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Visually-based sensations: from perception to the 'wow factor'

Floris L. van Nes
Eindhoven University of Technology
Den Dolech 2, NL-5600 MB Eindhoven,
The Netherlands. E:f.l.v.nes@tue.nl

ABSTRACT

Unusual visual phenomena are used to study perception and the following stages, characterized by: aesthetic appreciation and judgment; contributions from cognitive and emotional factors - and a combined *cognitive judgment, wonder and a strong positive emotion, colloquially known as 'the wow factor'. Examples of the latter are impressions of 'super depth' and 'super sharpness'; they may occur after cataract operations but also may follow less dramatic visual events. The research methods used are personal observation with introspection, and interviews. An important feature of many unusual visual phenomena is their temporariness, with, however, often the possibility to re-evoke them. Explanations to a certain extent may be found in Bayesian reweighting of perceptual criteria and also in neuroscience, in particular neuroaesthetics.*

Keywords: real-world vision, cataract operations, post-cataract experiences, super depth, super sharpness, aesthetics, affective responses to visual sensations, Bayesian cue reweighting, neuroaesthetics

1. INTRODUCTION

1.1 Background

This paper originates from my personal visual experiences after two cataract operations. As described before[1], these experiences, though short-lived were impressive, and accompanied by strong positive emotions. When I inquired after such post-cataract effects in others, a few of them described various, always short-lived experiences that were more or less comparable with mine.

These post-cataract phenomena because of their strength seemed to deserve documentation and further investigation. I'm not aware of literature accounts of similar phenomena; but present-day cataract operation techniques, characterized by the implantation of artificial lenses with generally excellent results, date only from after World War II, wherein it was discovered that pilots from fighter planes who during combat had gotten splinters from the windshields of their planes in their eyes, suffered no ill effects from those splinters: the material those windshields was made of turned out not to cause rejection reactions from the human body and therefore, together with other properties, was suited to fabricate artificial lenses. Probably we can't expect too many literature accounts from post-cataract effects similar to the ones described here from the 65 years or so since the widespread introduction of the new operation techniques. Moreover, vision scientists living after 1945 were not very inclined to pay attention to and report on such phenomena that appear to be unusual; hence I call them 'unusual visual phenomena'. We have to consult the older literature on vision sciences, from researchers such as Helmholtz[2], Mach[3] and Purkinje[4], to find references to this type of phenomena. This was then by someone like Mach in his 'The Analysis of Sensations - and the Relation of the Physical to the Psychical', embedded in reconsidering what role could be played by 'physical science' in the development of the 'physiology of the senses', namely providing 'powerful assistance' - without, however, being the sole source of that development.

In my view there is a fairly general neglect of these unusual visual phenomena; not only in society at large, but also in the vision research community itself. This paper tries to counteract that neglect, and aims to show that (re-)studying them may well provide some fresh insights in aspects of vision.

1.2 Examples of unusual visual phenomena

Definition. An exact definition is hard to give; maybe 'description' is a better term. I have in mind an observation that is generally short-lived, cannot be compared easily with every-day observations and frequently surprises us because it is unexpected – often because it seems to have no relation with usually observed objects or common larger visual fields as are seen in rooms or outside environments. There are two types: phenomena that in principle can be seen by everyone having normal vision, and phenomena that require special conditions, for example a preceding cataract operation.

Shadows of our retinal blood vessels. In the process of selecting a PhD research project I considered the study of stabilized retinal images by the Yarbus technique[5], and learned of the prime natural example of a stabilized image: that of the shadows of retinal blood vessels[6]. I was taught by experts in this field how to see those shadows without particular experimental methods, and for quite some time told everybody that wanted to listen to me about it, thinking that they would try to see their own retinal vessels, and share my fascination – which, however, only rarely happened. Later I found to my surprise that also in groups of vision scientists, such as can be met in a session of the HVEI conferences, there are only few people that know about the possibility to see their own 'Purkinje figures' – let alone having actually seen them.

