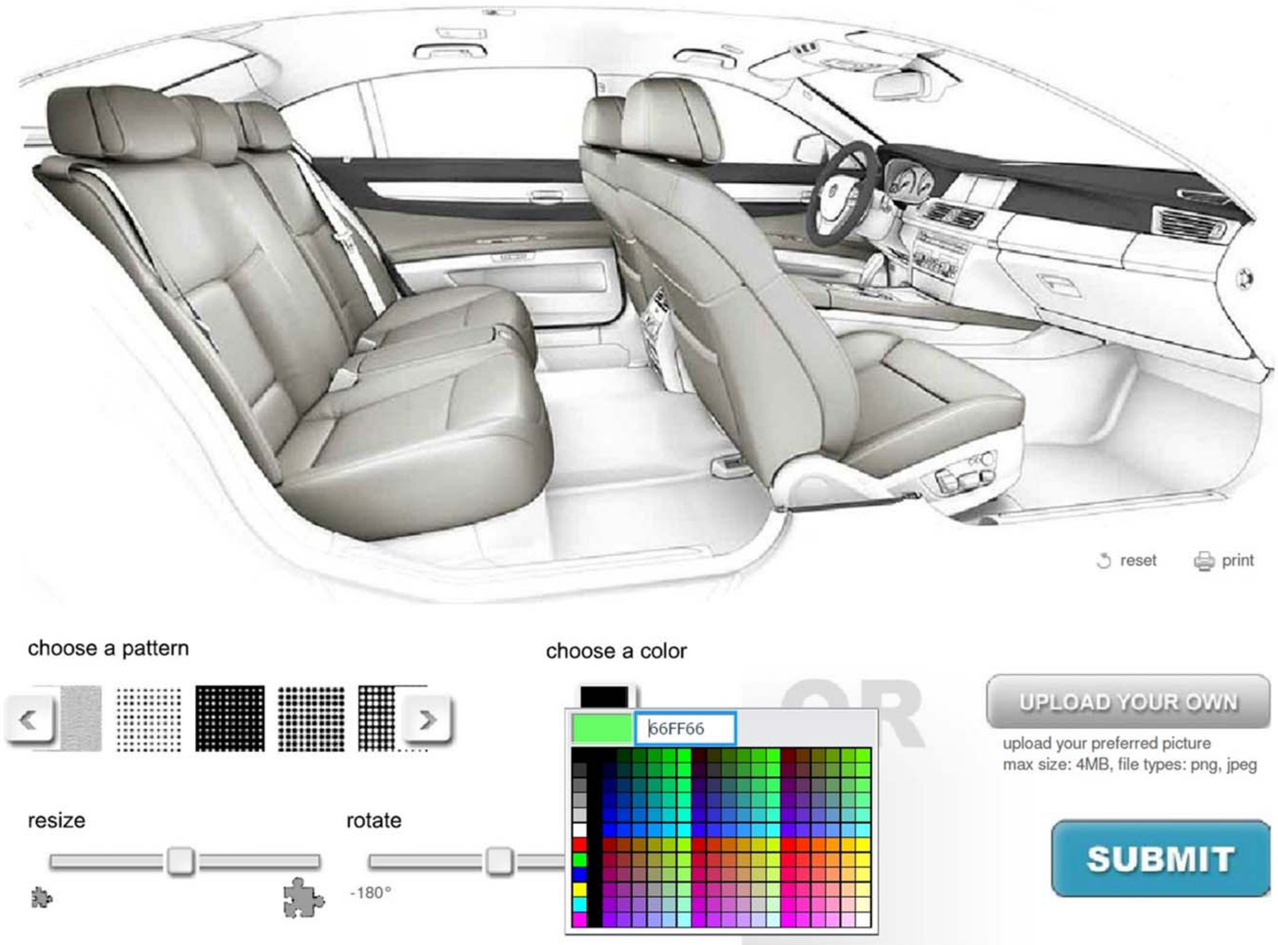

FIGURE 2 The gray car's interior before choosing a pattern/texture or color (the HSL color model: hue, saturation, lightness) [Color figure can be viewed at wileyonlinelibrary.com]

attribution of greater value of unique products compared to common ones.[58,59] Crowdsourcing can be a promising method to gather user ideas which can complement the idea generation of professionals.[55,60] In addition to lead user research, knowledge sharing and co-development in communities[56,61] follow a similar paradigm, for example, to solve an own need.[54] Users can also provide solution-based information in the idea generation of the new product development process[60] and, in case of brand communities, they have extensive product knowledge and are enthusiastic in product-related discussions.[61] Poetz's study[60] also highlights that user ideas score higher in terms of novelty and customer benefit. However, the users' capabilities and motivation in combination with the design of the crowdsourcing process tend to be determining factors for the successful application.[60] The PhD thesis of Wiegandt[62] shows the value creation potential of firmly established brand communities as a long-term competitive advantage through fostered relationships and increasing involvement.

Consequently, crowd sourcing seems a valuable approach to identify specific preferences of colors for automotive interiors.

2 | METHODOLOGY

To verify the four hypotheses, a web 2.0 community was used as a sample. Additionally, international participants were invited via blogs, social networks (e.g., Facebook), advertisements in automotive portals and women's blogs, design platforms and universities (e.g., in the Netherlands and Romania) active in design with a special focus on recruiting Chinese participants in their native language. Upon entering the web community, the participants had to register first while answering sociodemographic questions and questions regarding creativity and about the gateway for the contest. The aim of the contest was mainly to create product ideas for customization of the automotive interior, and the winners were decided after a peer-review process and a jury meeting. To motivate the participants and enhance their creativity,[63] a gray automotive interior of a BMW 7 Series was illustrated (Figure 2). For customizing the whole interior, the subjects could select the automotive interior elements (e.g., seats, back panels, dashboard, roof lining, floor carpet, door trims, etc.), define the structure (e.g., granulite, tiger print, etc.), and select the color. No incentives were awarded for the resulting designs specifically, so, this survey was a by-product of the contest. For each element, the researchers recorded how they were colored, the number of different colors and textures used per element, and the combination of colors and textures along with the peer evaluation of the resulting interior design. The hypotheses about the color preferences of car interiors are studied in relation to the evaluation of the sample. Visual Lightweight Design of dominant elements such as the seats can be realized by different colors of cushion and back panel (cf. BMW Z8 interior in Figure 1). For instance, the black leather seats combined with a blue back panel, the same blue hue, which is repeated in parts of the dashboard, door trims, center console and steering wheel (Hypothesis 1). A way to attain this impression is to repeat and group parts of these dominant interior components by applying the same or similar colors changing in hue or saturation (Hypothesis 3). Consequently, aside from repetition as a design principle to achieve harmony, the technique of variety is applied resulting from a use of pure hues combined with shades of a hue related to the parent hue.[51] Furthermore, the interior is framed by the large surfaces, that is, roof lining and floor carpet by a unique use of color or pattern (Hypothesis 4). Simultaneously, most-appreciated interior designs would follow common trends of colors for interiors and furniture Hypothesis 2). To identify these differences in color designs of car interiors, the most-appreciated ones are compared to the least-appreciated ones.

2.1 | The participants of the study

One thousand and seventy-five members participated in the community of the BMW Interior Idea Contest (Figure 3) from which 358 active members handed in one or more product ideas or configured designs.[17] Two hundred and four participants—179 males and 25 females—created 1,265 configured designs by changing the gray interior components of a BMW 7 Series in color or pattern (Figure 2). The three most productive members generated 402 ideas and 355 color combinations during the contest span of almost two months.

