

Getting into your comfort zone

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Are you sitting and seeing comfortably? Then let's begin.

Pause for a moment to think about the answer to that question. *Are you sitting comfortably?* How does your body feel right now? Where would you place yourself on a scale moving from absolute comfort to total discomfort, or even pain? Comfort is complex and multifactorial. This is no less true when it comes to the eyes, specifically the comfort experience of the contact lens (CL) wearer. This article explores the influences on CL comfort, examining how both physical and visual elements contribute to the overall comfort experience.

Key points

1. Overall Contact Lens experience is influenced by both physical and visual comfort
2. Ask not only 'how do your lenses feel' but also 'how comfortably can you see'
3. To improve physical comfort, apply a methodical approach to addressing issues
4. Visual comfort is often related to specific tasks or environmental conditions
5. To maximize visual comfort, advise on proper viewing techniques for near tasks and digital devices, correct any binocular imbalance and pay attention to glare sources in the patient's environment
6. In the future, it may be possible to deliver enhanced visual and physical comfort for the CL wearer

Defining comfort and discomfort

Defining comfort and discomfort is not straightforward. Neither is it a binary concept, where the absence of discomfort implies comfort and vice versa. Research in the field of ergonomics defines comfort as *"a pleasant state or relaxed feeling of a human being in reaction to its environment"* and discomfort as *"an unpleasant state of the human body in reaction to its physical environment"*.¹ Interestingly, the absence of discomfort does not automatically result in comfort, rather that without discomfort, nothing is experienced.² To report comfort, more must be experienced, and for studies of ergonomics, that extra is related to luxury, relaxation or feeling refreshed.¹

Contact lens experience

In terms of CLs, overall comfort is influenced by both the physical and visual experience (Figure 1).

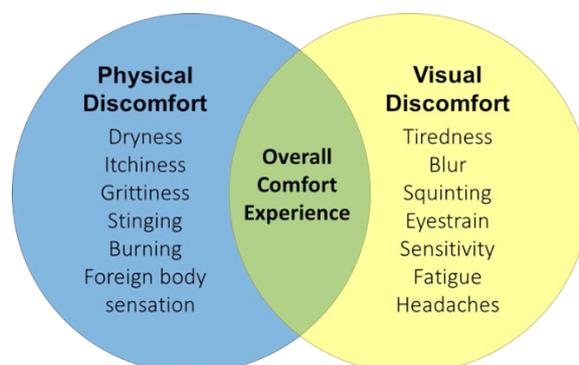


Figure 1: Contributors to the overall comfort experience of contact lens wear

Physical contact lens discomfort

With regard to the physical experience of CLs, discomfort is most often evident in the end of day sensations and reduced wear times patients may describe. For some it may simply be reported as an inability to wear lenses as

long as desired. For others, the sensations experienced may be described in words. “Dryness” and “discomfort” remain the most commonly cited reasons for drop out,^{3,4} especially for established wearers, and the practitioner should be alert to these words, or alternatives such as “stinging”, “gritty”, “scratchy”, or “irritated”. It is worth noting that new wearers experience issues with handling and vision, both of which can contribute to drop out among this group in addition to problems with comfort.⁵

The Tear Film and Ocular Surface Society’s (TFOS) 2013 workshop reviewed the evidence available about contact lens discomfort (CLD) in relation to its etiology, investigation and management.⁶ CLD is common, with on average around half of CL wearers affected.⁷ Unsurprisingly, the etiology of CLD is complex, with many possible causes contributing to the overall level of comfort experienced by the wearer. The report suggested how contributors to CLD can be classified into CL and environmental factors. CL factors cover material properties, design, fit and lens care. It remains challenging to study the contribution of these factors in isolation from each other: changing one material property to examine its effect on comfort invariably changes other elements within the CL. Table 1 contains a short summary of how these CL factors may contribute to CLD.