The blue arcs of Purkinje. The same applies *mutatis mutandis* to this phenomenon[4,7]. I discovered it myself just after acquiring my doctoral degree, when walking at night I passed the red standby light of a TV set at home, and later discussed it extensively with my then boss, first director of the Institute for Perception Research, Jan Frederik Schouten – who told me that he had also suddenly discovered these 'blue arcs of Purkinje' when he was a student. I found later that these arcs are even less known than the shadows of the retinal blood vessels – though everybody gets many chances to see them.

The 'green ray' at sunset. When the sun sets in a clear sky, without even a thin layer of clouds at the horizon, the last rays reaching an observer can be bright green instead of red, because of selective color absorption and the prismatic ray-bending effect of

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the atmosphere[8]. This phenomenon only lasts for a second or two, but it is striking because of its high purity and saturation, being spectral light. I have seen it only twice, both times at the promenade of Dieppe, Normandy in France. The second time was in August 2015; and I then regarded the hundreds of people, including my family (whom I of course had told before the *moment supreme* what might happen in a few minutes), strolling there and enjoying the beautiful summer evening – with, however, nobody sharing my experience though that was available for everyone.
On the other hand, a sign of this phenomenon being really 'unusual' is that up to the present day it appears to be an issue whether 'the green ray' is really a physical phenomenon – or rather an afterimage of the crest of the sun that was fixated before the sun disappeared. Having actually seen it I can say it cannot be an afterimage because it is far too strong for that, and because it cannot be brought back by winking – as afterimages can, albeit with gradually decreasing intensity.

2. METHODS

2.1 Personal observation, subjective sensations and introspection

To note and therefore observe an unusual, for instance entoptic or atmospheric phenomenon such as the blue arcs or the green ray requires nothing more than what may be called an open mind, maybe helped by knowledge on the phenomenon's existence, or luck. But to reflect on the subjective sensations resulting from these observations one needs introspection. Then the question arises: can this suite of events contribute at all to the development of vision science ? And if so, under what conditions ? How can it be verified and, preferably, quantified ? Can one train one's introspection, and if so, how ?

Verification is possible by comparison, for example by interviews, with the experience of others who have undergone the same or a similar suit of events. However, not too much is to be expected in that way, as shown by the small number of people knowing phenomena such as the blue arcs of Purkinje or the retinal blood vessels from their own observation. The appearance of the green ray at sunset in Dieppe, unseen by the great majority of all people present there, described above, is a good example of the general neglect of such phenomena - though its explanation is related to physics, not vision.

Quantification would require the development of, for instance, scaling techniques. Possibilities of applying the methodologies of experimental phenomenology[9] to this end are being investigated – but this might not be easy for the really worth-while cases such as the appearance of 'super depth'[1]. Because for those having had these *temporary* observations, like me, their occurrence generally lies already quite some time behind them; whereas for others I found it was far from simple to explain to them what I meant at all.

Training introspection may sound strange, but I think there are possibilities. For example, in my case it seems that I can so to speak "split off" a part of myself, that then observes the perceptions and emotions of 'the rest' – staying objective. The latter is an essential requirement, of course. It is interesting that Helmholtz[7], speaking about sensory sensations in general, states "we are wont to disregard all those parts of the sensations that are of no importance so far as external objects are concerned. Thus in most cases some special assistance and training are needed to observe these latter subjective sensations" (see for what Helmholtz meant with 'external objects' Section 3.2 of this paper). Helmholtz even felt "that for the discovery of subjective sensations some special talent is needed, such as Purkinje[4] manifested in the highest degree".
Another scientist who in the past applied and strongly advocated personal observation was the already mentioned biophysicist J.F. Schouten. Already in his doctoral dissertation he stated that, although it may seem then 'that a certain objectivity of observing gets lost, on the other hand in this research it was in the first place necessary to notice and evaluate the occurring phenomena'. Only after that an appropriate measuring method could be developed[10]. Schouten, who acquired fame with his studies of pitch perception, was the first director of the Institute for Perception Research in Eindhoven, The Netherlands, and in that function continuously urged his research personnel to apply this rule of starting investigations by personal observation – as was commemorated in his obituary: "The confidence in his own observation was there; he was an observer of acumen and could distinguish between perception and interpretation better than most men"[11].

