Can Visual Aesthetic Components and Acceptance Be Traced Back to Forest Structure?

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Abstract: The importance of local forests as places of recreation and human well-being depends very much on their visual impact on human perception. Forest managers, therefore, seek to achieve structural elements or attributes that can be used to enhance the visual aesthetics of managed forest ecosystems. The following survey was undertaken in the Tharandter Forest in Saxony (Germany). The field interviews were focused on visual aesthetics and acceptance. The statements of the 53 participants in the survey were used to analyse views concerning typical Norway spruce forest types: with the regeneration of deciduous tree species in the background, without regeneration, and with European beech as a second layer in the foreground. The evaluation of the questionnaires confirmed a clear ranking. The forest view with the regeneration of deciduous tree species received the highest number of positive scores, followed by the forest view with beech as a second layer. The forest view characterised by pure and dense Norway spruce trees received the worst rating, differing significantly from the other two, on the basis of the spatial arrangement, visual diversity and acceptance. Linear mixed models demonstrated that visual aesthetics was mostly explained by visual diversity as a result of tree species diversity or mixtures and age structures, the diversity of surrounding structures and colours, ground vegetation or visibility.

Keywords: visual perception; aesthetics; forest stand types; structural elements; recreation; Norway spruce; European beech

1. Introduction

The human requirement for multiple services from different landscape elements has increased continuously over recent decades [1–3]. In the intensively used landscapes of Europe especially, cultural services are strongly influenced by basic elements such as the proportions, patterns and forms of different land uses, for example, arable land, meadows, vineyards, orchards and forests [4,5]. All of the managed landscape types have a wide range of effects for the different categories of cultural service, such as recreation, mental and physical health, tourism, aesthetics, inspiration and spiritual experience [6]. The evaluation of visually perceivable landscape elements is one important aspect of harmonising humans’ environments by means of landscape planning and design, in particular in intensively managed environments [7,8]. According to Bell [4], ‘the framework for an aesthetic structure’ is defined by the interaction between the observer’s response and the observer as an active participant in the landscape scene. The visual impact of forests, and of forest management of varying intensities, as one part of landscapes are visually perceivable by their three-dimensional forms, tree species constellations, age classes, dimensions of trees, disturbances and seasonal aspects [9–11]. These elements describe the texture of forest landscapes. At the smaller spatial scale of forest areas, the category of forest ecosystem...
services addressing ‘cultural and human well-being’ is of growing importance relative to the traditional uses of forest resources (e.g., timber, food, medicinal resources) and the importance of the regulatory functions of forests (e.g., water, climate, habitat) [6,12–15]. The theoretical background to research associated with the different aspects of forests’ effects on human well-being is diverse, given the complexity surrounding cognitive skills and individual human perceptions [16–20]. The subjective human perception is a multisensory process with visual, acoustic, olfactory and haptic parts, but the visual part is considered to be the most important [4,21]. Forest aesthetics are directly influenced by forest management, and yet reflect the aesthetic emotions of a contemporary culture [22,23]. A growing objective of forest management, especially in the case of well-frequented urban forests, is to design forest landscapes generating positive aesthetic effects for recreation [1,18,24].

Most definitions of forest aesthetics are associated with the terms landscape and scenic beauty [25,26]. Pukkala et al. [27] once remarked that scenic beauty is strongly correlated with the recreation quality of forests. The aesthetics of forests can be defined as people’s perception of the coarse forest landscape as a visual resource and of the fine-grained structural elements, which usually involves judgment, evaluation and assessment [28–30]. It is necessary in analytical research to differentiate between the components that describe visual aesthetic experiences as multisensory intuitive experiences, namely coherence, aesthetic diversity, biodiversity, restorativeness, acceptance/acceptability and order [31–34]. This differentiation is required for aesthetic analyses at forest stand level (for detailed definitions, refer to the Materials and Methods section). These components allow for a disentangling of the complexity of the perception of visual aesthetics and to combine this perception with the structural components of forest ecosystems. Methods to assess the visual aesthetics of forest ecosystems range from field interviews [35–37] and questionnaires with pictures of forest stands or landscapes [18,38–40] to simulated virtual forest pictures [10,11].

The importance of forest structures has become clear for all manner of forest ecosystem services and precise techniques have been developed to measure forest structures exactly, for example, using laser scanning (e.g., [41]). Although many studies have addressed recreational and aesthetic effects, only a few included clearly defined forest structures that can be achieved at the level of the forest stand employing silvicultural measures [42,43]. Scenic beauty (distant scene, [27]), visual diversity, harmonious combinations of landscape elements and the degree of human impact were identified as being the most relevant for visual aesthetics at the landscape level [11,44–46], whereas striking old trees, stand density or the amount and consistency of dead wood have been described as structures and attributes (middle-ground and within-forest, [27]) strongly affecting the visual aesthetics of forest stands [42,47].

Local or regional preferences for tree species or tree species proportions have also been identified as crucial factors enhancing the visual aesthetic of forests, often strongly influenced by childhood experiences [36,48]. For example, Norway spruce (*Picea abies* L.) has a high level of dominance in forests of the low mountain regions of Germany. Hitherto, the visual assessment of forest structures was often focused on (i) the landscape scale including very contrasting forest management types (clearcuts versus closed forest) or land use types [4], (ii) very general statements along a scoring scale addressing the beauty of a forest (for example, from ‘like it very much/beautiful’ to ‘dislike/unattractive’) [49] and (iii) controlled reflections about a previously defined structural attribute, such as the habitus of single trees [50]. To obtain more precise information at forest stand level, we were interested in combining the regional forest matrix (landscape level) dominated by Norway spruce with the opportunity for forest viewers to perceive and identify small-scale structural elements decisive for the visual aesthetics of distinct forest views. Otherwise, it would be difficult to select visually important structural elements regardless of the complexity of human cognition skills [51]. The visual perception of single forest elements is determined by people’s ability to recognise objects by their external properties (shape, form, colour, size, etc.) and the relationship to the surrounding elements (e.g., contrasts in form or colour) [52]. Often, the visual perception and high aesthetic value attributed to
individual or small-scale structural forest elements contrasts strongly with their relevance in terms of forestry. The economic effort required to establish or preserve small-scale forest structures/structural elements can be high, whereas direct economic returns are low if only the aspect of wood production is taken into account. One such example is the admixture of individual trees of alternative species, which need intensive and continuous silvicultural management promoting their crowns to reduce the competitive pressure exerted by the surrounding forest stand. In contrast, European beech planted as a second layer under the shelter of Norway spruce aligns with the ecological and economic objectives of forest management, but little is known about the visual perception and the aesthetic value of this silvicultural approach. Therefore, the following study of visual aesthetics focuses on typically structured Norway spruce forests relatively strongly influenced by forest management, i.e., plantations.

The hypotheses underlying the study were:

1. The visual perception of specific structures or structural elements differs based on the admixture of deciduous tree species, and on where or how they are positioned within Norway spruce forests. Furthermore, people are able to freely associate perceived and desired structural elements for the chosen forest types.

2. There are two levels of visual effect, namely components of the predominantly emotionally controlled visual aesthetics and also acceptance, which is more strongly controlled by cognitive skills.