Table 1: Factors associated with Contact Lens Discomfort

CL property	Contribution to Contact Lens Discomfort
Material	- No difference in comfort demonstrated between hydrogel and silicone hydrogel materials ⁸⁻¹⁰
Surface Properties	- Low coefficient of friction important in driving comfort ^{9,11} - No peer reviewed conclusive evidence between on-eye (in vivo) wettability and comfort ¹⁰
Bulk Properties/ Design	- Lack of well-controlled studies linking comfort with modulus ¹⁰ - Edge design does appear to modulate comfort, with a thin tapered edge significantly more comfortable than chisel and round edge designs ¹² - Steeper base curve associated with greater comfort ¹³
Modality	- Daily disposable more comfortable than the same lenses worn on a frequent replacement schedule ¹⁴
Lens-Solutions Combination	- Some evidence of lower comfort in patients who exhibit solution induced corneal staining (SICs) ¹⁵

Addressing contact lens discomfort

To effectively manage this multifactorial problem, there are two important considerations. The first step is to question the patient thoroughly about their comfort experience. The amount of time CLs can be comfortably worn for should always be established. If a gap of two hours or more exists between the total and comfortable wearing time, it can be an indication of “less than successful wear”¹⁶ and the practitioner should be prompted to investigate and manage the situation. Use of a validated questionnaire is recommended to quantify and track change in symptoms over time. The CL dry eye questionnaire (CLDEQ-8) asks specific questions about the frequency and intensity of dryness and discomfort symptoms.¹⁷

The second important consideration in addressing CLD is to have a methodical approach. The TFOS CLD report suggests a management strategy which involves addressing co-existing factors prior to changing the CL or other ocular or environmental factors.¹⁸ For instance, presence of blepharitis would indicate this is managed first, followed by further recommendations that may include increasing replacement frequency by changing to a daily disposable and use of lubricating drops. The actions taken once any other co-existing factors have been addressed are summarized in Table 2:

Table 2: Options to manage Contact Lens Discomfort, adapted from TFOS International Workshop on Contact Lens Discomfort: Report of the Management and Therapy Subcommittee¹⁸

Change care solution

Change to daily disposable (eliminate care system)
Shorten replacement frequency
Change lens design and/or material
Tear supplementation: lubricant/wetting drops, lacrimal inserts, punctal occlusion
Dietary supplements (Evening Primrose Oil)
Topical medication (Azithromycin)
Improve environment: humidity/airflow

Finally, with reference to physical comfort, it must be acknowledged that studies suggest decline in comfort throughout the day may be more related to a fatigue-like response in the ocular tissues and changes in the ocular environment than to the contact lens itself.^{19,20}

Visual discomfort

The physical sensation of discomfort alone does not fully describe the CL wearing experience. To build a complete picture, the perceptual elements of visual comfort must also be considered. Visual comfort is of course relevant to all patients, irrespective of CL wear. The CL wearer however, presents a challenge to the practitioner, because both elements of physical and visual comfort must be considered to be able to fully understand and manage the patient.

Although no single definition of visual comfort exists, there are similarities between descriptions. Here, visual comfort is defined as “the feeling of ease, well-being, or satisfaction with the visual environment.” It has also been defined as “the subjective impression of comfort caused by visual stimuli”.²¹ A good example of the impact of visual discomfort is the fact that in the U.S. it is listed as a condition with applicable signs and symptoms for diagnosis in the international classification of disease (ICD-10) codes used for medical insurance billing purposes.²²

The sensations experienced by the patient when visual discomfort or eyestrain occurs range from feeling pain, to ache or tiredness around the eyes. Blurred or diplopic vision, headache and ocular fatigue may also be experienced. Blurred vision has long been associated with visual discomfort,²³ and uncorrected astigmatism has been found to be a major cause of eyestrain, headache and tired eyes.²⁴⁻²⁶ Accommodative and vergence anomalies are also sources of eyestrain.²⁷⁻³⁰ Oculomotor imbalances resulting from poorly compensated phorias also contribute to eyestrain.

