Can the correction of color perception deficiencies reduce migraine?

In today's hectic world, stress-related headaches and migraines are considered a widespread affliction. What accompanies the stress, due to tight deadlines set by the boss, and often goes unnoticed, is poor vision. This not only applies to traditional forms of ametropia, disturbances in color processing by the brain can also lead to hidden stress and be a contributory factor to a whole range of psychosomatic disorders. Can spectacle lenses that filter out certain color information help improve the situation?

By Sascha Ruschenburg, Sylvia Hergert and Erich Kasten

The effectiveness of tinted lenses for the treatment of various medical conditions has already been demonstrated in several studies. For example, they seem to have a positive effect not only on reading and writing disorders but also on migraines and epilepsy. This previously known aspect has also been taken into account in the present study.

A total of 27 subjects, divided into an experimental and a control group, were asked to wear either individual tinted lenses or lenses with only a slightly reflective coating. They were asked to record their weekly number of migraine attacks in a diary with and without the glasses. After an eight-week period of study, there was found to be a significant improvement in the experimental group.

Effectiveness of tinted spectacle lenses

Everyone knows the immediate relief felt in the summer in bright sunshine as soon as you put on a pair of tinted sunglasses. This is probably not only due to the reduction in the amount of light hitting the retina but also due to the decisive role played by the color of the lenses, heightening the contrast. However, how we react to specific colors differs from person to person.

Anyone attempting to limit glare in the summer by screwing up their eyes is very likely to end up with a headache or even a migraine sooner or later.

About a third of the human brain is involved in processing visual information. Thus it is quite understandable that the brain reacts with a headache as soon as it perceives everyday vision as a constant challenge. If the incoming visual signals are not well-adjusted, the visual centers have to put in more effort to extract the important information. It is not possible to keep maintaining this amount of effort for an extended period of time. At some point, the overstressed nerve cells will ‚protest' and cease to provide their service.

Everyone knows about stress-related headaches. In addition to this, migraines are accompanied by nausea or vomiting, lack of concentration, dizziness, speaking difficulties, hallucinations in the form of scotoma or even paralysis. To counteract these, only a few therapeutic methods are currently available, primarily medically based treatments. Besides this, side effects and painkiller-induced constant headaches often do not make it any easier for those affected (Diener, 2006, 2013), many people long for an alternative method.

However, in most cases headaches and migraines do not just have a single cause. Based on the multi causality principle, several minor problems combine unfavorably to cause the symptoms to manifest themselves. One of these contributory factors can well be the faulty processing of color information.

In an initial pilot study (Ruschenburg, Jobke & Kasten, 2006) carried out shortly after the turn of the millennium, we examined the effect of tinted lenses on various medical conditions including migraines. At that time, a small group of patients showed a significant improvement and this encouraged us to continue our investigations.

In our daily lives we are surrounded by colors everywhere, but how do our brains perceive them? Most people will still remember the anatomical requirements from their biology lessons at school. Rods and cones, the light-sensitive cells on the retina, transmit the information via the optic nerve, optic chiasm and optic radiation to the occipital lobe of the brain, where an initial analysis takes place and from where the information is sent on to other parts of the brain.

A key role in color perception is played by the V4 area (Ryberg, 1991). Strictly speaking, how we perceive color is an illusion of our brain, assigning a ‚color' to a particular frequency of light, which ultimately helps us to understand our complex surrounding. Our ancestors, for example, only managed to feed themselves by being able to distinguish red berries from green bushes (Kasten, 2008). Color vision thus made it easier to make sense of their complex surroundings. If people have difficulties distinguishing colors, depending on the particular surroundings, this can cause stress.

Light is also used as a therapeutic tool. It is well known that light therapy affects the level of melatonin in the metabolism and can thus have a positive effect on depression in winter (Birren, 1950, Koorengevel et al., 2001, Oren et al., 2002). Snoezelen rooms, for example, used for relaxing also make use of colorful lighting effects.

Migraines and color vision

"Migraine is a common condition that has become widespread. In Germany nine million people suffer from migraines. 20 percent of

those affected have migraines on more than eight days a month, six percent of those affected are unable to work on more than 30 days a year," according to Schäfer & Kitze (2007).