The sample consisted of a majority aged from 15 to 39 years, originating from various countries, for example, USA (18.1%), Germany (11.8%), Portugal (4.4%), India (3.9%), UK (3.4%), the Netherlands (2.9%), and China (2%). Whereas most of the participants lived in cities (major city 45.6%, small town 33.3%, megacity 10.8%) rather than rural areas (6.9%), their living conditions differ from being single and living in a household with other people (27.5%) to single and living alone (24.5%), or married with children (13.2%). Regarding the working background of the members only 10.3% showed a connection with the automotive industry. The participants own one or two cars (39.7%, 32.4%),

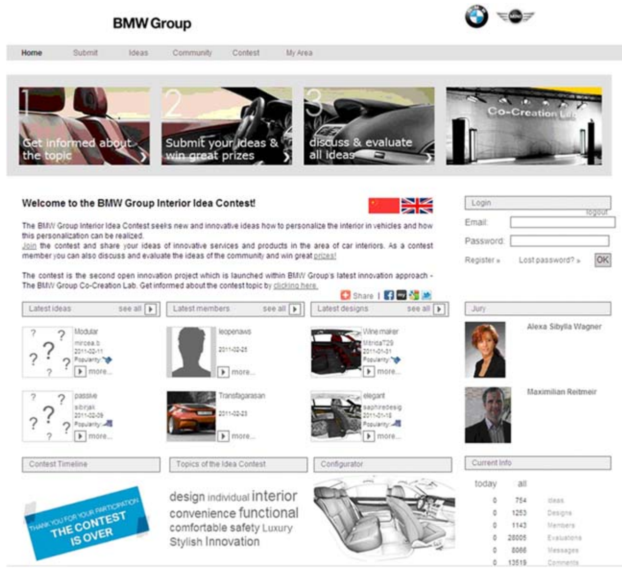

FIGURE 3 The web-based idea contest for automotive interior customization (left); the evaluation based upon the emotional responses of approach and avoidance for the criteria "I like this idea" and "I would use this idea"[17] [Color figure can be viewed at wileyonlinelibrary.com]

driving one to two hours per day by facing urban traffic (47.1%), or highways (32.6%). There is no inclination to particular car brands, which could facilitate an open-minded judgment of the colored interiors.

2.2 | Online crowd sourcing setup

The focus of the contest (Figure 3) was the crowd sourcing of ideas for customization of the automotive interior in three categories: function & convenience, style & design, and personal experiences. The participants were motivated by incentives for winning the contest, and features for interaction were installed, for example, comments, messaging and a tag cloud. Compared to the main part of the contest, this part was only evaluated by the community according to the two criteria "I like this design" and "I would use this design" (Figure 3), therefore focusing on the affective states of approach and avoidance.[45]

2.3 | Color configuration

To get an impression of the focus of the contest, that is, the customization of the automotive interior, an illustration of a typical BMW interior was used as a configurator to start the creative process.

Seventeen components within the interior could be individualized by 12 basic colors: black, dark gray, gray, light gray, very light gray, white, red, green, blue, yellow, cyan, and magenta. Additionally, the colors could be blended by three numbers in a HSL model color space[31] (cf. Figure 2). Like in Cubukcu's study of manipulated façades, the interior

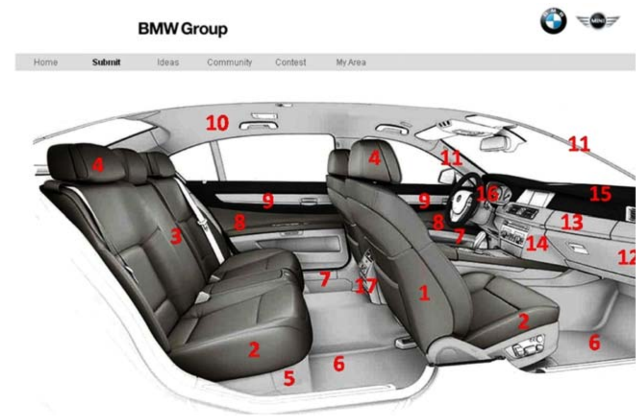

FIGURE 4 The 17 interior components (1, seat back panel; 2, seat cushion; 3, center console's back; 4, headrest; 5, seat frame and trims; 6, floor carpets; 7, door trims bottom; 8, door trims middle; 9, door trims top; 10, roof lining; 11, A-pillar; 12, glove box; 13, dashboard trims; 14, center console/radio; 15, center stack; 16, steering wheel; 17, center console) that could be adapted in hue, saturation, and lightness (HSL Model) or even combined with 30 different patterns (as shown in Figure 2) [Color figure can be viewed at wileyonlinelibrary.com]

components could be changed in hue and in saturation from white to a fully saturated color as well as in lightness from dark to light resulting in diverging chroma.

Considering the patterns, each component could be individualized by 30 patterns with the possibility to rotate from −180° to +180° (as shown in Figure 2) and resize the pattern from small to big. Also, members were able to upload their own pictures as types of pattern, for example, logos of luxurious brands (Figures 7 and 9).

The 17 components of the interior (1, seat back panel; 2, seat cushion; 3, center console back; 4, headrest; 5, seat frame and trims; 6, floor carpet; 7, door trims bottom; 8, door trims middle; 9, door trims top; 10, roof lining; 11, A-pillar; 12, glove box; 13, dashboard trims; 14, center console/radio; 15, center stack; 16, steering wheel; 17, center console) can be categorized into seats (back panel, cushion, headrest, seat frame and trims, middle part of rear seating), floor carpet, door (door trims at the bottom, middle and upper part), roof lining (roof lining, A-pillars), and dashboard (glove box, dashboard trims, dashboard center stack, steering wheel, center console/radio, center console) (Figure 4).

2.4 | Rating process and color analysis

By choosing "I like this design," the users evaluate their appreciated designs, that is, 264 designs which happen to be 21% of all designs. The second criteria "I would use this design" results in 53 top designs, that is, 4% of all designs (Figure 5). The sample favored 29 designs, but without any intent to use it. Opposing to the top designs, the researchers identified 34 designs that were neither appreciated by the peer reviewers nor considered to use in a car interior. In this context, the rating of "I would use this design" resembles a potential purchase decision and hence is the strongest selection criterion. The three clusters, that is, top designs, worst designs and designs liked but not used are analyzed further regarding peculiarities of color choices applied in the interior and regarding characteristics such as layering, repetition, and the level of variety. Therefore, the composition of top designs and worst designs are compared thoroughly. Additionally, it is tested whether specific regions, ages, or car drivers have a preference for a particular type of color or pattern combination. The researchers excluded haptics, environmental lighting conditions, and the exterior colors of the car from this study. Regarding color science, the focus is laid upon PC-colors. By a comparison of the top and worst designs, the most frequent hues are analyzed for each interior component to identify a pattern in color usage and a potential willingness to buy such an interior. Also, the color choices of more obtruding components like seats, dashboard, and door trims are compared in the top and worst designs to investigate the potential characteristics of a harmonic appearance (i.e., hypotheses). By conducting a Pearson correlation analysis, each component is searched for relationships to