Squinting is possible in response to blurred vision or extraneous light sources, and involves constriction of the orbicularis oculi muscle. Significant correlation between discomfort and blood flow to this muscle has been shown, and suggests that pain around the eye may result from over activation of the orbicularis while squinting.²⁴ Prolonged constriction of the corrugator supercilli muscle near the eyebrows has also been associated with migraine headaches, likely due to compression of the supraorbital and supratrochlear nerves that run through it.³¹

The contrast of the target,³² text size,³³ and cognitive demand³⁴ of the task also contribute to visual comfort. Blink rates have been shown to reduce with near tasks^{35,36} and incomplete blinks have been correlated with discomfort.³⁷ The evidence for pupil constriction being a source of pain remains equivocal, with a number of studies reporting that pupil constriction does not directly cause discomfort,³⁸⁻⁴⁰ and a recent study suggesting a more causal relationship.⁴¹ Irrespective of a direct link, pupil constriction is of course related to accommodation and convergence, and sustained near tasks place strain on this triad of close focusing systems.

Digital devices

Many of the additional factors associated with visual discomfort arise from the type of near task performed. While reports of visual discomfort can be found in literature dating back many hundreds of years, most relevant in today's modern society are those tasks completed on digital devices. It has been found that the magnitude of ocular symptoms are significantly higher when viewing digital displays compared to printed materials.⁴² Vision-related symptoms arising from the use of digital devices include eyestrain, blurred vision, dry eye, headache and discomfort.

The use of digital devices is widespread: a 2017 survey of US adults showed just over three quarters of Americans own a smartphone, with even higher penetration among the 18-29 year old age group of 92%.⁴³ The term "computer vision syndrome" (CVS) characterizes a group of ocular and non-ocular symptoms, and when this complete range of symptoms are taken in account, a prevalence of CVS of 90% has been reported.⁴⁴ The use of CVS to describe symptoms is gradually reducing in favor of the newer descriptor "digital eyestrain".⁴⁵ A survey of New York office workers found 40% reported "tired eyes" at least half the time, with nearly a third (31%) reporting "eye discomfort" at the same frequency.⁴⁶

The type of device used varies, from desk top VDU screens, through to laptops, and handheld devices. Each of these are used at different viewing distances and gaze angles, at different times of day, under different ambient illumination and in varied environments. This presents a complex range of demands to the visual system.

Photophobia

Visual discomfort can also be attributed to several ocular and systemic diseases, and medications. Photophobia is a cause of visual discomfort and is defined as "*a sensory state in which light causes discomfort in the eye or head; it may also cause an avoidance reaction without overt pain*".⁴⁷ Photophobia is associated with dry eye, migraine, depression, blepharospasm, progressive supranuclear palsy and the use of medications such as barbiturates and benzodiazepines.⁴⁷ Photophobia is linked to pain sensation, with functional Magnetic Resonance Imaging (MRI) recordings showing a pattern of activation which suggests photophobia is perceived as a true pain stimulus.⁴⁸

Glare

We are all susceptible to being troubled by excessive light levels: just think of how we shield the eyes from the sun on a bright day, or how uncomfortable we find oncoming headlights when driving at night. Viewing bright lights can cause the eye to respond with squinting and pupil constriction, which may lead to visual fatigue and discomfort. It is also common to deal with uncomfortable light levels by averting the eyes.

The American National Standard Practice for Office Lighting (ANSI) states that "*glare occurs when luminances, or luminance ratios are excessively high in relation to the state of adaptation*" (ANSI/IES RP 1-12). Luminous ratio is the luminance of the glare source divided by the luminance of the target. The ANSI standard states that the luminance ratio should not exceed 10:1 for remote light or more than 3:1 between the target and immediate visual surroundings. Use of sunglasses does not change the luminous ratio, however viewing through sunglasses feels more comfortable because overall retinal illumination has been reduced. This moves the exposure below the borderline luminance between visual comfort and discomfort (binary-code decimal (BCD) value). The BCD value is commonly used by lighting engineers and architects when determining the optimum, comfortable levels of illumination for a room.