The main therapy available today is in the form of pills; there are some psychotherapeutic and biofeedback approaches which aim to prevent migraines being triggered in advance. Thus only a small arsenal of treatments is available to help an extremely wide range of sufferers.

Patients suffering from migraine with aura are often affected by a variety of vision disorders. The aura usually precedes the migraine and manifests itself in the form of speech and vision disorders (Göbel, 2012). It may cause scintillating scotoma and also affect one's sense of smell.

Most people suffering from migraines are very sensitive to light, both once their headache has started but also in between attacks, and withdraw to darker surroundings (Drummond, 1986). Sensitivity to light is also associated with pain, the authors Harle & Evans (2004) claim. Thus there seems to be a clear connection between headaches and excessive visual demands.

Some studies have already been undertaken to investigate whether colored contact lenses or spectacle lenses can help to relieve migraines. Back in the 1960s, the scientist Helen Irlen showed that colored filters and colored lenses were helpful in treating both children and adults with dyslexia and other reading difficulties (Irlen, 1997). In her book ‚Reading with Colors' she defines the ‚Scotopic Sensitivity Syndrome'. Those affected by this ‚syndrome' have a distorted view of their surroundings because they are particularly sensitive to certain wavelengths of light. [...] For some people [...] reading problems arise from an inability to absorb light and process it appropriately." Irlen, 1997, p. 19.

According to Irlen (1997), this leads to tiredness when reading, headaches, eye strain as well as watery and tired eyes. According to recent studies, the visual strain may be so great that some people say they would even prefer to be blind (Gutschke, Stirn & Kasten, 2017).

In 2002 a study was carried out by Wilkins et al. on this topic. In a randomized, control study of cross-over design they compared the efficacy of precise ophthalmic tints in preventing

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headaches in migraine sufferers. 17 participants were asked to choose the shade of color which best reduced the perceived distortion of a text while maximizing both clarity and subjective comfort. Participants were later given either specially produced lenses with spectral filters, producing the ideal colors under normal white light, or lenses which produced a slightly different color (control group).

In an on-off designed trial, the tinted lenses were worn for a while, then taken off and then worn again, and so on. The diaries that were kept showed that headaches were less frequent when the tinted lenses were worn. Furthermore, the experimental group that wore the ideal lenses showed a significantly reduced frequency of headaches compared to the placebo group.

In 2011, Huang et al. carried out a study to investigate the effect of differently tinted lenses on migraine headaches. The scientists speculated that viewing certain patterns, such as black-and-white stripes, puts the brain under stress and leads to hypersensitivity of the visual cortex. Such strong visual stimuli may be one factor which triggers a migraine attack.

Participants were asked to look at a stress-producing striped pattern and a non-stress-producing pattern, each in turn through spectacles with gray lenses, colored lenses (similar saturation but a different color from the POT) and so-called 'precision ophthalmic tints' (POTs).

For this purpose, the participants worked in advance with a special device called an Intuitive Colorimeter that makes it possible to display a text in a specific colored light. The participant was then asked to choose the color he liked best with the least amount of visual distortion. This

