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Advancing Paediatric Vision Care

Evidence-based insights and best practices for dispensing spectacles to children

Association of British Dispensing Opticians

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Evidence-based insights and best practices for dispensing spectacles to children

Children's vision care is a critical component of their overall health and development, and dispensing spectacles to young patients presents unique challenges that require specialised knowledge and skills. This white paper brings together the latest research findings and evidence-based practices in spectacle dispensing to guide eyecare professionals in delivering optimal visual outcomes for paediatric patients. From understanding anatomical and psychological considerations to implementing effective communication strategies with parents and caregivers, this resource suggests spectacle dispensing best practice to ensure prescription accuracy, wearer comfort and adherence to wear for successful visual outcomes. By adopting these insights, practitioners can enhance visual health, support learning and improve quality of life for children worldwide.

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Introduction

This paper will seek to establish and advise on the critical elements in spectacle dispensing to children, starting with the importance of regular eye examinations for young children, and emphasising how prescribed spectacles can support visual function most effectively when they are dispensed accurately. The paper then examines craniofacial growth and facial development in children, demonstrating why paediatric facial anatomy differs substantially from that of an adult and why children cannot be considered 'small adults' when designing and producing spectacle frames.

Building on this anatomical foundation, the paper explores the importance of frame fit and stability, illustrating how inappropriate frame design or poor fitting can compromise lens positioning, optical performance and adherence to spectacle wear. The current paediatric frame market is reviewed, highlighting limitations in traditional scaled down adult designs. This is followed by a detailed discussion of the relationship between the frame and the face, introducing key facial measurements applied to spectacle frame design that will influence fit, stability and comfort for the wearer.

The central section of the paper presents paediatric facial anthropometric data related to spectacle frame wear, a research project funded by ABDO[1]. These data, derived from three-dimensional imaging, describe facial parameters by age, sex, ethnicity and in children with Down's syndrome. The purpose of this research was to inform frame design, the inclusion of adjustable features and therefore improve the fit of products for all children.

The paper then shifts focus from research to practice, outlining the child's journey through the optical practice. This includes pre appointment communication, the practice environment, practitioner appearance and effective communication with children and their parents or caregivers, emphasising a child-centred and inclusive approach.

Subsequent sections address practical dispensing considerations, including prescription analysis and lens design considerations, tints, UV protection and lens coatings. This is followed by the assessment and recording of key facial measurements to approach frame selection in a more evidence-based manner, and frame presentation strategies that encourage child engagement and ownership. Common adjustments and modifications are outlined alongside maintenance and care of spectacles, highlighting strategies to optimise comfort, durability and long term wear. The paper concludes by examining factors that influence adherence to spectacle wear and how working together supports successful visual outcomes.

Prescribing spectacles for children

Clear vision is critical for the successful development of the visual system in children[2,3] and to help the child achieve their full potential in both formal educational attainment[4,5] and developing essential social skills[6]. How children learn and develop is intrinsically linked to the senses, particularly what they see and the resultant learning from processing that visual information such as pictures in a book or a non-verbal cue from a parent/caregiver on how to behave appropriately in a social situation[7].

Children may not recognise or report reduced vision, and parental awareness of the importance of routine eye examinations remains inconsistent, with a recent report on children's eye health in the UK highlighting that one in five (21%) parents and caregivers deemed a child's eye examination to be 'less important' than other health checks[8]. Raising public awareness that an eye examination should be a routine health check from 3–4 years[8] and knowledge that not all children will be aware that they are experiencing suboptimal vision will be critical in detecting and prescribing for any visual anomalies to give every chance of a successful long-term outcome[2,9,10]. The 'critical period' in visual development is defined as 'the development and maturation of various functional properties of the brain during postnatal life, which extends up to 8 years of age'[11] during which it is deemed possible to influence the development of the visual pathway. If the results of an eye examination deem a correction and/or intervention is required, the spectacle dispensing process carries equal importance, as it determines the accuracy of delivering the prescription exactly as the prescriber intended. This is achieved by considering a range of factors including an appreciation of the child's facial features as well as all aspects of spectacle frame parameters and ophthalmic lenses.

Spectacles can fulfil a variety of optical functions as well as simply correcting vision. These can include myopia management, which utilises a peripheral treatment zone within the lens to slow down the progression of myopia[12], bifocal lenses to support accommodative insufficiency[13,14] or convergence excess[15], the inclusion of prism for binocular vision issues[16], and tints and various coatings that can be added to aid comfort and provide a degree of protection. The success of all these functions relies on accurate and stable positioning of the ophthalmic lenses in front of the eye by the spectacle frame.