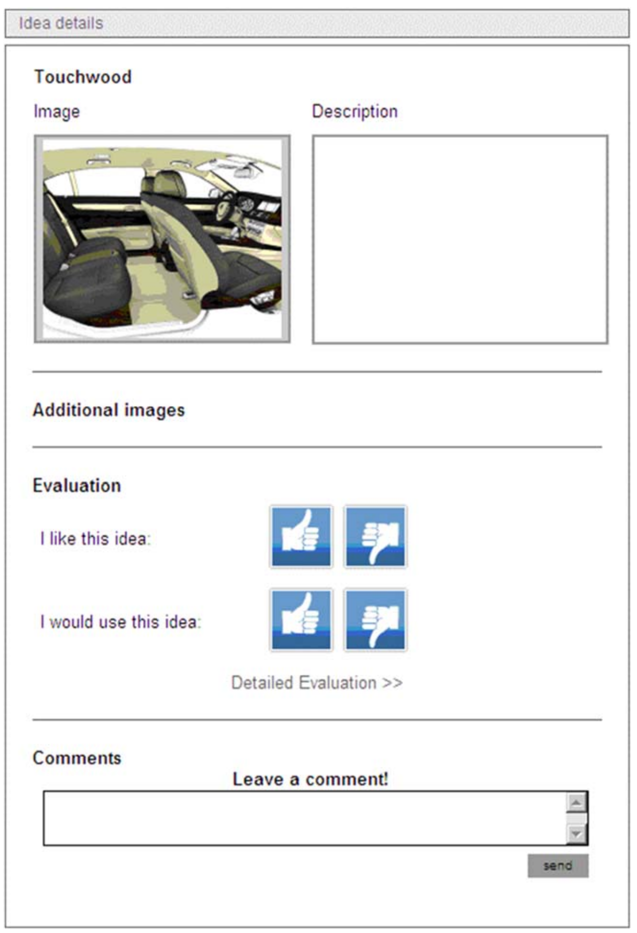

FIGURE 5 The peer-review of the interior designs of the community members among each other [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 1 Most frequent hues in either top designs, worst designs, and the designs that were appreciated but not intended to be used which means no intention to buy such an interior design

	Top designs (%)	Worst designs (%)	Like no use (%)
Black	28.3	24.8	28.4
Brown	15.2	5.1	9.8
Beige	13.0	1.5	7.8
Grey	10.3	14.6	15.7
White	5.4	8.0	7.8
Red	4.9	6.6	8.8
Green	4.3	10.9	2.0
Blue	2.7	5.8	5.9
Orange	1.6	6.6	1.0
Yellow	7.1	4.4	3.9
Cyan	1.6	1.5	6.9
Magenta	5.4	7.3	1.0
Purple	0	2.9	1.0

prove the hypotheses of Visual Lightweight Construction (Hypothesis 1), an adequate level of variety (Hypothesis 2), repetition of colors and clustering of elements (Hypothesis 3), and the framing of the interior by the applied color (Hypothesis 4). All the tests are used equally for the top- and worst-rated designs. To prove the validity of the hypotheses for well appreciated and harmonious designs, the authors expect that the distinctive peculiarities for those designs cannot be found among the 34 worst-rated designs. This leads to guidelines for harmonious car interiors.

3 | RESULTS

The community changed the gray car's interior by colors and patterns and evaluated the designs without an external jury's interaction. The colors can be created by a scale blending 6 × 36 colors (Figure 2). The researchers categorized all colored designs in 13 colors by clustering according to the findings in literature, such as black, brown, beige, gray, white, red, green, blue, orange, yellow, cyan, magenta, and purple. Furthermore, the designs are clustered corresponding to their evaluation in top designs ($n = 53$), worst designs ($n = 34$), and designs appreciated; but no intent to use them ($n = 29$).

The resulting demographics represent similar distributions of family status, population area, and gender among the designers of top designs, worst designs, and designs liked but not used. However, other criteria show different distributions among the contest participants. For instance, import/export business (31.9%) is rated first, followed by the automotive industry (22.4%), then architecture (17.6%). Among the sample's age, the groups of 20–24 years (20.7%) and 40–44 years (22.4%) are more frequent than others but with a tendency for younger and middle-aged people (total age span: 15–44 years). Regarding the mobility behavior, the majority of participants have no car (48.3%) or hatchbacks (46.6%). This specific sample shows a rather strong to very strong inclination for innovativeness (54.3% and 26.7%), rated by a 5-point Likert-Scale.

Table 1 illustrates the most frequent colors of the top interior designs, worst interior designs, and the interior designs that were appreciated but would not lead to a positive purchasing decision. Black is the most frequent color in all the designs regardless of the rating of the interior design. Whereas the top designs contain brownish hues (brown: 15.2%, beige: 13.0%), the worst designs contain gray (14.6%), followed by green (10.9%).

3.1 | Top designs

The 53 top-rated interior designs can be characterized by a modest use of diverging colors and patterns. As shown in Figure 6, generally three diverging colors are combined to subdivide interior components; hues and patterns are used to support this effect. Therefore, large parts of the automotive interior, for example, seats appear visually more lightweight which explains the rather high percentage of 84.9% applying

FIGURE 6 Two examples of the most-appreciated designs, succeeding in both evaluation criteria: use and like [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 2 The most-appreciated designs' color distribution of the seat components: cushion, belts, back panel, headrests, middle part rear seating, and seat frame and trims above and below 5% (unity: frequency [%])

	Seat cushion	Seat belts	Seat back panel	Middle part rear seating	Head rests	Seat frame
Black	9.4	20.8	9.4	7.5	13.2	13.2
Brown	17.0	9.4	15.1	28.3	17.0	15.1
Beige	26.4	18.9	26.4	20.8	28.3	22.6
Grey	11.3	17.0	11.3	11.3	13.2	11.3
White	1.9	3.8	5.7	1.9	1.9	5.7
Red	7.5	3.8	11.3	9.4	3.8	7.5
Green	5.7	5.7	7.5	3.8	3.8	7.5
Blue	7.5	1.9	1.9	1.9	5.7	3.8
Orange	3.8	3.8	0	0	1.9	0
Yellow	3.8	7.5	5.7	5.7	3.8	7.5
Cyan	1.9	0	1.9	5.7	3.8	1.9
Magenta	3.8	7.5	3.8	3.8	3.8	3.8

different colors, hues, or patterns for seat back panel and seat cushion.

By a subjective visual analysis of the top interior designs, the interiors tend to be more uniform and harmonious. A closer look at each component might explain this impression. Tables 2–5 illustrate the color distribution of components within the car's interior that are most appreciated accompanied by a willingness to buy such an interior.

The seat is one of the most dominant parts in the interior consisting of seat cushion, seat belts, seat back panel, headrests, middle part rear seating and seat frame and trims. The most predominant colors are brown and beige ranging from

TABLE 3 The most-appreciated designs' color distribution of the door trims components: bottom, middle, and top (unity: frequency [%])

	Door trims bottom	Door trims middle	Door trims top
Black	5.7	17.0	1.9
Brown	15.1	11.3	30.2
Beige	24.5	28.3	20.8
Grey	15.1	15.1	11.3
White	7.5	3.8	5.7
Red	13.2	5.7	11.3
Green	7.5	3.8	5.7
Blue	3.8	5.7	3.8
Orange	1.9	1.9	0
Yellow	3.8	3.8	3.8
Cyan	0	0	1.9
Magenta	1.9	3.8	3.8

TABLE 4 The most-appreciated designs' color distribution of floor carpet, roof lining, and A-pillars (unity: frequency [%])

	Floor carpet front_back	Roof lining	A-pillar
Black	9.4	11.3	18.9
Brown	13.2	7.5	11.3
Beige	35.8	37.7	28.3
Grey	17.0	20.8	18.9
White	5.7	5.7	3.8
Red	5.7	3.8	5.7
Green	0	1.9	3.8
Blue	3.8	1.9	3.8
Orange	1.9	0	0
Yellow	3.8	7.5	3.8
Cyan	0	0	0
Magenta	3.8	1.9	1.9

TABLE 5 The most-appreciated designs' color distribution of the cockpit components including steering wheel (unity: frequency [%])

	Glove box	Dashboard trims	Center stack	Steering wheel	Center console front	Center console
Black	15.1	1.9	15.1	24.5	1.9	13.2
Brown	13.2	37.7	13.2	11.3	18.9	24.5
Beige	24.5	17.0	22.6	17.0	32.1	17.0
Grey	13.2	9.4	15.1	11.3	9.4	17.0
White	5.7	3.8	3.8	5.7	5.7	0
Red	9.4	9.4	7.5	9.4	9.4	9.4
Green	7.5	5.7	7.5	3.8	7.5	3.8
Blue	0	5.7	1.9	3.8	1.9	5.7
Orange	1.9	0	1.9	1.9	1.9	1.9
Yellow	3.8	3.8	3.8	5.7	5.7	1.9
Cyan	0	1.9	1.9	0	0	1.9
Magenta	5.7	3.8	5.7	5.7	5.7	3.8

15% to more than 25%, except the seat belts which are most frequently colored black (>20%; followed by beige and gray). Although colors like red, green, blue, or yellow exceeded the 5% range for some seat components, the overall distribution remains below 5% in the entire interior (cf. Table 2) which indicates that the need for uncommon colors in car seat design exists, but is a niche market.