2.2 Interviews

Interviews, either formal or informal, in my view are indispensable for the study of unusual visual phenomena, especially those of the second type. They have proven their worth[1] and are being further developed now. The interviewer in this case unavoidably meets the problem of, to paraphrase Sylvia Pont's words, "how to relate scientific descriptions to semantic descriptions of visual phenomena by non-professional observers"[12].

2.3 Neuroscience

Research in neurophysiology does show promising developments and apparently applicable results that appear to parallel both the delight and the temporariness of new sensations such as 'super depth' and 'Super-Sharpness Impressions' or SSIs[1] after a cataract operation. For example, Biederman and Vessel have shown with modern brain research techniques using fMRI that seeing an entirely new and beautiful scenery can be coupled with measurable occurrences in certain brain areas, where opioid-like substances are secreted; the source of 'perceptual pleasure'[13]. However, this happens only, at any rate most strongly, when the scenery concerned is viewed and admired for the first time.

Would it be possible to employ such neuroscience techniques to verify and further elucidate the kind of percepts that are concerned in phenomena such as super depth and SSI ? Obviously this would not be easy, maybe even regarded as practically impossible, to put ex-patients of cataract in an fMRI scanner. However, it may be worth-while to further pursue ways to use these research methods.

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2.4 Serendipitous acuity difference

Before developing cataract I was myopic, and I had to wear corrective glasses most of my life. Therefore, I chose to become emmetropic with implanted lenses, even though I was warned I could only reach a moderate acuity due to astigmatism. After the operation it turned out to be 80 % for my left eye, and 70 % for my right eye, more than enough for 'daily use'. But for 'special purposes', I figured, I acquired 'distance glasses' for correcting my astigmatism. In hindsight it turned out that the relatively small gain in acuity I could get by putting my astigmatism-correcting distance glasses on was probably just the right amount to elicit the, short lasting, SSIs. Though it was not an intended method to obtain this result, it did serve as one.

3. ASSUMED PROPERTIES OF SOME POST-PERCEPTION STAGES

3.1 General

It is not possible to try to analyze, or even to just describe, processes following visually perceiving without making some assumptions about possible or probable phases in neural processing wherein the visual percepts are handled, and which ultimately lead to us becoming aware of our retinal output. So I need to do so - but I certainly do not claim the actual reality of such well-outlined phases; only the necessity of their contents.

3.2 Personal interest, followed by cognitive or emotional judgment

Although I possess corrective glasses that I only need to start wearing in order to increase my visual acuity by some 30 %, for everyday use I prefer to be without glasses, for instance because I actually did need such corrective glasses all day long during the largest part of my life. Actually this forsaking of acuity may be not too strange: most, maybe all of us for most of the time use our vision as a kind of tool to move about, take what we need from somewhere and place what we don't need any more someplace, etc. "Vision as a user interface", Koenderink has called it[14]. And, long ago, Helmholtz already stated "… that we are not in the habit of observing our sensations accurately, except as they are useful in enabling us to recognize external objects"[7]. However, there are many instances and circumstances when a specific result of our visual perception does really interest us, for instance when we need to take a train and try to read its departure time and platform somewhere in the distance, or when we're walking in a beautiful landscape or visiting a museum. The first example is purely utilitarian, the second one involves emotion and thus is more complex, but both presuppose that the visual percept is consciously registered, and then either cognitively or affectively judged.

3.3 Conspicuity

But even if we casually, without anything specific aimed at, see a visual scene something in it may attract our attention, say a color clearly different from the other colors present and therefore conspicuous. Then we really look well, and may come to some form of judgment; for example, aesthetic appreciation.