3. The strength of the correlations between the five components of perception (visual diversity, comprehensibility, ecological aesthetics, restfulness and spatial arrangement) depends on the visual effects of forest types and their perceptible structures.

2. Materials and Methods

We performed a questionnaire-based survey of passers-by visiting a forest of regional importance in order to evaluate their perception of three specified forest views.

2.1. Study Sites

To study the visual aesthetics of forest stand types dominated by Norway spruce, we established a trail crossing three different viewpoints in the Tharandter Forest (50°57′13.05″ N, 13°29′47.32″ E, 385 m a.s.l.), one of the largest continuous forest areas (more than 6000 ha) in the state of Saxony, Germany. The area is highly frequented by walkers and cyclists visiting from the larger neighbouring cities Freiberg and Dresden, which are located at distances of between 15 and 23 km from the forest, respectively. This part of the Tharandter Forest has been designated by the State Forest Service of Saxony as forest with a specific recreational function, addressing issues of medical health, nature-based leisure activities and natural experiences. The proportion of Norway spruce in the Tharandter Forest reaches 51%. European beech is present on 721 ha as a second stand layer to establish the next generation of trees in the course of forest conversion. Although the Tharandter Forest is not characterised by a high degree of structural heterogeneity, or the presence of near-natural forest structures, this forest region is highly frequented by visitors. We were interested in analysing the aesthetic relevance and the visual perception of relatively poorly structured forests by local visitors and tourists. The overall spectrum of forest structures and tree species mixtures was relatively low but increasing over time due to silvicultural measures implemented in the last twenty years. The general question was whether forest structures are important for visitors where the surrounding forest structures are relatively homogenous. Studies in the nearby Ore Mountains showed that visitors favoured structural landscape elements such as mountain meadows, raised bogs and mixed forest types [49]. The choice of the three following forest types was also justified by their dominance throughout the Tharandter Forest. The total length of the trail section was 750 m, and the three chosen stands were located directly alongside this trail (Figure 1).
Wooden frames starting at a height of 0.80 m above the ground and with a width of 2 m were placed at each of the three forest stands to define the ‘stand picture’ to be assessed by the visitors. These pictures are referred to in the following as the ‘forest views’ (fv). The distance between visitors and the wooden frame was always 1.5 m. The forest views were used to characterise individual within-forest scenes [27]. The chosen forest stand types were typical of managed Norway spruce forests (1) with the regeneration of deciduous tree species in the background, (2) without regeneration and (3) with European beech as a second layer in the foreground of the stand picture. According to Hoffman and Palmer [53], the three stand types can be described systematically by the following characteristics: trees (trunks and branches), surrounding matrix (foliage, sky, background) and ground plane (floor and understorey). On this basis, the first chosen forest view (fv1) was characterised by 90% Norway spruce overstorey trees with a mean age of 87 years with admixed silver birch (5%) and Scots pine trees (5%). The canopy cover in fv1 could be described as closed in the foreground with a large canopy gap in the background. Consequently, the first viewpoint consisted of two zones, the shadow zone in the foreground, where the viewer was standing, and the light zone in the background (Figure 1). Some spruces, birches and rowan trees had regenerated naturally within this background gap, whereas the beeches were artificially regenerated in groups (Table 1).

The overstorey trees exhibited larger dead branches and some bark damage caused by felling activities. The forest floor was covered by mosses, grasses such as Deschampsia flexuosa and needle litter of Norway spruce. One special feature of the first viewpoint necessary to take into account in the visual assessment was a small trench of 80 cm depth in the surroundings.

The overstorey Norway spruce trees in the second stand (fv2) were significantly younger than in the first viewpoint at just 31 years of age. The homogenous, mono-layered spruce stand was admixed with a proportion of only 5% birch trees. The canopy cover could be described as closed to very dense, and as a result the relative light intensity was very low with only some small patches of light penetrating during phases of direct sunlight (Figure 1). The crown dimensions of the single birch trees were small, because of the high crown competition exerted by the Norway spruce trees. The spruce trees had conspicuous...
dead, grey branches extending down to the ground. The forest floor was only sparsely covered by mosses. The ground surface consisted mainly of spruce needle litter and dry twigs or branches. Past felling activities were rendered visible by some old stumps and the larger white branches of birch trees.

Table 1. Overview of stand characteristics and forest inventory data relevant for visual aesthetics, silviculture and forest management (* specific age and height of underplanted European beeches).

| Categories           | Characteristics (Units) | Forest View (fv1) | Forest View (fv2) | Forest View (fv3) |
|----------------------|-------------------------|-------------------|-------------------|-------------------|
| Site                 |                         | lower mountain elevation | lower mountain elevation | lower mountain elevation |
|                      | climate                 | plateau            | plateau            | plateau            |
|                      | relief                  | moderate           | moderate           | plateu, gently sloping |
|                      | nutrient supply         | moderately fresh   | periodically wet   | moderate           |
|                      | soil moisture value     | periodically wet   | periodically wet   | moderately fresh   |
|                      |                         |                    |                    | periodically wet   |
| Tree layers          | tree species            | Norway spruce, European larch (Norway spruce, European beech, silver fir, silver birch, aspen, rowan) | Norway spruce, silver birch | Norway spruce, Scots pine (European beech, Norway spruce, silver birch) |
|                      | proportion of overstorey (understorey) trees (%) | 59.4 (4.1) | 76.3 (-) | 14.5 (44.7) |
|                      | number of vertical layers | two                | one               | two               |
|                      | form of admixture       | single tree to group | single tree       | single tree       |
|                      | age (years)             | 82–91 (7–21)       | 31                | 83–113 (8–17 *–44) |
|                      | height (m)              | 29–31 (1–16)       | 17                | 26–32 (1–6 *–13) |
|                      | dbh (cm)                | 42–53 (7–28)       | 24                | 37–50 (18)        |
|                      | standing volume (m³/ha) | 385 (25)           | 230               | 100 (10)          |
|                      | damage                  | storm damage, fresh and old stripping damage | fresh stripping damage | storm damage, fresh stripping damage |
|                      | target forest type      | beech–conifer forest type | oak–hornbeam–lime forest type | beech–conifer forest type |
| Ground layer         | vegetation              | Deschampsia flexuosa, Oxalis acetosella, mosses | Equisetum spec., mosses | Impatiens parviflora, Rubus fruticosus agg., Poaceae, mosses |
|                      | proportion (%)          | 6.0                | 0.9               | 2.4               |
|                      | litter proportion (%)   | 1.7                | 14.6              | 1.4               |
|                      | rocks, etc.             | trench, dead wood (Norway spruce) | dead wood (silver birch) | - |
|                      | proportion of sky (%)   | 4.1                | 0.9               | 25.3              |
| Surroundings         | structure of neighbouring forest stands | comparable       | older             | comparable, with succession on areas |
|                      | water                   | dry trench         | -                 | damaged by storm |
|                      | trails                  | -                  | -                 | -                 |