Glare reduces both contrast sensitivity,⁴⁹ and high and low contrast acuity.⁵⁰⁻⁵² It is generally categorized into two types. Disability glare is "*a temporary impairment of vision due to light*" and is caused by loss of retinal image contrast resulting from intraocular light scatter.⁵³ Discomfort glare is "*a transitory irritation caused by light*" and may be a response to the saturation of visual neurons.⁵³ In addition to the luminous ratio, and the size

and distance to the light source, a number of other factors contribute to discomfort glare. Awareness of these factors, summarized in Table 3, enables better advice to be offered to the patient troubled by glare-induced visual discomfort.

Table 3: Factors that contribute to discomfort glare

Factor	Contribution to discomfort glare
Angle	Glare worse with lower angle between glare source and line of sight
Contrast	Glare worse with higher contrast between glare source and background luminance ⁵⁴
Light adaptation	Adaptive state of the individual , for example the discomfort felt by a fully dark-adapted person when a room light is turned on
Wavelength of glare source	Glare varies with spectral composition of light source; humans are most sensitive to the central range of the visible light spectrum, between 510 nm and 550 nm ⁵⁵ , and are typically more annoyed by shorter (eg: 400 nm) than longer (eg: 700 nm) wavelengths
Time of day	Lower angle of the sun being more bothersome in the mid-morning and mid-afternoon
Natural mediators	Lightly pigmented Caucasians more bothered by bright light compared to individuals with increased pigmentation ⁵⁶ Less visual discomfort has been correlated with higher macular pigment densities ⁵⁷

Compensating behaviors

A number of compensating behaviors are employed to help mediate visual discomfort. Squinting occurs in relation to uncorrected refractive error, binocular vision imbalances, and glare. Excess light is often blocked by a hand shielding the eyes or use of sunglasses. The compensating behavior particularly associated with glare is avoidance. Examples of this include looking away from car headlights at night, or flipping down the visor when driving towards low setting sun.

Overlap between physical and visual discomfort

Figure 1 listed the physical and visual factors that contribute to overall comfort when wearing CLs. In reality of course, these factors may overlap. In a survey of habitual reusable CL wearers 59% reported a decline in comfort, overall lens satisfaction and vision quality over the course of the day.⁵⁸ Of this “declining” group, the most commonly described symptoms were “tired eyes” and “dry eyes”. The former refers to a visual factor, the latter to a physical sensation. Changes to the tear film could provide part of the explanation for these overlapping sensations of discomfort: CL wear promotes a more unstable tear film which can lead to both discomfort, dryness and fluctuations in vision.⁵⁹

Overlap between comfort and vision was investigated in a study which looked at the influence of vision on ocular comfort ratings.⁶⁰ Under some circumstances comfort was reduced with induced visual blur, and the authors suggested complex psychological influences and higher-order sensory integration of vision and pain processes may be involved.

Conclusion

In terms of what is best for our patients, it is important to be aware that discomfort can manifest as both physical and visual sensations. Recognizing the total comfort experience consists of both elements allows us to elicit better information from our patients, and from that, to make more useful recommendations to manage their discomfort. While we may regularly ask our CL wearers “how comfortable their lenses feel”, we have an opportunity to also enquire about “how comfortably they can see”.

Comfort and discomfort in CL wear is driven by multiple factors, which can overlap and influence each other. It is important to take a methodical approach to management. Follow best practice guidelines for addressing physical CL discomfort, and provide appropriate visual correction and advice on near focusing and light

management to help optimize visual comfort. In so doing, the practitioner will help improve the patients' overall CL experience, satisfaction, potentially reduce drop out and increase recommendation.

Future CL technology may be developed to aid some of these issues. For example, in addition to providing UV-blocking, it may be possible for a CL to selectively filter light to enhance visual performance. Remembering that in the field of ergonomics, comfort is only achieved when something additional is experienced, perhaps we can hope for future CL technology to not only avoid feelings of 'discomfort', but actually to deliver *enhanced* visual and physical comfort for the wearer.

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