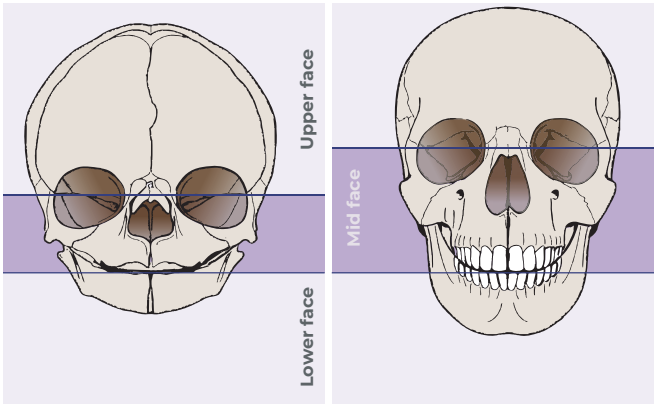


FIGURE 1. *Craniofacial development at birth compared with an adult skull*

In the UK, the Optician's Act 1989[17] requires that the sale and supply of spectacles to children under 16 years of age be carried out by, or under the direct supervision of, a General Optical Council (GOC) registered optometrist or dispensing optician. Optometrists and dispensing opticians share the same standards and professional responsibility for dispensing to children. Many optometrists dispense to children regularly, but their primary expertise typically focuses on the assessment and management of refractive error and ocular health. The dispensing process requires complementary expertise in areas such as facial development and associated parameters; ophthalmic lens properties and suitability; frame materials, properties and selection; and frame fitting, adjustments and modification techniques, which lie with the expertise of a dispensing optician.

Working collaboratively, along with ophthalmologists and orthoptists where appropriate, a multidisciplinary approach ensures the best possible outcomes for children who require spectacles. This timely and effective intervention relies not only on accurate prescribing, but also on the successful dispensing of spectacles that deliver the intended correction under real world conditions.

For the purposes of this paper, a child is defined as being under 16 years, the age at which GOC regulatory protection ceases. However, with research advancements in areas such as myopia progression in young adults[18], amblyopia treatment beyond the critical period[19,20], facial development in males[21] and the prevalence of refractive error found in vulnerable adults[22] such as patients with learning disabilites[23,24], this may suggest that regulatory protection would be beneficial for some patient groups beyond the age of 16.

Facial development in children

The position and proportion of a child's facial features from birth are wholly different to that of an adult[25] (**Figure 1**). Craniofacial development in a child continues to progress after birth in a disproportionate manner[26,27], ie rates of growth and associated physical changes observed in the upper face, midface and lower third of the face change at vastly differing rates[1,25].

In the baby skull, the cranial development in the upper face is much more apparent due to the associated brain development, and the orbital development also appears to be relatively advanced with over half of its growth achieved by aged 2 years and completion of growth at 7 years of age[26]. After birth, the need for sustenance drives the growth of the lower third of the face, encompassing the jaw and the development of teeth, completing at 18–25 years of age with the eruption of the third molars[26]. The midface section shows the nasal bone complete in development around the age of 10 years[28]; however, nasal cartilage and soft tissue change the appearance of the nasal bearing surface until around 16 years for females and 17 years for males when nasal maturity is reported to be achieved in White adolescents[21].

Given the complexity of upper and midface growth in children, it is evident that their facial features cannot be considered proportionate to those of smaller adults[29–31]. These developmental differences directly affect factors relevant to dispensing, including head and temple width, pupil and ear point positions, and the shape, position and prominence of the nasal bearing surface, therefore directly impacting on the design requirements of a paediatric spectacle frame.

The importance of frame fit

The skill of a dispensing optician lies in the knowledge that a paediatric frame needs to make adequate contact with the developing nasal bearing surface, which will take the majority of the spectacle weight, and therefore needs to be spread across the largest possible surface area. The pupils will sit central to the lens (**Figure 2**) ensuring correction in all aspects of gaze. The lugs of the frame will be set to allow clearance at the temple width of the face and yet make contact at the ear point to create the correct amount of lateral tension, reducing the load on the bearing surface. A gentle bend should then spread the weight over the external ear and adequately anchor the spectacle frames during play and everyday activities.

Figure 3 shows an image of a 4-year-old boy wearing spectacle frames that are aimed at the paediatric market and yet represent a small adult frame evidenced by the relatively high and narrow bridge design. The resultant fit demonstrates no weight distribution around the nasal bearing surface at the intended position of wear and, coupled with unwanted tension at the temple, the frame will slide to find the first point of anchorage. This is often at the nasal bulb for a young child, allowing the child to look over the top rim of the frames and thus gaining no benefit whatsoever from the spectacle correction during this critical time in their development[2]. Even if this child managed to look through the top of the lenses, the increase in the vertex distance would mean the effective power would not match the prescribed power, and the child would not benefit from any intervention, treatment zones or protection supplied by the lenses. Furthermore, if this child is myopic, the increased vertex distance would effectively cause an undercorrection of myopia, which has been reported to potentially increase the rate of myopia progression[12,32,33]. If the frame holds the lens in a position that results in the optical centre not being accurately placed in front of the pupil centre, there will be an induced prismatic effect[34], and similarly, if the frame holds the lens at an inappropriate pantoscopic angle, then oblique astigmatism will be encountered[35].