The third stand chosen (fv3) consisted of a low number of Norway spruce shelter trees aged 113 years. The dense second layer of European beech was underplanted 17 years previously. Both tree species were present across the whole stand area. Within the stand, the relative light intensity was low due to the very dense beech layer. The old Norway spruce trees had short and light crowns, and straight trunks without branches. The forest floor was covered by beech leaves and sparse grasses. At the front of the stand, next to the trail, blackberry (Rubus fruticosus agg.) and touch-me-not (Impatiens parviflora DC.) could be found growing.
2.2. Survey Implementation and Theoretical Approach

The survey was performed during weekends from July to August 2018 with sunny weather conditions and without rain. The interviews were carried out between 10:30 a.m. and 5:00 p.m., as this corresponded with the times of the best availability of local public transport for visitors to the forest. Visitors were asked whether they would be prepared to participate in a survey about the perception of forests. The questionnaire was handed out with some additional explanations about the short trail and with the request that participants complete the questionnaire individually. The questionnaire was divided into two parts. The first part collected the following personal information about the respondents: gender [54], age [37], profession, residential environment [55] and frequency of visits to the forest [56]. The second part of the questionnaire comprised ten statements to assess the visual aesthetic experiences for each of the three viewpoints (Table 2) following the components of perception explained by Kaplan and Kaplan [57] and Hauru et al. [34].

The manifold levels of human cognitive perception [58] render it difficult to quantify and assess just how environmental conditions affect aesthetic preferences. The description of visual perception alone is characterised by very complex relationships [52]. Various preference-based methods are used for this purpose [57]. In accordance with Kaplan and Kaplan [57] and Hauru et al. [34], we applied a method that includes different components of perception. This approach makes it possible to evaluate and summarise the impact of the visual aesthetics of individual forest views. This method is a further development of preference-based methods, augmented with an evaluation of the psychological reactions of forest visitors to the physical features of the chosen forest views. The categories of psychological reaction form the components. We chose the components of perception method because it can be combined well with the main focus on visual aesthetics. The meanings of the individual components chosen for the study are explained below.

Table 2. Overview of the ten statements in the questionnaire and the associated components of perception according to Hauru et al. [34] combined with the type of statement formulation (+ positive, - negative control statement).

| Statement Formulated in the Questionnaire | Components of Perception |
|------------------------------------------|--------------------------|
| 1. I find this forest view beautiful.     | Aesthetic effects (+)    |
| 2. Within this forest view there is much to discover. | Visual diversity (+) |
| 3. This forest view is not very exciting. | Visual diversity (-) |
| 4. The elements within this forest view reveal a harmonious design. | Comprehensibility (+) |
| 5. I associate this forest view with an attractive habitat for wildlife and plants. | Ecological aesthetics (+) |
| 6. This forest view gets me thinking about other things. | Restfulness (+) |
| 7. This forest view is depressing.       | Restfulness (-)          |
| 8. This forest view leaves one with the impression of neglect. | Order/spatial arrangement (-) |
| 9. This forest view leaves a good impression. | Order/spatial arrangement (+) |
| 10. I would visit this forest for just such a scenic view. | Acceptance (+) |

For each formulation, a specified set of response options was provided [59]. A scale of seven score gradations was used for the assessment, starting with $-3$ (‘I do not agree with that statement’) and ending with $+3$ (‘I fully agree with that statement’) [60]. All statements were formulated positively, but the statements related to visual diversity, restfulness and order had additional, negatively formulated control statements [34]. The first statement, ‘I find this forest view beautiful’, was an important statement in terms of giving an overall impression of each of the three forest views. This statement was, therefore, used for more detailed analyses than the tenth statement, ‘I would visit this forest for just such a scenic view’. The latter illustrated the viewers’ individual reflections, their satisfaction with the environmental conditions and, consequently, the ‘acceptability’ of the respective forest stand [17,34].
As the main aim of the study was to assess the relevance of forest structures for visual aesthetics, the statements referred to structural attributes of the viewpoints connected with visual components. For example, the fourth statement was: ‘The elements within this forest view reveal a harmonious design’. This statement related to the component ‘comprehensibility’, defined as a direct reaction of visitors reflecting the visual aesthetic of forest stands. It means that the viewer is able to classify visible forms, colours and textures within the perceptible environment and summarise these impressions to certain main elements [61]. Recurring elements (e.g., forest structures) and comparable textures increase the comprehensibility of the forest [57]. The statements correlated with the term ‘restfulness’ described the reaction to experienced recreation from everyday stress and worries within a defined environment, for example, a forest landscape [12,34]. The statement related to ‘acceptance’ or ‘acceptability’ reflected the attitude of respondents towards the surrounding conditions, and also included background knowledge about ecological aspects, silvicultural techniques and environmental experiences, going beyond the visually perceivable aesthetics of forest [62,63]. In addition to the aforementioned statements, there was an opportunity for respondents to make individual comments. These comments could be provided in the context of answers to the following open questions: ‘What are you noticing in this forest?’ and ‘What else would you like to see in this forest?’. By using open questions, it was possible to extend the level of pure visual perception and description to include individual associations in relation to desired forest conditions and the forest as a place of self-reflection [52,64].

2.3. Statistical Analyses

A total of 98 visitors were asked to participate in the survey, 54% of whom agreed. Six of the 53 participants (24 women, 29 men) were excluded from statistical analyses, because their answers provided for all three viewpoints in the questionnaire were incomplete. The basis of the statistical analyses performed in this study, therefore, comprised 47 people (20 women, 27 men). Given the relatively low number of participants, all analyses were performed without consideration or differentiation of the personal data provided, but some general information about the respondents can be given here. Most visitors (62.2%) came from an urban environment. The frequency of visits to the forest was less than once a month (49.0%), with only 43.4% visiting the forest several times a month. The age spectrum revealed a high proportion of visitors between 31 and 59 years (51.0%) and over 60 years (39.6%). The proportion of younger people (18 to 30 years) was only 9.4%. Of the visitors, 28.3% were retired, while those in work were mainly employees (37.7%) and self-employed people (16.9%).

A general comparison of differences between the aesthetic components of the three different viewpoints was made using the non-parametric Wilcoxon test, because of the lognormal distribution of the data [65]. Spearman’s rank correlation coefficients for ordinal scales were then calculated to identify the relationships between the different components of the visual aesthetics of the three forest stands [65]. It should be noted here that the problem of collinearity between explanatory variables must be considered when discussing the model results (refer to the Discussion section). Dormann et al. [66] defined a correlation coefficient of >0.7 as being critical for the quality of the model and its interpretation. A concurrent development of attribute-dependent ranks led to a correlation coefficient of +1 and a completely contrary ranking resulted in a coefficient of −1.

The second step was to test whether the overall scores (visual perception of aesthetics) differed significantly between the three forest views, for which all components were examined in summary. A non-metric multidimensional scaling (NMDS) ordination was used for visualisation [67]. This approach allowed us to see the entire reactions of the participants in a visually condensed way [68]. In accordance with Anderson [69], a permutation test was used subsequently as a resampling method. This non-parametric method is based on generating new samples from an existing sample (scores of the test participants) by calculating the probability that the original distribution can be described as a random
distribution. If the probability of a random distribution is low, significant differences can be assumed [70].