3.4 Affective approaches to vision, such as aesthetic appreciation and –judgment

In their model of aesthetic appreciation and aesthetic judgments Leder et al.[15] aim to explain why people are attracted by art. In this quest, starting with early psychologists such as Fechner[16] in 1871 and Wundt in 1874, they start their general conclusion by stating that aesthetic experience is particularly interesting for psychologists "because it consists of cognitive and emotional processes evoked by the aesthetic processing of an object". This processing, if completed, will take 'sufficient time', they concede. Anyway, aesthetic appreciation of art seems indeed to take some time, as observing the visitors of a museum shows immediately. On the other hand, aesthetic appreciation of a natural environment may be a very fast process, as can be distilled from Ulrich[17] drawing, for instance, from Zajonc[18].

3.5 Other forms of 'affective resonance', and affective judgment - the 'wow factor' leading to a 'wow experience'

Many visual scenes that we observe give rise to certain emotions, for instance, a feeling of well-being, or of disgust. The strength of such feelings is widely different, and they may or may not cause a form of affective judgment; some form of consciously choosing how to deal with the emotion caused by the visual percept at hand appears to be generally involved. However, conscious choice and time-consuming processing is not always involved, since there appears to be a special 'stage' following visual perception that can suddenly become active, often combining keen cognitive judgment, wonder and a strong, positive emotion. This layer is tied to what is colloquially known as 'the wow factor'. Personally I have been so much impressed, even thrilled with the power of this complex sensation that I used the word 'delight' for it[1]. It is characterized by an emotion that cannot be ignored, even might be overwhelming. It is so impressive that it will not be forgotten, but is fairly easily recollected and reported, after having been triggered by appropriate questioning by an interviewer. I now know of a few individuals, apart from myself, who have had 'strong wow experiences' of this type in comparable circumstances. For two of them it was a consequence of one or two cataract operations, and for the third one it was tied to an after-cataract treatment. But there certainly are other events or circumstances leading to the characteristic combination of a cognitive judgment concerning an aspect of the visual percept, for example 'super depth' , and an emotional resonance that is very positive and impossible to ignore. Also, this emotion is so strong that it may lead to a kind of almost uncontrollable excitement, that by itself may be regarded as inappropriate, or even embarrassing – if it were known as such by others.

4. RESULTS

4.1 Wow experiences

Personal. As explained in the previous section, with a 'wow experience' I mean a well-structured visual percept accompanied by a strong, positive emotion, frequently combined with a form of cognitive judgment. My second of these post-cataract experiences happened when I was driving alone in the dark on a desert road

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and suddenly became aware of the letters and numbers on a traffic sign. What struck me then was their sharpness; it made me say aloud: "I think I've never seen such sharp, high-contrast letters ever before !". Simultaneously I thought: "why am I thrilled by that ? That's absurd !" This was my first 'super sharpness impression', or SSI[1]. In that paper on the after-effects of cataract operations I also described my own sensations of 'super depth'. These lasted a few minutes, and occurred for the first time when I regained stereo vision, after my second eye had been operated. I had lost vision in depth after the first operation, because I then had one emmetropic and one myopic eye, until the second operation. For some months following the implantation of new lenses I had occasionally super-depth impressions lasting a few minutes. Later I had as a number of SSIs, that, also for a few minutes, followed when I suddenly increased my acuity by about 30 %, by putting on the distance glasses correcting the astigmatism remaining after the operations[1]. These SSIs, albeit in an ever decreasing occurrence and intensity, still may follow the sudden increase in acuity that I enjoy after putting on these corrective glasses – again, only for a few minutes, yet very noticeable.

Given the large role played by color in visual perception[9,19], one might expect it to figure prominently in wow experiences, maybe more so than what I experienced myself; with one notable exception. In February 2014 I was at 'Dante's View', an excellent viewpoint in Death Valley National Park, just before sunset. The sky was partly clouded, and the color of the sky where the sun had already disappeared behind the mountains was an intriguing mixture of dark blue and black with shades of dark red and purple. After I put on my distance glasses, thereby seeing the rim of the mountain range and the edges of some clouds sharper than before, the whole scene acquired a fairy-like appearance - for a very short time, not only because of the temporariness of all my wow experiences, but also because of the setting of the sun, causing a rapid discoloration of the sky.