The color variation of the doors (Table 3) within the top-rated designs seems to correspond to the findings of the seat. In either door trims at bottom, middle, and top, beige and brown are used frequently from 10% to 30%, but complemented by gray, black, and red (>10%). Less common colors such as green, white, blue, yellow, orange, and magenta are seldom requested (slightly above and below 5%).

The large-scaled components like floor carpet or roof lining added by the A-pillars show a strong inclination for beige and gray from 15% to more than 35% of the designs, that is, lighter hues of the color variety, but also black and brown above and below 10%. There is a decisive difference according to the sizes of the surfaces, for example, the A-pillar as much smaller parts are favored comparably more in black than floor carpet and roof lining (cf. Table 4).

Table 5 displays the color distribution of a conglomerate of dashboard parts, steering wheel, and center console. Whereas the use of brown, black, and beige define the coloring of those parts, there is a slight difference between larger and smaller parts. The larger parts are more frequently colored in beige or sometimes brown. Simultaneously, the smaller parts tend to be colored in darker colors like black comparable to the findings of the A-pillars, roof lining, and floor carpet.

An analysis of the differences in usage of patterns shows that mostly no pattern was applied to the components. Furthermore, the second most frequently used pattern differed among each component with an occasional use of extra patterns, that is, an individual creation and uploads of patterns (cf. Figure 7: the use of two most frequently used patterns).

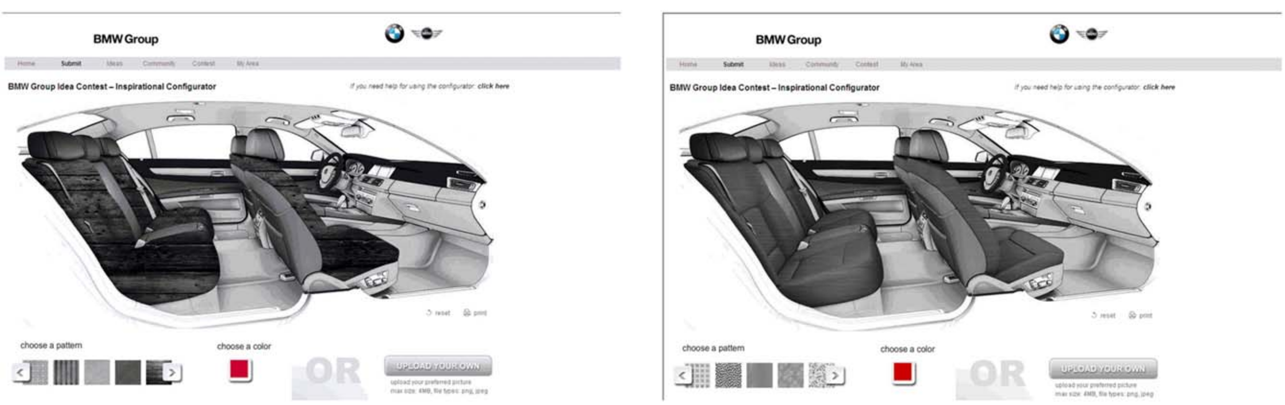

FIGURE 7 Examples of pattern changes in the configurator (left: wooden appearance of the seat; right: brushed aluminum look) [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 6 Summary of the Pearson Correlation analysis of top designs

	Pearson correlation
Colors of seating	
Seat back panel & seat frame and trims	0.751*
Seat cushion & headrests	0.886*
Middle part rear seating & headrests	0.751*
Colors of door trims	
Door trims bottom & steering wheel	0.649*
Door trims middle & center/radio console	0.674*
Door trims top & dashboard trims	0.779*
Colors of surrounding parts	
Floor carpet & steering wheel	0.673*
Roof lining & dashboard trims	0.640*
A-pillar & door trims top	0.736*
Colors of surrounding dashboard parts	
Dashboard & glove box	0.857*
Steering wheel & center/radio console	0.703*
Steering wheel & glove box	0.730*
Center console & center stack	0.642*
Color & pattern of seating	
Seat cushion & headrests	0.803*
Middle part rear seating & seat back panel	0.738*
Seat back panel & floor carpet	0.911*
Headrests & roof lining	0.828*
Seat frame & seat back panel	0.770*

**Note*. The significance level (i.e., the probability the correlation equals zero) is <0.0005 for all correlations in the table.

No paradigm can be identified among the different patterns and particular colors in the remaining components of car interiors. An intense relationship between hue, saturation, and lightness or chroma in agreement with the principles of variety for harmonious design could be found.[51]

A Pearson correlation analysis of the interior components resulted in significant findings except in the pairings of seat back panel/floor carpet, floor carpet/middle part rear seating, and floor carpet/dashboard trims, which indicates no dependencies on their colorings for those respective parts (cf. Table 6). The strongest significant correlations of seating components were found between seat back panel and seat frame and trims ($\rho = 0.751$), seat cushion and headrests ($\rho = 0.886$), and middle part rear seating and headrests ($\rho = 0.751$). Therefore, the material of the different seat parts can be differentiated into plastic parts and cushion parts with similar upholsteries (cloth, artificial leather, and leather). The doors have strong correlations corresponding to the various positions: door trims bottom and steering wheel ($\rho = 0.649$), door trims middle and center/radio console ($\rho = 0.674$), and door trims top and dashboard trims ($\rho = 0.779$). Consequently, in those parts the various locations of the parts influence the colors of the parts close by. The surrounding parts floor carpet and roof lining also show correlations (floor carpet & steering wheel $\rho = 0.673$, roof lining & dashboard trims $\rho = 0.640$, A-pillar & door trims top $\rho = 0.736$). Comparable to the seat components, the dashboard components show strong correlations with each other (dashboard & glove box $\rho = 0.857$, steering wheel & center/radio console $\rho = 0.703$, steering wheel & glove box $\rho = 0.730$, center console & center stack $\rho = 0.642$). Again, the common materials of car interiors seem to influence the color choices of interior components as those parts mostly display a similar appearance. For instance, the steering wheel and glove box are commonly covered in leather or plastic covered with foam or foils with the same grain to create a harmonious interior through repetition and variety. Between colored components and patterns, few, and weak significant correlations could be found. A paradigm cannot be identified among the different patterns and particular colors in the remaining components of car interiors in both tests. The patterns of interior parts show strong correlations to other component's patterns. In the case of seating parts, there are not only correlations to seating parts (seat cushion & headrests $\rho = 0.803$, middle part rear seating & seat back panel $\rho = 0.738$), but also other components (seat back panel & floor carpet $\rho = 0.911$, headrests & roof lining $\rho = 0.828$, seat frame and trims & center console $\rho = 0.537$, glove box & seat cushion $\rho = 0.562$, steering wheel & seating back panel $\rho = 0.770$). Consequently, the use of patterns in the top-rated designs complies with common materials of car interiors, although, a harmonious interior requires a repetition of materials in adjacent parts, and parts with the assumed similar consistency.