The last step of the statistical analyses involved testing whether the components of visual perception can be used to explain visual aesthetics and acceptance of forest structures. Linear mixed models (LMMs) were used for this purpose due to the clustered, i.e., grouped, structure of the data [71], which included visual aesthetics and acceptance as dependent variables and the different components (visual diversity, comprehensibility, ecological aesthetics, order and spatial arrangement, restfulness) as explanatory variables. Using linear mixed models, it was possible to demonstrate which components were responsible for the overall reaction of participants with regard to visual aesthetics and acceptance of forest views. All statistical analyses were performed using R version 3.4.1 [72].

3. Results
3.1. Visual Aesthetic Components and Acceptance of the Different Study Sites

The number of votes for the positively formulated statements and the related components of visual aesthetics revealed that fv1 (scores ≥ +2) and fv3 (scores ≥ +1) were mostly evaluated positively. In contrast, fv2 received a higher number of neutral (score 0) or negative (scores ≤ −1) scores (Figure 2).

![Heatmaps showing the frequencies of votes for the seven positively formulated components for the three different forest views (from left to right fv1—Norway spruce forests with regeneration of deciduous tree species in the background, fv2—Norway spruce forest without regeneration and fv3—Norway spruce forest with European beech as a second layer in the foreground of the stand).](image)

The visual aesthetic effects obtained 90.5% positive votes for fv1, 69.8% for fv3 and only 20.8% for fv2. This meant that fv1 and fv3 were deemed visually attractive or beautiful. Comparable statements were recorded for the components of visual diversity, ecological aesthetics and acceptance. A particularly conspicuous aspect was the high proportion of negative votes for the components order/spatial arrangement and acceptance in fv2 with 62.3% and 54.7%, respectively.

The non-parametric pairwise Wilcoxon test confirmed that the differences in the valuations of all listed components of visual aesthetics were significant between fv1 and fv2 (p ≤ 0.001) and between fv2 and fv3 (p ≤ 0.001). This was also evident for the comparison of fv1 and fv3 and the components aesthetic effects (p ≤ 0.01), visual diversity (p ≤ 0.001) and acceptance (p ≤ 0.05). This underlined that the appraisal of the younger Norway spruce stand without regeneration (fv2) differed significantly from that of the other two forest stand types (fv1 and fv3) overall.
3.2. Relationships between Visual Aesthetic Components

The relationships between the different aesthetic components were tested using Spearman rank correlations separately for fv1 to fv3 and summarised for all three forest types (Table 3).

Table 3. Results of Spearman rank correlations for all three forest stand types (coefficients, p-values: *** ≤ 0.001, ** ≤ 0.01, * ≤ 0.05) and summarised. (The numbers represent the following perception components: 1—aesthetic effects, 2, 3—visual diversity, 4—comprehensibility, 5—ecological aesthetics, 6, 7—restfulness, 8, 9—spatial arrangement, 10—acceptance. The additional symbol next to the statement number marks the type of formulation: + positive, - negative).

| Forest View | Perception Components | fv1 (1+), fv2 (2+), fv3 (3+) | Norway Spruce Stand with Deciduous Tree Species Regeneration (fv1) | Norway Spruce Stand with European beech as a second layer (fv3) |
|-------------|-----------------------|-------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
|             | 1 (+)                 | 2 (+)                         | 3 (+)                                                         | 4 (+)                                                         | 5 (+)                                                         | 6 (+)                                                         | 7 (+)                                                         | 8 (+)                                                         | 9 (+)                                                         | 10 (+)                                                        |
| Norway spruce stand without regeneration (fv2) | 0.646 ***              | 0.140                         | 0.517 ***                                                     | 0.321 *                                                       | -0.532 ***                                                    | -0.414 **                                                    | 0.141                                                         | 0.504 ***                                                     |
|             | 2 (+)                 | 0.629 ***                     | 0.271                                                        | 0.447 ***                                                     | 0.415 **                                                      | -0.275                                                       | -0.362 **                                                    | -0.050                                                        | 0.441 ***                                                     |
|             | 3 (+)                 | 0.034                         | 0.324 *                                                      | 0.255                                                        | -0.020                                                       | 0.195                                                        | 0.175                                                        | 0.167                                                        | 0.100                                                        |
|             | 4 (+)                 | 0.515 ***                     | 0.261                                                        | 0.362 *                                                      | 0.374 *                                                       | -0.131                                                       | -0.264                                                       | 0.207                                                        | 0.356 *                                                      |
|             | 5 (+)                 | 0.572 ***                     | 0.415 **                                                      | 0.568 ***                                                     | 0.584 ***                                                     | -0.440                                                       | -0.393 **                                                    | 0.254                                                        | 0.569 ***                                                     |
|            | 6 (+)                 | 0.447 ***                     | 0.250                                                        | -0.185                                                        | 0.301 *                                                       | 0.473 ***                                                     | -0.399 **                                                    | -0.265                                                       | 0.177                                                        | 0.507 ***                                                     |
|            | 7 (+)                 | -0.067                        | 0.063                                                        | 0.195                                                        | -0.037                                                       | -0.210                                                       | -0.163                                                       | 0.501 ***                                                    | -0.054                                                        | -0.285 *                                                      |
|            | 8 (+)                 | -0.327 *                      | -0.056                                                       | 0.175                                                        | -0.023                                                       | -0.067                                                       | -0.175                                                       | 0.501 ***                                                    | -0.106                                                        | -0.299 **                                                     |
|            | 9 (+)                 | 0.526 ***                     | 0.350 *                                                      | 0.048                                                        | 0.473 ***                                                     | 0.361 **                                                     | 0.474 ***                                                    | -0.151                                                       | -0.287 *                                                      | 0.333 *                                                      |
|            | 10 (+)                | 0.599 ***                     | 0.514 ***                                                     | 0.106                                                        | 0.595 ***                                                     | 0.729 ***                                                     | 0.508 ***                                                    | 0.610 ***                                                    | -0.203                                                        | 0.610 ***                                                     |

These analyses illustrated that only some combinations of components exhibited significant relationships. The overarching statements pertaining to visual aesthetics (no. 1, ‘I find this forest view beautiful’) and acceptance (no. 10, ‘I would visit this forest for just such a scenic view’) correlate best, and significantly, with nearly all other statements, whether positive or negative. This was confirmed by the separate assessment of the forest views and in the summation (fv1 to fv3). It was evident that, in general, the negative statement pertaining to visual diversity (no. 3, ‘This forest view is not very exciting’) exhibited only very sporadic correlations to other components (refer to Discussion). Statement 9 addressing spatial arrangement (‘This forest stand leaves a good impression’) was identified as another with a low number of significant relationships with other statements, in particular for fv1.

Very strong and highly significant relationships were found for the statements pertaining to ecological aesthetics (no. 5 (+)) and restfulness (no. 6 (+)), regardless of the forest stand type. Therefore, forest types assessed positively as a habitat for other organisms are simultaneously seen as a positive place for human recreation.

We used ordination (see above) to obtain an idea of the complexity of visual aesthetics composed of the different components and related to the three different forest stand types. Figure 3 includes the valuations for all components of visual aesthetics. Each symbol in the graph represents the summarised valuation given by the respondents for the different forest stand types. The statistical key value ‘stress’, which was calculated for the non-metric multidimensional scaling ordination to characterise the goodness-of-fit, attained a value of 0.076. The stress value can be interpreted as ideal for the interpretation of the
ordination [68,73]. From the graph, the strong overlap of the results for the visual aesthetics of fv1 and fv3 was evident, as was the shift of fv2 along the NMDS1 axis.