Then there was 'the green ray' that I saw at sunset in Dieppe, in August 2015. It might have given me a starting 'color wow experience', given its striking character; but that's hard to say, since it lasted only a few seconds. In this case, as in the two following ones, the wow character had nothing to do with an SSI caused by a sudden acuity increase.

I remember that long before my cataract operations I had twice an experience that I now would give a 'wow label'. Both times this happened during a tour in the mountains; once when the trail I was following suddenly went over a mountain pass and I could look at the beautiful scenery at the other side; and the second time after having reached a summit, thereby suddenly seeing another distant mountain peak in all splendor. In these two cases there was no relation with a sudded acuity increase; in fact they are of the type described by Biederman and Vessel[13].

Other people. I found through the interviews which I held with fellow-patients three other persons who had such after-cataract wow experiences.

The first person was a man of 82 years. His experiences were not so much linked to stereopsis or acuity, but rather consisted of suddenly perceiving one or two particular trees in a forest as beautiful and very symmetrical. This happened only a number of times. Like myself, he was aware of the peculiarity of this reaction, even found it somehow embarrassing[1].

The second person was a woman, aged 76/77 years (at the first/second operation). After her first cataract operation she was driving on a motorway in The Netherlands. All of a sudden she realized that everything she saw from her car, was 'unbelievably bright and sharp'. This sensation was accompanied by very positive feelings, and lasted in hindsight 'rather long', i.e. at least a quarter-hour. At any rate it was finished before the end of her trip (that lasted maybe 90 minutes). Her second special experience occurred during a walk with her husband, at the edge of a wood, where a number of paths went in, all straight. They had to turn in the path where a gate should be visible at a distance. At one path she said "yes, there's the gate" – whereupon her husband reacted with surprise: "a gate ? But **you** surely can't see that, can you ?" – for his acuity in general was considerably higher than hers, but he now didn't discern a gate. Then, when they had reached the gate, she had the impression that 'everything was normal again'. A number of months after her operations she never had experiences like these anymore, and then felt disappointed. She said that they should have warned her at the eye clinic that such delightful experiences would stop after some time, because then she would have enjoyed them even more.

In the third case with a wow experience it didn't follow a cataract operation proper, but rather an operation that happened in its aftermath. A university colleague told me that at first he hadn't noticed much difference at all in his eyesight after undergoing cataract surgery in both eyes. But then he developed after-cataract, or 'posterior capsular opacification'. This caused a kind of haze over his entire field of view. The problem was solved by a laser treatment. When, after that treatment, he happened to look at the small Persian carpet he had purchased himself in Isfahan, Iran he was suddenly very impressed by the beauty and vividness of its colors – in fact even more so than after he had acquired the carpet. In this case the wow experience clearly did involve color.

Apart from those post-cataract cases, I collected a number of what may also be called wow experiences, from other people under other conditions. All of them were told me after I described my own delightful post-cataract sensations, but were not elicited by the same events. It seems likely that the concurrent emotions varied in strength, but all were related to me as analogues of my wow experiences. They follow:

- a friend compared the SSIs, including their temporariness, with using his telescope: "if you pick it up, adjust the settings for both eyes and let their images fuse, you get for a few moments an *AHA Erlebnis !* But if you then put the telescope down, and a bit later look through it again, everything is all of a sudden normal – though you do see, as expected, one enlarged image"

- another friend applied the concept of a short-lasting wow experience to the first time he watched an autostereoscopic 3D TV set: he was at first impressed by the new depth of TV images, but this soon disappeared. Yet another friend applied it to the first time he watched a 3D movie in a cinema: at first he felt such a movie was very special; but already after a few minutes he had forgotten about the stereopsis, and felt it was the same as watching a conventional 2D movie.