3.2 | Worst designs

The 34 worst-rated interior designs can be characterized by a broad use of diverging colors and patterns. In Figure 8, generally three diverging colors are combined to cluster interior components with the help of hues and patterns. Despite the top designs, large parts of the least-preferred and used designs are less frequently subdivided by color, saturation, or pattern. For instance, this visual segmentation of seat cushion and back panel shows a lower percentage of 73.5% compared to the top designs.

FIGURE 8 Two examples of the least-appreciated designs, failing in both evaluation criteria either use and like [Color figure can be viewed at wileyonlinelibrary.com]

The interiors of the worst-rated designs seem to be more diverse and less uniform; therefore, a more thorough analysis is needed. In addition to the use of black (24.8%), gray (14.6%), and green (10.9%) are the most common colorings of these interiors. The brownish colors are chosen in <5%.

Tables 7–10 illustrate the least-appreciated color distribution of components within the car's interior, accompanied by an unwillingness to buy such an interior. The most noticeable colors of seat components are green, gray, and red despite the seat belts which are most frequently colored white. Green is more frequent in cushion, middle part rear seating, and headrests than in the rest of the parts. For seat belts, back panel and seat frame and trims, gray outweighs the rest of the colors. Additionally, various colors like magenta, yellow, purple, white, or blue exceeds the 5% range for seat components and the overall frequency of these colors among all the interiors of the worst designs is also above 5% (cf. Table 7).

The doors show a similar color distribution to the seats with an intense use of green, gray, red, and yellow (Table 8). Compared to the top designs, the color choices of the doors of the less-appreciated designs resemble the findings of the seat. However, the door trims at the middle height level shows no use of green, like the rest of the door trims which indicates a framing effect or the design principle of variety even among the least-appreciated designs.

Even large-scaled components like floor carpet or roof lining show no inclination for hues other than gray and green (cf. Table 9). However, the large-scale surfaces (floor carpet, roof lining) differ from the A-Pillar color use in the frequency of green (>15% in floor carpet and roof lining, < 15% in A-pillars) and white (>15% in A-pillars, about 10% in floor carpet and roof lining).

In Table 10, the color usage of dashboard parts, steering wheel, and center console of the least-preferred designs is

TABLE 7 The least-appreciated designs' color distribution of the seat components: cushion, belts, back panel, headrests, middle part rear seating, and seat frame and trims (unity: frequency [%])

	Seat cushion	Seat belts	Seat back panel	Middle part rear seating	Head rests	Seat frame
Black	2.9	5.9	0	0	0	2.9
Yellow	2.9	5.9	2.9	5.9	11.8	5.9
Cyan	2.9	2.9	2.9	0	2.9	0
Magenta	5.9	5.9	8.8	11.8	5.9	11.8
Purple	8.8	0	2.9	5.9	8.8	0
Brown	2.9	0	2.9	5.9	2.9	5.9
Beige	5.9	0	5.9	2.9	2.9	5.9
Grey	14.7	29.4	29.4	14.7	17.6	26.5
White	8.8	20.6	8.8	5.9	5.9	14.7
Red	8.8	11.8	2.9	17.6	8.8	2.9
Green	20.6	8.8	17.6	17.6	20.6	5.9
Blue	2.9	2.9	8.8	5.9	5.9	5.9
Orange	8.8	5.9	5.9	5.9	5.9	11.8
Extra color	2.9	0	0	0	0	0

TABLE 8 The least-appreciated designs' color distribution of the door trims components: bottom, middle, and top (unity: frequency [%])

	Door trims bottom	Door trims middle	Door trims top
Black	0	8.8	0
Yellow	2.9	2.9	11.8
Cyan	2.9	2.9	5.9
Magenta	5.9	5.9	5.9
Purple	2.9	8.8	2.9
Brown	5.9	0	2.9
Beige	2.9	2.9	0
Grey	23.5	35.3	17.6
White	8.8	2.9	11.8
Red	5.9	14.7	5.9
Green	23.5	0	23.5
Blue	11.8	8.8	8.8
Orange	2.9	5.9	2.9
Extra color	0	0	0

illustrated. Whereas the use of gray, green, blue, magenta, and red defines the coloring of those parts, there is no difference between larger and smaller parts like with the top designs. Hence, the missing variety and equal colorings of adjacent parts result in the negative evaluation of the subjects.

The usage of patterns indicates that like among the top designs no pattern was chosen to individualize the components. However, the second most frequently used ones were the extra patterns created and uploaded by the users (cf. Figure 9).

A Pearson correlation analysis of the colors of interior components of the least-preferred designs was conducted for a thorough analysis (cf. Table 11). Less significant findings could be identified than among the top designs. The seating parts show strong significant correlations among each other and adjoining parts (back panel & headrests $\rho = 0.657$) like doors (back panel & door parts middle $\rho = 0.566$), dashboard parts (seat cushion & glove box $\rho = 0.976$), or the surroundings (headrests & roof lining $\rho = 0.660$). Hence, the colors of those parts are influencing each other. Additionally, the lateral perspective of the interior leads to strong correlations between components of the same height level (middle part rear seating & center/radio console $\rho = 0.640$). Very dominant parts, for example, floor carpet and seat cushion, seem to have an effect on the respective coloring ($\rho = 0.974$). The bottom and middle door trims show strong correlations to the A-pillar ($\rho = 0.660$), whereas the top door trims only show low correlations. The dashboard parts indicate strong correlations to each other (steering wheel & dashboard $\rho = 0.666$, dashboard trims & dashboard $\rho = 0.513$), but also to seating parts ($\rho = 0.640$) or surroundings, for example, roof lining ($\rho = 0.536$).

Though few correlations can be detected between color and pattern (floor carpet & seat cushion $\rho = 0.518$, glove box & seat cushion $\rho = 0.553$), there are comparable findings between the patterns of components regardless of color. For instance, seat parts or dashboard parts tend to have a strong relationship to other seat parts (back panel & seat frame and trims $\rho = 0.551$) or dashboard parts (dashboard & steering wheel $\rho = 0.975$), but also to adjoining parts (seat cushion & glove box $\rho = 0.896$) or of similar height levels (head rests & A-pillar $\rho = 0.950$). Regardless of the evaluation of an interior design, comparable dependencies exist among the colorings or color and patterns of the components. In comparison to the analysis of the top designs, significant relationships between color and pattern could be found. Hence, in the case of a not favorable design, color and pattern are both supporting this. Comparable to the top-rated designs, here the pairings of a component's color and hue also proves to be significant. Thus, the intense relationship between hue and saturation due to the principles of variety for harmonious design[51] cannot be the only reason for an evaluation of a car interior. Other significant findings

TABLE 9 The least-appreciated designs' color distribution of floor carpet, roof lining, and A-pillars (unity: frequency [%])

	Floor carpet front_back	Roof lining	A-pillar
Black	0	0	0
Yellow	0	11.8	5.9
Cyan	2.9	2.9	2.9
Magenta	11.8	2.9	2.9
Purple	2.9	5.9	2.9
Brown	11.8	5.9	2.9
Beige	.0	0	2.9
Grey	20.6	26.5	32.4
White	8.8	11.8	17.6
Red	8.8	11.8	0
Green	17.6	17.6	14.7
Blue	8.8	2.9	8.8
Orange	2.9	0	5.9
Extra color	2.9	0	0

TABLE 10 The least-appreciated designs' color distribution of the cockpit components including steering wheel (unity: frequency [%])

	Glove box	Dashboard trims	Center stack	Steering wheel	Center console front	Center console
Black	2.9	5.9	5.9	8.8	0	2.9
Yellow	2.9	11.8	2.9	2.9	8.8	5.9
Cyan	0	2.9	0	2.9	0	5.9
Magenta	2.9	11.8	2.9	5.9	5.9	11.8
Purple	5.9	5.9	5.9	2.9	0	5.9
Brown	5.9	5.9	11.8	5.9	2.9	0
Beige	2.9	0	2.9	2.9	2.9	5.9
Grey	23.5	20.6	17.6	20.6	26.5	23.5
White	5.9	8.8	8.8	5.9	14.7	2.9
Red	5.9	8.8	2.9	8.8	11.8	5.9
Green	14.7	14.7	14.7	14.7	14.7	14.7
Blue	11.8	2.9	11.8	8.8	2.9	11.8
Orange	11.8	0	11.8	5.9	8.8	2.9
Extra color	2.9	0	0	2.9	0	0

regarding gender or other sociodemographic data such as education or occupation could not be determined.