**Figure 3.** Results of ordination statistics to differentiate between the evaluations of fv1, fv2 and fv3. The axes describe the non-metric distances between the objects (forest views). The distances reveal which objects are similar to one another.

The results of the ordination were underpinned by the calculation of the pairwise permutation test, which was used to test whether the differences between the three forest view valuations were significant (Table 4). The difference between the valuations of fv1 and fv3 and those of fv2 were highly significant. The differences in the model variations fv1 to fv2 and fv2 to fv3 were explained by the forest views with 28% and 20%, respectively. The permutation confirmed that fv1 and fv3 were perceived similarly by the participants.

**Table 4.** Results of the pairwise permutation tests for the three different forest views (fv1 to fv3) including 9999 replications ($p$-values: ** $\leq 0.01$, * $\leq 0.05$).

| Forest View | f Model | $r^2$ | $p$-Value |
|-------------|---------|-------|-----------|
| fv1 to fv2  | 36.358  | 0.281 | 0.002 **  |
| fv1 to fv3  | 2.752   | 0.027 | 0.039 *   |
| fv2 to fv3  | 23.155  | 0.203 | 0.002 **  |

All permutation tests, including the personal data of respondents to identify additional explanatory variables, showed no significant results.

3.3. Modelling the Complexity of Visual Aesthetic Effects and Acceptance

The following linear mixed effects models were used to describe the relations between the different components considered such as the time of assessment, forest types and participants as random effects, and their relevance in explaining the visual aesthetics of the chosen forest types (refer to Materials and Methods section). A first LMM (Table 5a) involved all of the components of a description of visual aesthetics, whereas the second model featured only those components that produced the best model adjustment (Table 5b). The coefficient values revealed that the components visual diversity ($\beta = 0.472, p \leq 0.000$) and restfulness ($\beta = 0.148, p \leq 0.05$) were the most relevant of the participant statements for the assessment of the forest views. This effect increased in the second part of the model (b), which included only the two components, visual diversity ($\beta = 0.533$) and restfulness ($\beta = 0.250$), as highly significant fixed effects ($p \leq 0.000$). The Bayesian information criterion (BIC) values 452 and 439 also illustrated the increase in quality in model (b) together with the lower number of fixed effects parameters.
Table 5. Coefficients and significance values for linear mixed models (LMM) explaining the visual aesthetics of forest views by (a) all components of perception and (b) the two most relevant components. (BIC—Bayesian information criterion, β—unknown coefficient of fixed effects, p-values—levels of significance).

**Model Including All Components (BIC = 452.191)**

| Fixed Effects                  | Coefficients (β) | Standard Error | t-Value | p-Value |
|--------------------------------|------------------|----------------|---------|---------|
| intercept                      | 0.205            | 0.292          | 0.701   | 0.485   |
| visual diversity               | 0.472            | 0.066          | 7.164   | 0.000   |
| comprehensibility              | 0.082            | 0.057          | 1.439   | 0.153   |
| ecological aesthetics          | 0.145            | 0.073          | 1.988   | 0.049   |
| restfulness                    | 0.148            | 0.065          | 2.272   | 0.025   |
| order/spatial arrangement      | 0.110            | 0.055          | 2.010   | 0.047   |

Model components representing the best overall fit (BIC = 439.114)

| Fixed Effects                  | Coefficients (β) | Standard Error | t-Value | p-Value |
|--------------------------------|------------------|----------------|---------|---------|
| intercept                      | 0.768            | 0.292          | 2.627   | 0.010   |
| visual diversity               | 0.533            | 0.063          | 8.415   | 0.000   |
| restfulness                    | 0.250            | 0.057          | 4.382   | 0.000   |

The second LMM revealed the statistical significance of the visual model components for the acceptance of forest views (Table 6). Within the second variant of the model (b), the component 'comprehensibility' was removed as the only non-significant fixed effect within the model. The BIC exhibited only a very small reduction in value, from 484 to 479, as a consequence.

Table 6. Coefficients and significance values for linear mixed models (LMM) explaining the acceptance of forest views by (a) all components of perception and (b) the two most relevant components. (BIC—Bayesian information criterion, β—unknown coefficient of fixed effects, p-values—level of significance).

**Model Including All Components (BIC = 484.206)**

| Fixed Effects                  | Coefficients (β) | Standard Error | t-Value | p-Value |
|--------------------------------|------------------|----------------|---------|---------|
| intercept                      | −1.005           | 0.297          | −3.389  | 0.001   |
| visual diversity               | 0.258            | 0.075          | 3.438   | 0.001   |
| comprehensibility              | 0.124            | 0.066          | 1.878   | 0.063   |
| ecological aesthetics          | 0.280            | 0.081          | 3.469   | 0.001   |
| restfulness                    | 0.313            | 0.074          | 4.226   | 0.000   |
| order/spatial arrangement      | 0.306            | 0.063          | 4.887   | 0.000   |

Model components representing the best overall fit (BIC = 479.177)

| Fixed Effects                  | Coefficients (β) | Standard Error | t-Value | p-Value |
|--------------------------------|------------------|----------------|---------|---------|
| intercept                      | −0.966           | 0.295          | −3.270  | 0.001   |
| visual diversity               | 0.286            | 0.074          | 3.852   | 0.000   |
| ecological aesthetics          | 0.311            | 0.080          | 3.903   | 0.000   |
| restfulness                    | 0.323            | 0.074          | 4.340   | 0.000   |
| order/spatial arrangement      | 0.332            | 0.061          | 5.426   | 0.000   |

In both linear mixed models, the components restfulness and order/spatial arrangement had the most significant value to explain the acceptance of the forest views by the respondents.
### 3.4. Assessment of Visual Perceptions and Desires Regarding the Different Forest Views

A statement addressing the first open question, ‘What are you noticing in this forest?’, was given by 79% (fv1), 72% (fv2) and 68% (fv3) of the respondents (Table 7).