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4.2 Additional data on unusual visual phenomena elicited by suddenly sharpening the observed image

Super sharpness. These data refer to myself again, and were collected after I presented my first paper on this subject[1]. As to super-sharpness impressions, SSIs, in the precursor to this paper I wrote under 'Conclusions' that "the super-depth experience occurs only in a limited period, shortly after the operation on the second eye, but the SSI can be elicited more or less at will"[1]. With the passing of time after the operations, I have to qualify the second conclusion; the first one still holds, although it may be good to underline that these super-depth experiences always occurred *without* corrective distance glasses, i.e. even with a slightly out of focus retinal image. As to the second one, of an SSI, since that was such a delightful experience I kept trying to evoke it, at least until the end of the summer of 2015, but found that its emotional effects either did not occur at all anymore or were greatly diminished; with a few very notable exceptions. As to the other side effects of the sudden sharpness, viz. surprise and wonder on the existence, or possibility of such a sharpness: they could not have been expected to last, since I knew them after their first few occurrences. A couple of examples of 'mini-SSIs' follow:

- A few days after presenting my paper preceding the present one, in February 2014, I drove in Zion National Park and had put on my distance glasses – which led to an 'unusual joy', so to speak bordering on delight, when watching the sharpened scenery. This small delight was accompanied by a strange sensation of "I'm now in another, super-real world where I normally can't be" (and sure enough I left that world when everything was getting its normal appearance again, after some minutes).

- When, in June 2015, I looked up in the crown of a sunlit oak at a distance of about 15 m, without glasses, I felt it was beautiful. After putting the corrective distance glasses on, for the very first moment I felt delighted, at seeing tiny structures I had missed before, with some added depth differences. Also, the small branches and leaves seemed to have acquired an extra reality, as it were over the normal one, which fact by itself elicited some delight. It should be realized that I was not aware of any unsharpness in the foliage or twigs of the oak *before* I put the glasses on.

- Looking down from a height of 450m on the 'Skytree', a new television relay tower in Tokyo - where I had never been before - the buildings in its neighborhood, below, with their windows illuminated, were considerably more interesting and pleasant to look at when I suddenly put on my distance glasses and then looked again. Also, they then seemed to acquire a strengthened or enlarged reality, as if they now had 'surpassed everyday reality'. This was just after sunset.

- At the same sight-seeing trip in Japan, in November 2014, when after visiting the Zenkoji temple I looked back on the slanting road to the town of Nagano, the many pedestrians on that road were 'unusually well visible' after I suddenly put on my distance glasses, which somehow was impressive.

- The wow-effects that I may experience when watching *letters and words* with suddenly increased acuity, by putting on corrective glasses, as appeared on: outdoor chairs with a label showing their manufacturer; car license plates; a prohibition sign,'DEPOT INTERDIT'; are perhaps the most persisting of all my SSIs.

Increased depth caused by sudden acuity gain. In 2014 I wrote that "true stereopsis is a good example of our general capacity to 'switch' between 'regular' and 'attentive' vision"[1]. At the end of the summer of 2015, a still persisting effect of increasing my visual acuity by putting on distance glasses was, temporarily, an apparently increased range of somewhat strengthened stereopsis. An interesting case of this was a pile of tree trunks: especially one of them *gradually* 'gained in depth' after I put my glasses on. This process was rather slow; it seemed to take a few seconds - reminding me of Christopher Tyler's report that he can see how the supposed Bayesian reweighting of stereopsis is building up, after an appropriate visual scene is presented[20]. Yet another example of sharpness-stereopsis interaction occurred fairly recently, viz. on February 6, 2015 (more than three years after the cataract operations), in Capitol Reef National Park, at the entrance to Capitol Gorge, a canyon that in former times was the only way to get by car through the "Waterpocket Fold". Both the impression of depth of the landscape close to where I stood and an 'imposing reality' of the distant canyon were strongly accentuated, if not evoked, by putting on my distance glasses.