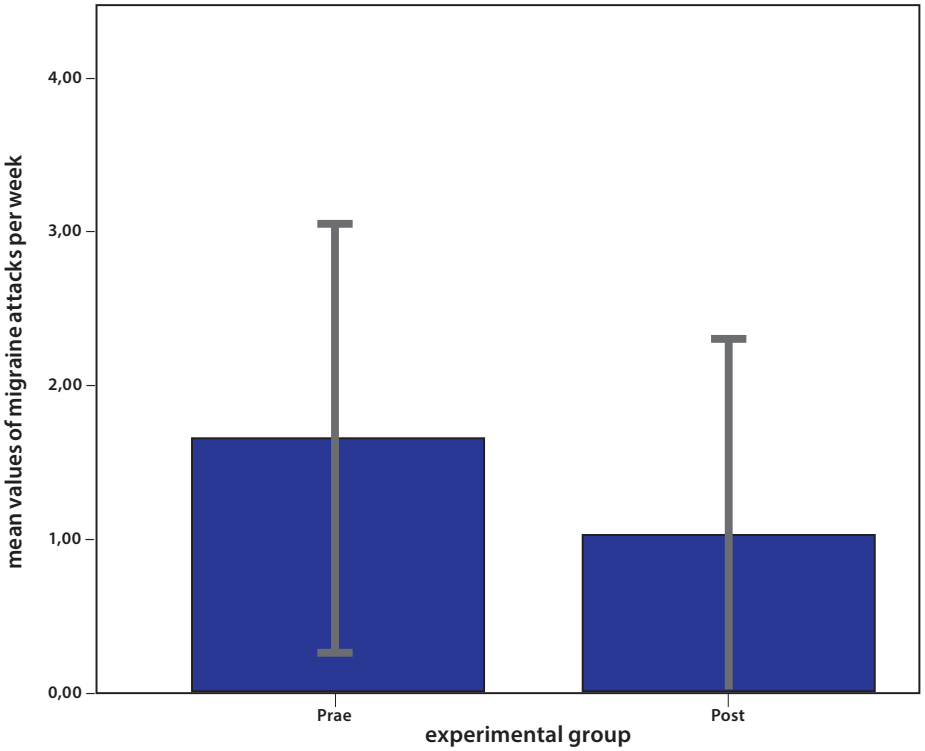

Figure 1: The diagram shows the mean values of migraine attacks per week in the experimental group comparing the period prior to wearing the tinted glasses (prae) to the eight-week trial period with the tinted glasses; the standard deviation is also shown.

was then adapted to the POT. The POTs have been shown to reduce cortical activity – believed to be responsible for the headaches and spasms associated with epilepsy – compared to the other two types of lenses, and provide greater comfort to the wearer. This was also confirmed by nine of the eleven migraine patients in the study by Huang et al. (2011).

The pilot study by Ruschenburg, Jobke and Kasten (2006) was the first study carried out in Germany on this topic. It showed that wearing tinted lenses has a effect on various medical conditions such as impaired color perception, epilepsy and migraine and that some of the conditions could thereby be improved. During the study, carried out between 2003 - 2006, a total of 82 persons were examined. 13 of the participants suffered from impaired color perception, 14 from migraines, 52 from dyslexia and 3 from epilepsy.

Before the color correction, the migraine patients suffered on average from 3.1 migraine days per month. After using the tinted lenses, migraine attacks averaged only 0.7 days per month which was a significant improvement. This study was only exploratory in character and contained some methodological errors. The aim of the current work was thus to examine in more detail the validity of the previous findings.

For this new study, we were able to recruit 39 test persons, of whom finally only 27 (29.6% men and 70.4% women) were able to actually participate and provided useful data. Data was collected on an experimental group and a placebo group, each classified by age and gender.

First, the mean number of migraine attacks was recorded during a pre-study period. Regarding the average frequency of migraine attacks, there was no significant difference between the two groups prior to the start of the study (Mann-Whitney U-Test). However, the frequency of attacks in the placebo group turned out to be slightly lower, which could not be completely avoided due to the random selection of the groups. Both spectacle wearers and non-spectacle wearers were invited to take part, however all participants had to have either impaired color perception or be color blind.

In addition, they had to have had at least two migraine attacks per month over the previous twelve months. Their color recognition ability was assessed by means of an Ishihara test. This test (Ishihara, 1998) comprises 21 different pictures with numbers hidden in them. In the first trial run, participants were asked to identify what they could see in each individual picture. As previously mentioned, only participants with color recognition deficiencies were allowed to take part.

Subsequently, each participant in the experimental group was tested again using different tinted lenses. In a fixed sequence, 16 different color filters were held in front of the eyes of the participants, from which they were then asked to choose the color filter which best enhanced the contrast. This process was repeated several times on both the dominant and the non-dominant eye. Up to three colors were then combined and the most appropriate spectacle lenses produced for the participants in the experimental group. For the control group, lenses (or clip-ons) with a reflective coating on the front surface were provided as a placebo. However, as the reflective coating also reduced the overall amount of light by about 8%, over the entire light spectrum, these lenses also slightly improve the contrast. In the experimental group, only a restricted range of wavelengths were affected, resulting in an individual, preferential influencing on the colors. The reflective coating of the lenses in the placebo group was chosen because it was very conspicuous, thus strengthening the impression that the spectacles had some kind of beneficial effect.