| Categories               | Characteristics                          | What Do You Notice in This Forest? | What Else Would You Like to See in This Forest? |
|--------------------------|------------------------------------------|-----------------------------------|-----------------------------------------------|
|                          | fv1| fv2| fv3| fv1| fv2| fv3|                     |                     |
| Surroundings             | proportion of sky                        | 5| NA| 2| NA| NA| 2|                     |                     |
|                          | light conditions                         | 5| 9| 6| 1| 4| 2|                     |                     |
| Structure of the tree layer | tree diversity                           | NA| NA| NA| 1| 6| 5|                     |                     |
|                          | tree species                             | 22| 21| 17| 2| 8| 3|                     |                     |
|                          | old trees                                | NA| NA| NA| 1| NA| 3|                     |                     |
|                          | vital trees                              | NA| NA| NA| NA| 5| 1|                     |                     |
|                          | dead trees                               | NA| NA| NA| NA| NA| NA|                     |                     |
|                          | branches                                 | 5| 2| 3| NA| NA| NA|                     |                     |
|                          | moss covered trunk bases                 | 1| NA| NA| NA| NA| NA|                     |                     |
|                          | stem damage                              | NA| NA| NA| NA| NA| NA|                     |                     |
| Ground layer             | ground vegetation species                | NA| NA| NA| 2| 6| 3|                     |                     |
|                          | herbs                                    | 12| 7| 20| NA| NA| NA|                     |                     |
|                          | grasses                                  | 9| NA| 9| NA| NA| NA|                     |                     |
|                          | mosses                                   | 17| 2| 1| NA| NA| NA|                     |                     |
|                          | regeneration of tree species             | 19| NA| 24| NA| 2| 2|                     |                     |
|                          | mushrooms                                | NA| NA| NA| 8| 4| 2|                     |                     |
|                          | lying dead wood                          | 13| 19| 8| NA| NA| NA|                     |                     |
|                          | stumps                                   | 4| 3| NA| NA| NA| NA|                     |                     |
|                          | litter                                   | 1| 4| 1| NA| NA| NA|                     |                     |
|                          | cones                                    | 6| 3| NA| NA| NA| NA|                     |                     |
|                          | roots                                    | 4| 1| NA| NA| NA| NA|                     |                     |
|                          | ploughed up forest soil                  | 7| NA| NA| NA| NA| NA|                     |                     |
|                          | trench                                   | 9| NA| NA| NA| NA| NA|                     |                     |
|                          | rocks                                    | NA| NA| NA| 2| 1| NA|                     |                     |
|                          | water                                    | NA| NA| NA| 3| NA| NA|                     |                     |
| Other components         | green coloured fields of view            | NA| NA| NA| 1| 4| NA|                     |                     |
|                          | wild animals                             | 10| 7| 3| 8| 3| 7|                     |                     |
|                          | visitor infrastructure                   | NA| NA| NA| 3| 1| 2|                     |                     |

The second open question, ‘What else would you like to see in this forest?’, was answered by 55% (fv1), 55% (fv2) and 51% (fv3) of the survey participants. Table 7 summarises all of the answers provided and divides them into the parts of each forest view, namely the surrounding matrix, tree layer, ground layer and other components [53]. The respondents characterised the surroundings of fv1 and fv3 as being bright, whereas fv2 was perceived as being dimly lit. The respondents desired a brightening up of fv2. Table 7 shows that the characteristics of the overstorey tree species and their vitality were often acknowledged for all three forest views, but the respondents wished for a higher number of different tree species. The presence of tree regeneration was detected by 45.2% and 66.7% of the respondents for fv1 and fv3, respectively, and the absence of young trees was recognised for fv2 (Table 7). The different categories of ground vegetation such as herbs, grasses and mosses were described by high proportions of respondents, 57.1% and 44.4% for fv1 and fv3, while their presence was desired for fv2. The presence of dead wood was noticed for fv1 (31%) and fv2 (50%), but this structural element was not sought after for any
of the chosen forest types. The respondents stated they would like to see mushrooms, in particular in fv1, and more wild animals in general. Some respondents expressed a desire for better visitor infrastructure, such as seating arrangements.

4. Discussion
4.1. Suitability of the Perceived Components Used to Survey Visual Aesthetics and Acceptance of Local Forest Types

The five components of perception visual diversity, comprehensibility, ecological aesthetics, restfulness and order/spatial arrangement were chosen for this survey of local forest types dominated by Norway spruce to explain the two levels of visual perception: visual aesthetics and acceptance. These two levels constitute descriptions of psychological/mental human effects engendered by appreciated physical forest structures [7]. Visual diversity and comprehensibility are essentially more intuitive sensations, originally developed over the course of evolution [74]. In this biologically influenced context, people assess the advantageousness of a forest type or view by its suitability as a habitat within a landscape and within the natural settings preferred by people, as was explained by [57]. By comparison, the acceptance of a forest type is based on information and on an understanding of how forest ecosystems should be managed to fulfil the demands of recreation. Therefore, ecological aesthetics has high relevance for acceptance, but both aspects are not the same [63,75]. Differences in people’s imaginations with respect to forest management are related to differences in acceptance. For example, people can accept forest types and views they might not prefer on the basis of aesthetic reasons, but which are seen as acceptable in the context of the need for specific silvicultural techniques or measures to produce and use forest goods and services. This means that acceptance is rather a cognitive skill that can be influenced by knowledge. The valuation of dead wood, for instance, depends on knowledge of the functions of dead wood as a natural part of ecological processes and systems [38]. Dead wood was perceived as a structural element within the three forest views by the respondents but not its ecological functions. This was evidenced by the fact that dead wood was not listed as an important or as an absent element.

The overall rankings of the three evaluated forest types led to the same order for both visual aesthetics and acceptance, starting with the most favourably assessed forest type, Norway spruce forests with the regeneration of deciduous tree species in the background (fv1), followed by the Norway spruce stand with European beech as a second layer in the foreground of the stand (fv3) and in third place the Norway spruce stand without regeneration (fv2). The results of the ordination analysis and the permutation tests proved that the differences in the visual effects were low between fv1 and fv3, but significant in comparison with fv2. However, Norway spruce forests enjoyed greater acceptance where the forest view included some deciduous tree species. The preference for mixed forests was demonstrated and primarily interpreted as a preference for visual diversity [76,77]. One basic problem of using a number of selected components to evaluate people’s perceptions in surveys is the high degree of subjectivity and complexity, which is typical for the field of perception psychology [18,74]. To ensure relevance in terms of practical forest management, this study was established as a preference-based study, which sought to determine causalities between forest structures, and the perception thereof, rather than using ‘black box’ systems [78]. It is important to find out which components of psychological perception can be directly linked to specific structural categories of ecosystems as an important part of people’s environments [44,79]. Our attempt to test the functionality of negatively formulated control statements in the survey with respect to visual diversity (statement 3), restfulness (statement 7) and order/spatial arrangement (statement 8), in accordance with [34], failed only for the negative control statement addressing visual diversity (statement 3). The reason for this was perhaps an unfavourable formulation of the statement with a double negative in the questionnaire. This led to irritation amongst respondents in terms of classification within the rating scale (Table 3). A better formulation for this third statement would probably have been: ‘There is little to be discovered within this forest type’.
In this study, with its high degree of local colour, we used five components which were demonstrably known to be of particular relevance in evaluating the visual perception of forest structures [33, 34, 74]. It could be shown by means of linear mixed models that the chosen components were mostly appropriate to obtain information about the visual perceptions and acceptance of forest types and structures by the people who participated. An extensive proportion of the explanation was provided by the component visual diversity (Table 5), especially for the appraisal of the visual aesthetics. Visual diversity was substantially lower in terms of explaining acceptance (Table 6). The results of previous studies documented considerable differences in the strength of relationships between aesthetic diversity and acceptance or acceptability [34, 57, 75]. The visual diversity component of forest views involved not only the number of perceived structures or structural elements, but also the shapes, colours and the individual significance of structures or structural attributes for people [45, 47]. Hence, from the freely associated statements provided by the respondents, tree species, species of ground vegetation and forest structures characterised by different colours could be assigned to the component visual diversity [42, 43, 76, 80]. For example, the white bark of the birch tree in fv2 differed from the brown bark of the Norway spruce trees. This contrast of colours may have increased the total frequency of perception of visual diversity, even if the beholder’s knowledge (see ecological aesthetics) of tree species was low or the surrounding environment within the forest view was uniform [26, 45, 81]. Palmer et al. [82] and White et al. [20] demonstrated that contrasts in form, colour, material and light conditions have an effect in terms of the perception of the visual diversity of landscapes and of forest ecosystems. The correlations between different visual components (Table 3) can also produce certain overlay effects, which serve to increase or reduce the relevance of individual components and their meaning [66]. The critical correlation coefficient value of 0.7 was reached only for ‘aesthetic effects’ (statement 1) and ‘ecological aesthetics’ (statement 5) in relation to ‘acceptance’ (statement 10) (Table 3).