Another persistent consequence of suddenly increasing my acuity is an increased depth of field, next to an increased depth effect. This manifests by what at first seems a *simultaneous* sharpness of (close) foreground and (far away) background. But then it turns out that these two sharpness impressions alternate, when focusing attention on foreground, respectively background. Needless to say that I can't accommodate anymore with my implanted eye lenses. Attention anyway plays an important role in many of the unusual visual phenomena.

4.3 Positive and negative Bayesian reweighting of perceptual criteria

In the precursor to this paper I mentioned one 'assumed neurophysiological mechanism' to explain, or at least make plausible or acceptible, the wow experiences following my cataract operations : Bayesian reweighting of perceptual criteria[1]. There I also distinguished 'positive and negative reweighting', positive leading to a heightened awareness of the characteristics of new images, which on its turn caused a short-lived wow experience, and negative following the sudden decrease in acuity after putting my glasses off: an unpleasant experience of 'the world looking extremely unsharp'.

Meanwhile I have collected more instances of this alleged negative reweighting, for myself and one other person. For me it occurs now and then - but that might be because I only now and then mind this effect - after having worn my distance glasses for a considerable period, and then putting them off. It implies that I am all of a sudden aware of everything being fuzzy. This sensation greatly exaggerates the acuity loss that really follows putting the glasses off, up to a passing thought such as "I seem to be half blind now !". Fortunately, this impression disappears again after some time. However, this return-to-normal takes noticeably longer than its positive counterpart; the time constants of positive and negative Bayesian reweighting are clearly different.

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The other person regularly having this experience, wears (variable-focus) acuity-increasing glasses on a daily basis. When he gets up in the morning he may forget to put these glasses on because he does not experience unsharpness until having to accomplish particular tasks such as reading a newspaper. However, when putting them off again after some time, everything at first looks very unsharp - until, after a certain period, his acuity seems to re-establish to the previous level. Then he, again, can do most things he wants to do without the glasses.

4.4 Wow experiences in other senses

Audition. After I once gave a lecture on unusual visual phenomena in Japan, somebody spontaneously came to me to report what he considered an 'auditory wow experience': when he put on the special headset of his friend that caused 'super hifi', for instance while playing a game with surf sounds, he was carried away by these sounds. However, if he heard the same sounds through a regular hifi headset, nothing particular happened.

Smell. This sense provides another example, probably known to many people, albeit of a weaker kind as to its wow effect. In my case it occurs sometimes outside, when I'm suddenly keenly aware of a sense of 'freshness', connected with a particular blend of smells that may vary; for instance when entering a stand of conifers after having walked through a meadow. This sensation is clearly pleasurable – but lasts very short, maybe less than 10s. It cannot be re-evoked by taking a deep breath.

5. DISCUSSION

5.1 Precondition for wow experiences

In general it turns out that, in order to evoke delight after increasing my acuity, a structured scene is necessary; a 'customary vista' has no effect. This may explain why it took me so long, viz. more than seven months after the second cataract operation[1], to discover SSIs; all that time I only now and then put distance glasses on, and then obtained, as it were subjectively, a smaller acuity increase than I had expected before acquiring these glasses.

5.2 Aesthetic judgment

We see, and judge, everything we make, for instance when typing a text. I have stated before that the reason so many projected texts at presentations have poorly legible color combinations of letter and background color is that the authors of those texts were not satisfied with simple black-on-white texts, but wanted to embellish them by coloring – often at the cost of decreasing their letter-background luminance contrast, and thereby legibility[21,22]. Other examples of efforts to beautify printed matter are given by commercial brochures, with a figuratively structured instead of plain uniform background - with the effect of diminishing contrast, and thus reducing legibility. These examples show that aesthetics is probably regarded by most people as 'higher', or more important, than utility.