4 | DISCUSSION

The comparison of the findings of the top-rated to the worst-rated interior designs verifies all of the hypotheses of the study leading to stronger customer appreciation and as a next step to a positive buying decision for a specific car interior. The hypotheses of Visual Lightweight Construction (Hypothesis 1), a modest use of color and pattern variety in order to achieve a harmonic interior design (Hypothesis 2), the repetition and grouping of interiors by a systematic use of color or pattern (Hypothesis 3), and the framing of the interior by roof lining and floor carpet colorings (Hypothesis 4) are evaluated in relation to the peculiarities of the top-rated designs. Where the worst-rated designs proved the exact opposite, the hypotheses can be sustained. Concerning the color choices of both opposing interiors, black is the most frequently used color, although the major difference is the rest of the most frequent colors. Brownish hues, such as brown, cognac, or beige were commonly favored colors among the top-rated designs, whereas the worst evaluated designs showed a tendency for gray and green. Despite the diverging hues, the number of colors used simultaneously in an interior is identical. Generally, three colors were combined with the purpose of structuring the interior. While the number of diverging colors is an important evaluation criterion of the sample, the color composition and kind of colors of the components add up to an overall positive impression that harmonious designs are more decisive.

4.1 | Visual lightweight construction

Dominant parts of the interior like the seats, doors, or dashboard can be visually subdivided by applying different colors

FIGURE 9 Two examples of uploaded patterns evaluated as least-appreciated designs [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 11 Summary of the Pearson Correlation analysis of worst rated designs

	Pearson correlation
Colors of adjoining parts	
Seating back panel &headrests	0.657[a]
Back panel & door parts middle	0.566[a]
Seat cushion & glove box	0.976[a]
Headrests & roof lining	0.660[a]
Colors of parts of the same height level	
Middle part rear seating & center/radio console	0.640[a]
Colors of dominant parts	
Floor carpet & seat cushion	0.974[a]
Bottom/middle door trims & A pillar	0.660[a]
Colors of surrounding dashboard parts	
Steering wheel & dashboard	0.666[a]
Dashboard trims & dashboard	0.513[a]
Dashboard trims & seating parts	0.640[a]
Dashboard trims & roof lining	0.536[a]
Color & pattern of seating	
Floor carpet & seat cushion	0.518[a]
Glove box & seat cushion	0.553[a]
Back panel & seat frame	0.551[a]
Dashboard & steering wheel	0.975[a]
Seat cushion & glove box	0.896[a]
Headrests & A-pillar	0.950[a]

[a]Note. The significance level (i.e., the probability the correlation equals zero) is <0.0005 for all correlations in the table.

or patterns. For instance, the seat back panel and seat cushion use different colors, hues, or patterns by an above average percentage of the top-rated designs. However, differences between the top and worst designs can be detected (cf. Tables 2 and 6) in the frequency analysis. So, there is a less frequent use of distinct colors among the worst-rated designs than the top-rated designs, indicating that an application of appearing more lightweight designs can lead to an increase in customer appreciation. This difference, however, is not unambiguous. Significant findings in both design categories, appreciated and not appreciated were identified which were caused by the materials of the seating parts. The interior trim and upholstery seem to follow common expectations of materials such as fabric or leather for cushions and plastic for back panels. Although the layering of colors happens in both designs (most and least-preferred ones), the underlying color differs. In case of the most preferred designs, the brownish hues can be summarized to parent colors, whereas the type of color of the worst-rated designs is opposing or entirely different colors. As this influences the entire composition, the harmony principle can be validated.[51]

4.2 | Modest use of color and pattern variety

Further characteristics are expected to result in the color preferences of car interiors. In this study, a general modest use of color was found among all designs. Both the top-rated interiors and the worst-rated ones show three diverging colors. But there is a difference in the kind of hues which is used in both design categories. Whereas the top interiors were mostly colored in brown and beige, the worst ones had a strong inclination for gray and green. The use of the color black is independent from user preferences in this study. A visual subjective analysis conducted by the researchers indicates that an interior being more uniform than diverse results in increased appreciation. This finding follows the design principles for harmony.[17,51,52]

The composition of a top design consists of brown or beige for the seats and door trims, black seat belts, lighter hues for roof lining, and floor carpet which are framing the interior (cf. Hypothesis 4). The dashboard, center console, and all adjacent parts can be subdivided according to their size and the respective color. So, larger parts tend to be beige or brown, whereas smaller parts are black. Mostly no pattern is used. The most common patterns show a wooden appearance or an appearance like brushed aluminum.

On the other hand, a typical composition of a bad evaluated design uses green, gray and red for the seats and doors with white seat belts. The roof lining and floor carpet, regardless of their framing character, are colored gray and green like the rest of the interior. The dashboard parts and center console show no difference between large or small parts and use the colors gray, green, or more noticeable hues such as blue, magenta, and red. No pattern is used unless in some designs the user created and uploaded individual patterns (cf. Figure 9), although, both design categories differentiate into the materials of parts of interior trims and upholstery, for example, seat cushion and back panel.

4.3 | Repetition of colors and grouping of elements

No significant findings could be detected for colors and patterns of components, only between colors and saturation among the top designs. However, the colors and patterns of the worst designs showed significant findings between colors and saturation. No distinct inclination can be found. The repetition of colors can lead to a better understanding of successful interior designs.

The strongest correlations of the seats of the top designs can be subdivided according to their materials in framing parts (seat back panel, seat frame and trims), seating surface (seat cushion, headrests), and smaller seat parts (middle part rear seating, headrests). However, the seats of the worst evaluated designs cannot be subdivided in these categories, as further correlations are found for the seat parts, for example, seat cushion and floor carpet. This finding supports the subjective visual analysis of the more uniform interior of the top-rated designs, whereas the doors of the top designs seem to show significant correlations in relation to the height of components due to the sideways perspective of the evaluating subjects. No such result can be found among the worst designs, as those are more focused on adjacent parts. Additionally, the top design's dashboard parts and center console indicate correlations with each other, whereas in the worst designs the perspective of the viewer is more decisive, for example, glove box and floor carpet. This indicates that the subjective observation that the worst designs are more diverse is valid.

A closer look at the correlations of the components patterns show different correlations of top and worst designs, but similar ones in its characteristics. The correlations found were either among adjoining parts or parts at the same height level according to the viewer's perspective.

4.4 | Framing of the interior by dominant elements of the interior

The findings of roof lining, A-pillars, and floor carpet as main parts framing the interior correspond to the hypothesis of Tofle et al.[5] about the sense of spaciousness influenced by contrast effects, especially regarding the distinction of lightness or chroma. Even though both the best- and worst-rated designs show a rather high percentage of gray hues, the major difference is the rest of the color choices. The framing surfaces of interior design show a strong inclination for beige among the top-rated designs which corresponds to Kwallek's findings[29] for office walls. Additionally, the discovery of a dislike for greenish hues aligns with the color scheme of large framing surfaces. The use of bright colors can be attributed to the importance of spaciousness even in automotive interiors.