The test phase lasted eight weeks, during which participants in both groups wore their glasses and recorded their number of migraine attacks. In the experimental group, it was found that wearing the tinted lenses the number of migraine attacks per week was significantly lower

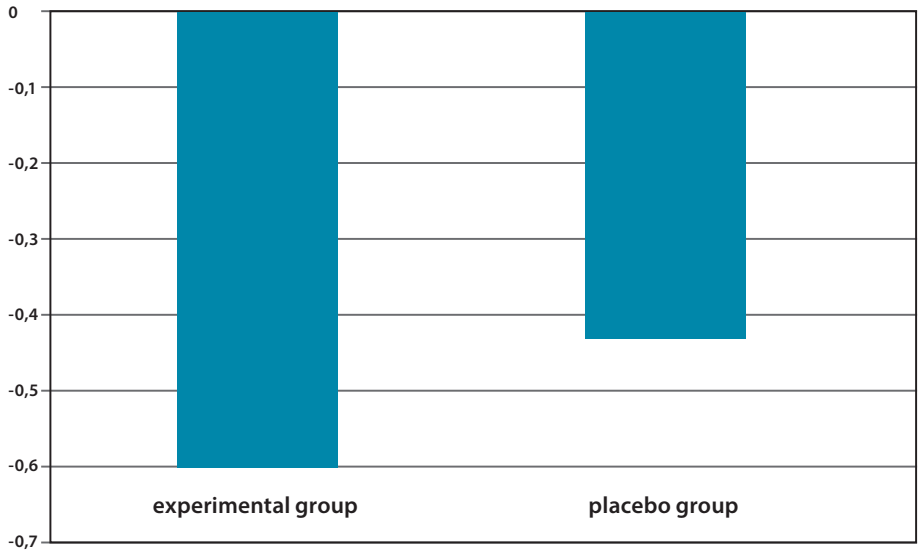

Figure 2: Comparison of the reduction in migraine attacks per week between the experimental group (left) and the placebo group (right) showing a significantly greater decrease in the experimental group than in the placebo group.

than prior to wearing them (a decrease from 1.63 to 1.03, see Fig. 1). Although there was also a reduction in the number of migraine attacks in the placebo group (from 1.29 to 0.86), this was not considered significant.

Conclusion

In conclusion, it can be said that the tinted glasses led to a greater decrease in weekly migraine attacks than the placebo glasses, although the latter also slightly improved the contrast. The data presented here also supported the findings of other researchers in previous studies mentioned above. Customized color filters are not a universal remedy for migraine; the lenses are only effective in case of people with color recognition deficiency.

Evidently, every day vision is more tiring for patients with color perception deficiencies and tinted lenses have a positive effect in reducing this strain on the brain. Contrast perception may also be improved and it can be assumed that this also relieves the strain on the visual cortex.

It is important to stress here that the color of the lenses should not be chosen arbitrarily, rather it should be chosen individually for the person concerned – as was already pointed out in the studies by Irlen (1997) and Huang et al. (2011) as well as in the present study.

Furthermore, wearing tinted lenses improves color perception deficiencies and contrast vision. This is also confirmed in the study by Ruschenburg et al. (2006) and by the present results. Although the approach described here is not a panacea for remedying headaches, it does show a new, side-effect-free approach that can be used by some sufferers to reduce the number of migraine attacks.

Erich Kasten

Erich Kasten was born in Travemünde on the Baltic coast. He studied psychology at the Christian-Albrechts-University in Kiel until 1983 and did his doctorate in 1993 on computer-assisted therapy options for partial blindness following brain damage. In 1999, he completed his habilitation on the restitution of neurological visual disorders. The psychologist and neuroscientist worked at the Universities of Lübeck, Göttingen and Magdeburg. At the turn of the millennium he held a visiting professorship at the Humboldt University in Berlin. In 2007 he was appointed visiting professor and since 2013 W3 professor of neuroscience at the Medical School in Hamburg.