The latter was also shown by the method of working by several matrix-letter configuration design teams at the former Institute for Perception Research: the first design step consisted of drawing a number of alternative letter shapes within the boundary conditions of those matrices, and asking subjects to rank them in order of acceptability as representations of the letters concerned. Only after that phase the two or three most acceptable versions of each letter were tested as to their discriminability, with an experimental set-up wherein on average 50 % of all letters were identified correctly[23,24].

5.3 Bayesian reweighting and neuroaesthetics

In my preceding paper in this field of unusual, mostly short-lived phenomena of visual origin, I mentioned the Bayesian paradigm's popularity in models of perception[25], also offering a way to imagine what really could be happening in our brain. My first SSI occurred in the dark, i.e. with my pupils enlarged, leading to an additional advantage of wearing my distance glasses, compared with daylight, hence a letter/number image with much higher local edge contrast than I was used to. This could lead to Bayesian reweighting of the effect of this contrast, leading to an awareness of an extraordinary sharp image - a completely new experience. But what puzzled me after this 'Bayesian explanation' was the delight and surprise, about this sharpness per se but also about the excitement evoked thereby.

An explanation of these emotions may be found in the study of metabolic activity in particular regions of the brain by observing the blood flow and oxygen use there. One area of such studies is named *neuroaesthetics;* defined as "a multi-disciplinary field aimed at understanding the neural basis of aesthetic experience and behavior"[26].

Although there is a large difference between beautiful scenery seen for the first time[13] and the roadsigns that I saw at night[1], it still seems possible to account for my delight in terms of the brain mechanisms elucidated by Biederman, Vessel and their colleagues - in particular if the mechanisms they describe have been preceded by a Bayesian reweighting, as in the case of the local, edge-determining contrast between letters and background on the roadsigns in Death Valley.

There may be another reason for the strength of my first SSI, evoked by the images of letter symbols, which could also be why viewing letters or words after a sudden acuity increase is the cause of "the most persisting of all my SSIs", as I wrote in Section 4.2. This reason is that for me, because I have a long and intense research experience with the design and subsequent, often repeated judgment of letter configurations[21,24,27], seeing such configurations or shapes under conditions that make them prominent could lead to a kind of resonance with traces from these design and judgment activities left in my brain - similar to the 'self-referential mental processing' described by Vessel, Starr and Rubin[26].

5.4 'Reality' and the wow factor

In section 4.2, trying to describe the phenomena that were elicited by suddenly sharpening what I saw, I talked about a "super-real world", "strengthened or enlarged reality", "surpassing everyday reality", and an "imposing reality". What is meant by all that ? Maybe I am here at the limit of what I can express with words about those 'sensations'; yet these impressions are so profound that I feel almost compelled to mention them. Everything

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I saw, or perceived then (in my case it always was somewhere outside, usually in nature) was not only sharper, but also as it were dowsed with something special, giving it this super-real, sometimes solemn character - but always only for a rather short time. I must confess that I have no explanation at all for this impression of 'super reality', that might be called a special kind of wow factor - maybe it can be found in the future in neuroscience. At any rate I have by no means the illusion that what I have written above, for instance on the connections between neuroscience and the 'wow factor', as defined in this paper, really explains it. But it perhaps elucidates it somewhat.

6. CONCLUSIONS

1. Unusual visual phenomena are of two kinds: observable by everybody with normal vision under normal conditions; and those that can only be observed in special conditions, as may be observed after cataract operations on one or both eyes. .
2. Those of the first kind can be perceived, but because of their brevity and disparity with the rest of the visual field generally pass unnoticed. However, those of the second type often are so far out of the ordinary that they simply are not overseen.
3. History has shown that the study of unusual visual phenomena yielded worth-while information, for example on vascular[6] or neural[4] pathways. That those phenomena of the second kind also deserve further study seems clear, after their apparent potential to contribute to a framework for the description of stages with contributions from cognitive and emotional factors following visual perception, as was advocated in this paper.
4. To my knowledge the older literature, for instance by Helmholtz[2], on what I have called 'unusual visual phenomena' here, makes no reference at all to the emotional effects in a 'wow experience', such as being thrilled, or excited.

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