A relatively common feature of managed Norway spruce forests are the remains of tree crowns consisting of fresh green needles left on the forest floor after felling activities. Fresh needles and leaves are normally appraised positively in contrast to a brown needle-horizon on the floor, but in assessing the component ecological aesthetics, the observer reflects upon the fact that this element is not natural in origin, or the result of anthropogenic activities [21, 36]. As a consequence, this element is valued negatively, with an additional negative feedback loop for visual diversity. In our survey, it could be shown that this reflection was not driven by the component comprehensibility, because neither visual aesthetics nor acceptance were significant explanatory variables within the models (Tables 5 and 6). Although it could be assumed that the local people represented in the survey had some knowledge of the dominant tree species Norway spruce and the admixed species such as birch or European beech, this was not directly apparent from the results of the modelling process for visual aesthetics or acceptance. The meta-analyses presented by Stamps [79], who also included studies concerned with forests, demonstrated that the relationship between comprehensibility and aesthetic preferences has a very broad range, with opposing statements made in different studies. In our study, the component ecological aesthetics was more relevant to explaining the acceptance of forest types than visual aesthetics (Tables 5 and 6). This was in line with observations from Gundersen and Frivold [83], who noticed that structures are only perceived when background knowledge of the forest ecosystem is available, or when the structure differs in form or colour from the rest [61]. The aforementioned authors also pointed out, however, that ecological aesthetics can also be driven by emotional contexts. Examples of this might be a theoretical imagining or feeling about how a real natural forest structure should look, and which structural attributes are originally a part of natural forests. As a result, most respondents favour forests that look natural from their individual point of view in combination with some aspects of ecological knowledge; for example, deciduous tree species are rare in this region and should be an important component of these forests [1, 21]. From the perspective of ecological aesthetics, fv3 obtained nearly the same positive evaluation scores as fv1,
even though the beech looked relatively homogenous within fv3 and were established by means of significant anthropogenic intervention. The component restfulness obtained the second rank within the model (Table 5), which explained the visual aesthetics, and was highly significant for the model explanation of acceptance (Table 6). This could again be explained by the perception of naturalness. If the sense of closeness to nature increases during the visual reflection of a specific forest, the feeling of restfulness also increases [84]. According to Kaplan’s [12] ‘attention restoration theory’, restfulness can be described as an unconscious reaction which leads to specific attention directed towards objects within the environment or, as in this case, in the forest. Restfulness has also been described as a complex reaction summarising different components, which is why the relevance of this component for visual aesthetics should not be over-interpreted [27]. The statements addressing order/spatial arrangement also obtained higher valuations, in particular for fv1 and fv3, but the notion of order/spatial arrangement in natural systems is possibly too abstract and may have been interpreted differently by the visitors (see also [34]). This became particularly obvious in the case of fv2, which was assessed negatively in terms of order/spatial arrangement, even as the corresponding structural parameters and silvicultural valuation units suggested this was the most homogeneous structure for this forest type. The terms ‘order’ and ‘spatial arrangement of environmental structures’ were interpreted as examples to inspire a high level of individuality [85,86]. These authors summarised the considerations with the question: What is orderly and how much human impact/care is appropriate for the forest structure? In the case of our study, this was obvious; for example, in relation to fv1, where the trench and old stumps were the result of a direct human impact, but this impact was not deemed by the respondents to be negative with regard to visual aesthetics or acceptance. The last component in particular confirmed that silvicultural activities at local and regional scale are accepted by forest visitors whose appreciation of the visual aesthetics is underpinned by basic ecological knowledge and understanding. Over the last decade, the need for state and private forest enterprises to effectively present and communicate their forest management activities to the public has increased greatly for urban forests and in forest areas with a high appeal for tourists [87,88]. Public relations activities addressing the topic of forest conversion [89], for example, the conversion of homogenous Norway spruce forests to European beech or mixed forests, have been undertaken by the state forestry administrations in Germany for many years now [90]. As was explained in Section 2.1, this was one reason for the choice of the three forest views selected as typical examples of frequent forest structures. The local population is well informed about the topic of forest conversion, the related ecological processes and silvicultural techniques. The preparation of additional information is required for tourists, and the further adaptation of forest structures along the main trails should be strengthened accordingly. The results showed that contrasting tree species mixtures with higher proportions of deciduous tree species should be supported by silvicultural measures. It was also shown that tourism concepts should integrate information for visitors, both local and non-local, about the ecological role and value of dead wood. These concepts might include guided forest tours, forest-related education events or educational forest trails [38,91].

4.2. Relationship between Forest Structures and Components of Visual Aesthetics

Overall, the participants in this study did not focus overly much on the structural details of the forest views [28]. They described the coarse structures of the forest types and surrounding elements such as light conditions, canopy closure or the proportion of visible sky. This perception was driven by the human quest to identify the optimal proportion of light and shadow in the surrounding habitat at every time of the day [81]. Tree regeneration was the forest structure most frequently referred to by the survey participants in response to the open questions (Table 7). The specific identification of the perceived tree species combined two aspects of visual aesthetics: (i) the visual capacity for perception (cognitive), if the habitus and the colour of different tree species are comparable, and (ii) knowledge of tree species. The latter is part of ecological aesthetics and comprehensibility,
but only in rare cases was more than one tree species named [92]. On the other hand, it is conceivable that rarely mentioned structures have a specific and individual meaning for some respondents [21]. Damage to individual trees was not described, which was consistent with [93], who differentiated between the experiences of landscapes expressed by laypeople (emotional) and by experts (cognitive). Water was one desired aesthetic component of forests, as found previously by [20]. More regeneration of deciduous tree species was listed as a desirable forest structure, serving to increase diversity and the proportion of ‘green’ within the forest types [94]. Shades of the colour green have been demonstrated to have a strong psychological effect for humans and on the interpretation of what respondents have seen [74,95,96]. At the same time, dense green regeneration in the foreground blocks views into the forest and reduces opportunities to see ground vegetation and wild animals, and hampers the picking of mushrooms [97,98], which are also desired activities. It is important, therefore, that causal analyses differentiate between visual aesthetics and recreational amenities, as was stressed by [27].