However, the color preferences are not that uncommon in comparison to the options offered by car manufacturers today, as all color extremes were evaluated accordingly (c.f. 3.2 Worst Designs). This might be caused by how objects are portrayed in advertisements, especially considering certain stereotypes. Nevertheless, customers are unconsciously aiming to be mature and sophisticated and therefore favor beige or brownish interiors.[18]

5 | CONCLUSION

The study serves as a first indication of customer choices for the concrete environmental context of car interiors. Notwithstanding, the patterns of preferences to develop distinct design guidelines for harmonious interiors are difficult to find. Consumer preferences are not completely heterogeneous but seem to follow weak patterns beyond pure chance,[56] although the color preferences follow the customization guidelines. But an increase in the number of design feature options may not make a difference in customer satisfaction with the mass customization process (Kamali & Loker, 2002). Therefore, the portfolio has to consist of an adequate number of design features, but in a sort of balance to create additional value for customers. Beyond a certain level of choice options, consumers tend to become irritated by too many options.

The limitation to spontaneous affective states of approach and avoidance by ignoring other emotions can bias the study. For instance, Cubuku measured color preferences along with arousal, naturalness, and relaxation.[31] Thus, the combination of presenting colored interiors and rating those by like or dislike, enables a spontaneous affective response.[45] In addition, the study considered multiple colors of various interior components. So, the spontaneous emotional judgment of liking or disliking an interior design represents the preference for a combination of colors. Cubukcu assumed the settings to be more realistic, if a study is not limited to investigate the effects of single colors.[31]

No significant differences in gender could be identified.[8,17,23,28] Even though sociodemographic data like education or occupation was gathered, those could not be used as the data focused on the creators of the interior design but not the evaluators. Consequently, missing significant relations to color preferences only imply that a conclusion for the creators' sociodemographic data can be made.

To prevent interdependencies by the use of color names, the HSL color model was applied for color classification of the interior components giving a rather broad range of choices. Consequently, the subjects were able to choose the colors directly while designing the interiors. Afterward, the same colors of the HSL model were evaluated in combination with interior components. This approach is not uncommon as today's cars are personalized by using configurators and toolkits. The colored interior is then displayed to the potential buyer. The resemblance of the car seats to furniture leads to the stereotypical color preferences of brown and beige. Buyers expect harmonious car interiors and have a very precise idea of how car interiors should look. But color perception per se is influenced beyond saturation, lightness/chroma, and hue by the respective viewing angle, amount and type of ambient light, and presence of other colors or further environmental conditions.[39–42] For instance, the exterior color of a car might have an influence on the color preferences of the car interior, a fact which is excluded from the study so as to focus on the interior. The interdependency of exterior and interior design might need further research. Another limitation of the study is the static approach of the color evaluation. Because human color vision changes according to the various lighting conditions, the coloring of interior components should be tested in a mock-up under real-life situations and both extremes in bright sunlight as well as dusk, where color vision tends to be unreliable.[7] A standardization of illumination is required as it can be difficult to discriminate between colors which might corrupt the results.[7] This is why in car development and design, mock-ups and clay models are used for complementing virtual engineering methods. Sunlight simulation and field tests enable engineers to identify the suitability for daily usage. To identify the environmental impacts on colored surfaces, further research with actual mock-ups or cars might be useful to exclude dazzling or possible interaction with exterior color or the physical shape of interior components. Common taste or cultural factors can also have an impact which is not necessarily static over time.

Additionally, customization principles are related to general human–product interaction principles, assuming the possession of the product. During times, in which owning a car becomes less attractive in cities and car-sharing solutions increase in popularity, the human–product relationship changes intensively. As a continuous change of interior trim and upholstery for each customer of a car sharing business is seldom a competitive and cost-effective way to reach customer satisfaction, further individualization techniques should be investigated such as customization by interior lighting and changing colors[4] or flexible individualizable storage solutions by standardized interfaces.[64] Nevertheless, the findings of the color preferences for car interiors should be taken into account for car sharing interiors.

ORCID

Alexa-Sibylla Wagner http://orcid.org/0000-0003-2591-4899

REFERENCES

[1] Audenhove F-JV, Korniichuk O, Dauby L, Pourbaix J. *The Future of urban mobility 2.0: Imperatives to shape extended mobility ecosystems of tomorrow*. 2014.

[2] IFMO. *Mobilität junger Menschen im Wandel – multimodaler und weiblicher*. 2011.

[3] IFMO. *'Mobility Y' – The Emerging Travel Patterns of Generation Y*. 2013.

[4] Wagner A-S, Kilincsoy Ü, Reitmeir M, Vink P. Adaptive customization –Value creation by adaptive lighting in the car interior. In: Vink P, ed. *Advances in social and organizational factors* (pp. 40–50). AHFE Conference; 2014.

[5] Tofle R, Schwarz B, Yoon S, Max-Royale A. Color in healthcare environments. Bonita, CA: *The Coalition for Health Environments Research*; 2004.

[6] Sheppard JJ. Human color perception: A critical study of the experimental foundation. New York: American Elsevier Pub. Co; 1968.

[7] Verity E. Color observed. Van Nostrand Reinhold Company; 1980.

[8] Katz D. The world of colour; vol *44*. Routledge; 2013.

[9] America CCO, Ostwald W. *Color Harmony Manual*. 1958.

[10] Hering E. Outlines of a theory of the light sense. Cambridge, MA: Harvard University Press; 1964.

[11] Itten J, Birren F. The elements of color. New York: John Wiley & Sons; 1970.

[12] Munsell AH. A color notation. Boston: Munsell Color Company; 1919.

[13] Newton I. Opticks, or, a treatise of the reflections, refractions, inflections & colours of light. North Chelmsford, MA: Courier Corporation; 1979.

[14] Ostwald W. Colour science; London: Windsor and Newton; 1931.

[15] Bakker I. Uncovering the secrets of a productive environment, a journey through the impact of plants and colour. TU Delft: Delft University of Technology; 2014.

[16] Bakker I, van der Voordt TJ, de Boon J, Vink P. Red or blue meeting rooms: does it matter? The impact of colour on perceived productivity, social cohesion and wellbeing. *Facilities.* 2013b;*31*:68–83.

[17] Ou LC, Luo MR, Woodcock A, Wright A. A study of colour emotion and colour preference. Part I: colour emotions for single colours. *Color Res Appl.* 2004;*29*:232–240.

[18] Schloss KB, Palmer SE. Aesthetic response to color combinations: preference, harmony, and similarity. *Attent Percept Psychophys.* 2011;*73*:551–571.

[19] Bakker I, van der Voordt T, Vink P, de Boon J, Bazley C. Color preferences for different topics in connection to personal characteristics. *Color Res Appl.* 2015;*40*:62–71. https://doi.org/10.1002/col.21845

[20] Eysenck HJ. A critical and experimental study of colour preferences. *Am J Psychol.* 1941;*54*:385–394. https://doi.org/10.2307/1417683.

[21] Funk D, Oly Ndubisi N. Colour and product choice: a study of gender roles. *Manage Res News.* 2006;*29*:41–52. https://doi.org/10.1108/01409170610645439.

[22] Dittmar M. Changing colour preferences with ageing: a comparative study on younger and older native Germans aged 19–90 years. *Gerontology.* 2001;*47*:219–226.

[23] Katz D. Gestalt psychology, its nature and significance. Westport CT: Greenwood Pub Group; 1979.

[24] Zentner MR. Preferences for colours and colour--emotion combinations in early childhood. *Dev Sci.* 2001;*4*:389–398.

[25] Madden TJ, Hewett K, Roth MS. Managing images in different cultures: a cross-national study of color meanings and preferences. *J Int Market.* 2000;*8*:90–107.