Different qualities of relations between the components of visual aesthetics and acceptance could be proven for the three chosen forest types by the correlation analyses [57,79]. The first forest type with old Norway spruce trees in the overstorey and a mixture of mainly deciduous young trees in the background received the most positive overall assessments for visual aesthetics and acceptance, although this forest type was also dominated by conifers. This ranking could largely be attributed to the age and dimensions of the Norway spruce trees. It has frequently been shown that old trees with larger diameters (>40 cm in this forest stand) are perceived positively by forest visitors [36,99]. Humans show a strong mental connection to old and big trees in large part because of their worldwide cultural–historical significance as objects of self-reflection, religious and symbolic character [100]. Another positive effect in terms of the visual aesthetics of older forests is the high visibility [42,99] or visible depth [30,83]. Old, mono-layered Norway spruce forests with low stocking densities and no regeneration layer in the foreground form a simple structure, which is relevant in the context of the theoretical background covered by the ‘information-process theory’ [57]. The structural information encrypted in this forest type is relatively simply perceived by visual skills, while the visual value of fv1 was further improved by the clearly visible aggregate of a mixed deciduous tree species regenerating in the background [86,101]. Aggregated tree species admixtures are preferred in some forest regions of central Europe [48,81]. The positive visual effect of the visible regeneration is supported theoretically by the ‘prospect-and-refuge theory’ [102], which emphasises that the possibility to easily spot interesting things exists within this forest type, and also to find options for a place of refuge. Both aspects have their origins in humankinds’ evolutionary development and behaviour within a natural environment. The admixed deciduous tree species in the background also contrast with the pure old Norway spruce trees in front in both form and colour [61,92]. This is in line with the valuation of restfulness, illustrating the fascination with the concentrated regeneration and highlighted by the visible depth [12,84]. The low proportion of dead wood had a positive effect in relation to the visual component order; it was not perceived as a disturbance [42]. The third forest type differed significantly in structural composition from the perspective of silvicultural management but contained comparable key structural elements such as old Norway spruce trees combined with only one deciduous tree species. This led to an only slightly poorer valuation, with a small shift in the ordination results (compare Figure 3) of fv3 compared to fv1. The dense European beech layer, established to achieve forest conversion, reduced the visibility and visible depth significantly, with a lower value in terms of aesthetic effects [42,83,99]. Buhyoff et al. [103] and Ribe [104] found that for trees of dimensions less than 12 cm dbh the effect of visual aesthetics can be described as a bell-shaped curve, which increases with densities from 1000 to 4000 plants before decreasing again with higher tree densities. The Norway spruce trees in the overstorey of fv3 provided a low degree of canopy closure. This relativised the effect of density in the second layer and created a mystical effect with hidden areas in this forest type waiting to be discovered [33]. The curiosity of visitors will be
stimulated, but at the same time the accessibility of these forests is low. The second forest type comprising mono-layered Norway spruce trees with a high stocking density obtained the lowest rank in the assessment of visual aesthetics and acceptance. These middle-aged coniferous forests with low proportions of admixed tree species were obviously the forest types with the lowest visual attractiveness, even though Norway spruce has a high presence in this region and a particular cultural–historical significance [77,80]. The main reasons for this low appraisal were the lack of regeneration, the structural uniformity of the overstorey and the ground layer, and the limited visibility [42,53,78]. On the basis of a structural description of this forest type using silvicultural standards, it could be assumed that there was little to discover in this forest type, yet this contradicted the number of valued structures listed by respondents. It appeared, therefore, that the visually perceived structures were linked to negative information with a low level of comprehensibility. Structures such as the dead wood found in the form of individual admixed birch trees and the high number of dead branches at eye level on the trunks of Norway spruce trees had a negative symbolic character. Some respondents used the term monoculture, which confirmed the negative valuation of the ecological aesthetic and the existing knowledge or intuitive perception that this forest was not naturally structured [19,105]. Moreover, the visual dominance of brown coloured forest structures led to an increasing desire for the colour green [94,106].

5. Conclusions

In this local case study, survey respondents’ assessments of the visual aesthetics and their acceptance of different forest types on the basis of visually perceivable structures could be interpreted by means of a clear ranking of the three chosen forest types. It became clear that the assessment of visual aesthetics and acceptance were based on different levels of cognitive ability (perception versus knowledge-based). As a consequence, it was at times difficult to identify direct links between the different components of visual aesthetics and forest structures or overlay effects. Nevertheless, some unambiguous statements could be deduced with regard to silvicultural management seeking to enhance the effect of visual aesthetics by adapting structural elements within Norway spruce-dominated forests. Most of the following conclusions enhancing visual aesthetics and acceptance are in line with the requirements for silvicultural measures in state forests. First of all, longer rotation periods serving to increase the age of overstorey trees and, consequently, to produce larger stem dimensions improve the visual aesthetics and acceptance of various forest types in general. Second, it appears to be irrelevant whether the regeneration of deciduous tree species is established by means of natural or artificial regeneration, but in all cases, an increasing proportion of appropriate tree species regeneration produces a positive effect in terms of visual aesthetics. In the case of the study area considered here, this means that forest conversion strategies (planting beech) and near-natural silvicultural measures (natural regeneration within gaps) will enrich the visual aesthetics. It was obvious that the combination of trees and tree species of different ages was positively evaluated, because of the increasing visual diversity and ecological aesthetics this created. Perhaps on the larger spatial scale, forest planning should provide for an alternation of tree species, ages and spatial arrangements of regeneration areas between forest types. This is necessary to guarantee structural and visual diversity at the landscape level also, or on the scale affected by the management activities of forest enterprises. This is also the case in terms of supporting tree species mixtures, in particular for combinations of locally adapted groups of tree species such as Norway spruce, silver fir, European beech, sycamore, silver birch or rowan (ecological aesthetics) and for combinations of tree species generating visual contrasts on the basis of their leaves, bark or the habitats they create. The survey revealed that very dense Norway spruce forests with high numbers of dead branches and without canopy gaps were evaluated negatively. The visual aesthetics and acceptance would profit from silvicultural measures reducing thinning residues within these forests. In old Norway spruce forests, thinning regimes based on single-tree and group selection methods could increase structural diversity (the establishment of regeneration, diverse tree species and
developmental stages, canopy openings) and visual diversity (varied light conditions, contrasts in colour and shape). All these silvicultural measures should be implemented using techniques leaving few visible traces, given the limited acceptance of human impacts and the resultant negative impact on visual aesthetics.

**Author Contributions:** Conceptualization, F.F., F.H., S.W. and N.W.; Methodology, F.F., F.H., S.W. and N.W.; Software, F.F. and S.W.; Validation, F.F., S.W. and F.H.; Formal Analysis, F.F.; Investigation, F.F. and F.H.; Resources, F.F., S.W. and F.H.; Data Curation, F.F.; Writing—Original Draft Preparation, F.F., F.H., S.W. and N.W.; Writing—Review and Editing, F.F., F.H., S.W. and N.W.; Visualization, F.F. and F.H.; Supervision, S.W., N.W. and F.H. All authors have read and agreed to the published version of the manuscript.

**Funding:** Open Access Funding by the Publication Fund of the TU Dresden.

**Acknowledgments:** The authors would like to express especial thanks to our proof reader, David Butler Manning.

**Conflicts of Interest:** The authors declare no conflict of interest.

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