[26] Saito M. Comparative studies on color preference in Japan and other Asian regions, with special emphasis on the preference for white. *Color Res Appl.* 1996;*21*:35–49.

[27] Bakker I, Van de Voordt DJM, Vink P, De Boon J, Bazeley C. Color preferences for different topics in connection to personal characteristics. *Color Res Appl.* 2013;*40*:62–71.

[28] Katz S, Breed F. The color preferences of children. *J Appl Psychol.* 1922;*6*:255.

[29] Kwallek N, Lewis C, Lin-Hsiao J, Woodson H. Effects of nine monochromatic office interior colors on clerical tasks and worker mood. *Color Res Appl.* 1996;*21*:448–458.

[30] Brill M, Margulis ST, Konar E. Using office design to increase productivity; vol *2*. Workplace Design and Productivity, Inc; 1985.

[31] Cubukcu E, Kahraman I. Hue, saturation, lightness, and building exterior preference: an empirical study in Turkey comparing architects' and nonarchitects' evaluative and cognitive judgments. *Color Res Appl.* 2008;*33*:395–405. https://doi.org/10.1002/col.20436

[32] Schloss KB, Strauss ED, Palmer SE. Object color preferences. *Color Res Appl.* 2013;*38*:393–411.

[33] Holmes CB, Buchanan JAB. Color preference as a function of the object described. In: Society P, ed. Bulletin; vol *22*:423–425; 1984.

[34] Fenko A, Otten JJ, Schifferstein HN. Describing product experience in different languages: the role of sensory modalities. *J Pragmatics.* 2010;*42*:3314–3327.

[35] Hekkert P, Karana E. Designing material experience. *Mater Exp Fundament Mater Des.* 2013;1.

[36] Gagg R. Basics interior architecture 05: Texture+ materials. Muttenz, Switzerland: Ava Publishing; 2012.

[37] Roberts SC, Owen RC, Havlicek J. Distinguishing between perceiver and wearer effects in clothing color-associated attributions. *Evol Psychol.* 2010;*8*:147470491000800304.

[38] Choo S, Kim Y. Effect of color on fashion fabric image. *Color Res Appl.* 2003;*28*:221–226.

[39] Brainard DH, Radonjic A. (2014). Color constancy. In Werner JS & Chalupa LM, eds. The new visual neurosciences. MIT Press; 2014: 545–556.

[40] Elliot AJ. Color and psychological functioning: a review of theoretical and empirical work. *Front Psychol.* 2015;*6*:368. https://doi.org/10.3389/fpsyg.2015.00368

[41] Fairchild MD. Seeing, adapting to, and reproducing the appearance of nature. *Appl Opt.* 2015;*54*:B107–B116. https://doi.org/10.1364/AO.54.00B107

[42] Hunt RWG, Pointer MR. Spectral weighting functions. In Measuring colour. Ëhichester: John Wiley & Sons, Ltd; 2011:19–40.

[43] Guilford JP, Smith PC. A system of color-preferences. *Am J Psychol.* 1959;*72*:487–502.

[44] Pomerleau A, Bolduc D, Malcuit G, Cossette L. Pink or blue: environmental gender stereotypes in the first two years of life. *Sex Roles.* 1990;*22*:359–367.

[45] Zajonc RB. Feeling and thinking: preferences need no inferences. *Am Psychol.* 1980;*35*:151.

[46] Sears DO. College sophomores in the laboratory: influences of a narrow data base on social psychology's view of human nature. *J Personal Soc Psychol.* 1986;*51*:515.

[47] Poldma T. Learning the dynamic processes of color and light in interior design. *J Interior Des.* 2009;*34*:19–33.

[48] Merleau-Ponty M, Smith C. Phenomenology of perception. Motilal Banarsidass Publishe; 1996.

[49] Winchip SM. Designing a quality lighting environment. New York: Fairchild; 2005.

[50] Shulman K. The color of money. In Metropolis; 2001.

[51] Feisner EA, Reed R. Color Studies; vol *2*. New York: Fairchild Books; 2006.

[52] Ou L-C, Chong P, Luo MR, Minchew C. Additivity of colour harmony. *Color Res Appl.* 2011;*36*:355–372.

[53] Von Hippel E. Democratizing innovation: the evolving phenomenon of user innovation. *Journal Für Betriebswirtschaft.* 2005; *55*:63–78.

[54] Von Hippel E. Lead users: a source of novel product concepts. *Manage Sci.* 1986;*32*:791–805.

[55] Gassmann O. Crowdsourcing: [Innovationsmanagement Mit Schwarmintelligenz; Interaktiv Ideen Finden; Kollektives Wissen Effektiv Nutzen; Mit Fallbeispielen Und Checklisten]. Hanser; 2012.

[56] Franke N, Piller F. Value creation by toolkits for user innovation and design: the case of the watch market. *J Prod Innov Manage.* 2004; *21*:401–415.

[57] Kamali N, Loker S. Mass customization: on-line consumer involvement in product design. *J Comput Mediat Commun.* 2002;*7*.

[58] Brock TC. Implications of commodity theory for value change. In Greewald TCBaTMOAG, ed. Psychological foundations of attitudes. New York: Academic Press; 1968:243–275.

[59] Fournier S. Meaning-based framework for the study of consumer-object relations. *NA-Adv Consumer Res.* 1991; *18*.

[60] Poetz MK, Schreier M. The value of crowdsourcing: can users really compete with professionals in generating new product ideas? *J Prod Innov Manage.* 2012;*29*:245–256.

[61] Füller J, Matzler K, Hoppe M. Brand community members as a source of innovation. *J Prod Innov Manage.* 2008;*25*:608–619.

[62] Harhoff PD, Wiegandt P. Value creation of firm-established brand communities. Gabler Verlag; 2009.

[63] Füller J, Bartl M, Ernst H, Muehlbacher H. Community based innovation: how to integrate members of virtual communities into new product development. *Electron Commerce Res.* 2006;*6*, 57–73.

[64] Wagner A-S, Kilincsoy Ü, Reitmeir M, Vink P. Functional customization: value creation by individual storage elements in the car interior. *Work.* 2016;*54*:873–885.

AUTHOR BIOGRAPHIES

ALEXA-SIBYLLA WAGNER is working for the BMW Group in different departments of Purchasing and Controlling. After studying economics as a major and mechanical engineering as a minor at the Munich University of Technology and her diploma thesis at BMW, she got a profound insight into the automobile development and production. She started her doctoral project at BMW in Munich with the Department of Concepts for Body and Interior Trims after graduation. The core aim of the thesis is to create an adaptive and customizable interior by involving end-users in the product development and customization process to achieve a new level of human–car interaction and a new human–car experience.

Ümit Kilincsoy studied mechanical engineering with a special focus on automotive technology and production management at TU Munich. In his diploma thesis, he gathered a knowledge of human postures and comfort, which was analyzed thoroughly after graduation in his succeeding PhD project at BMW to establish design guidelines for automotive rear seats. He worked in different departments of research and development in lighting engineering and geometrical design at the BMW Group.

Peter Vink is leading the Department of Design Engineering at the faculty of Industrial Design Engineering and is working on interior design and the effects on comfort. He is on the editorial board of many scientific journals (e.g., Applied Ergonomics), member of the jury of the Crystal Cabin Award (the most prestigious prize in aircraft interiors) and won the Hal W. Hendrick Award in 2011, which is for a non-U.S. citizen who has made outstanding contributions to the human factors/ergonomics field.

How to cite this article: Wagner A-S, Kilincsoy Ü, Vink P. Visual customization: Diversity in color preferences in the automotive interior and implications for interior design. *Color Res Appl*. 2018;43:471–488. https://doi.org/10.1002/col.22218