FIGURE 2. *A 4-year-old patient presenting wearing a frame manufactured with evidence-based parameters.*

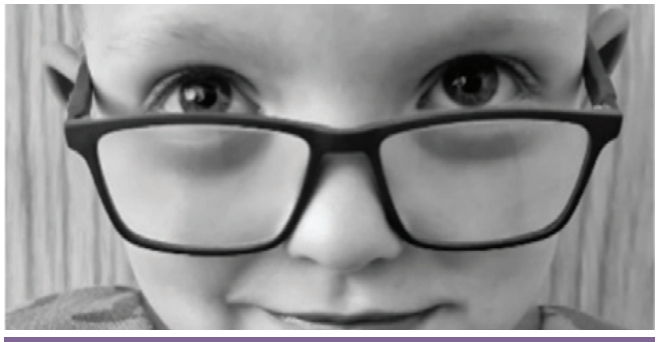


FIGURE 3. *A 4-year-old patient presenting wearing a frame based on small adult facial parameters.*

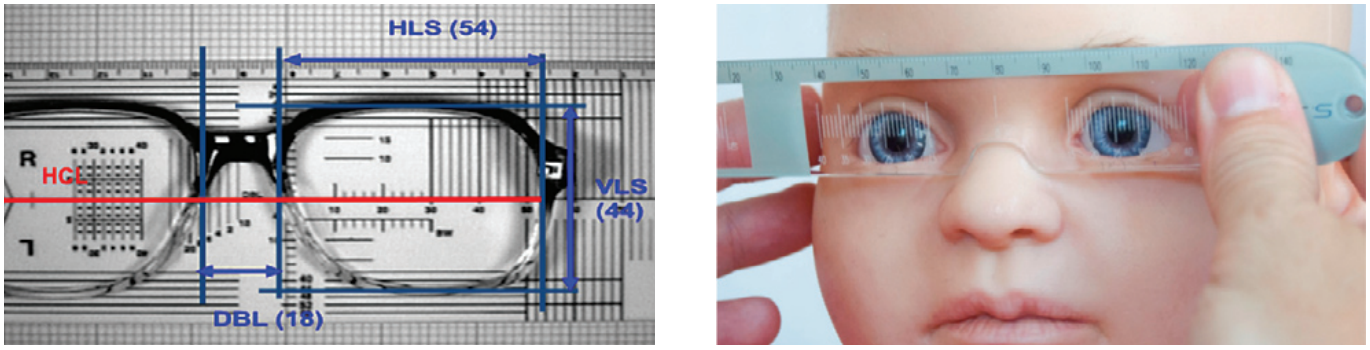


FIGURE 4. *The relationship between the boxed centre distance and the pupillary distance*[1]

The current frame situation

The majority of frame manufacturers in the paediatric market produce frames that are simply scaled-down versions of an adult frame[1,36]. These frames are often embellished with popular characters or high fashion brands, which may seem positive for a child in terms of their desire to wear spectacles; however, they are rarely suitable in terms of fitting a child's facial characteristics. With advancements in research in this field[1], a growing number of manufacturers are now producing more evidence-based frames for children. Ideally, a balance of cosmetic appeal and functional fit would be achieved to allow a child to have a desirable frame, coupled with evidence-based parameters and adjustable features to allow the frame to perform as the intended medical device.

Most frame manufacturers produce standard dimensions to spectacle frames, namely the horizontal lens size (HLS) or 'A' measurement and vertical lens size (VLS) or 'B' measurement, the minimum distance between the lenses (DBL) and the total side length. While this information may be useful for an overall width, or boxed centre distance (BCD) of the frame, there are no other correlations between the supplied frame parameters and a patient's facial characteristics.

The relationship between the frame and the face

A spectacle frame is a three-dimensional inanimate object that needs to conform to fit the requirements of a living, moving, typically non-symmetrical human face.

There are several facial measurements that a dispensing optician will consider at the time of dispense and will either take these measurements physically or appraise the patient's face. These will directly impact on the frame parameters selected, albeit their relevance will vary by the bridge design of the frame.

Frame width and facial considerations

The pupillary distance (PD) is defined as the distance between the centres of the pupils when the eyes are in the primary position. The boxed centre distance (BCD) is defined in British Standards as the *'intersection of the horizontal centreline and the vertical centreline of the rectangular box which circumscribes the lens shape'*[37].

Ideally, these two parameters (**Figure 4**) should match to avoid excessive decentration of the lens, which will induce thickness at either the nasal edge in the case of a positive power lens decentred inwards, or at the temporal edge in the case of a negative power lens decentred in the same direction. Nasal lens thickness can impact on the ability to make physical adjustments of nose pads to ensure nasal widths and angles can be successfully achieved. Temporal lens thickness can also impact the cosmetic appearance of the spectacles with the temporal edge being more visible and may also affect side closure.

The head and temple width (**Figures 5 and 6**) will also impact on the frame width selected, especially in the case where these are found to be much wider than the BCD of the frame. In this case, the dispensing optician may consider selecting a frame with an extended or adjustable lug or having lenses surfaced using worked prism to physically move the optical centres away from the geometric centre of the lens.

The temple width (TW) is measured on the head between the temples at 25mm behind the plane of the cornea, and the equivalent on a frame is defined in British Standards as the *'distance between the sides 25mm behind the back plane of the front'*[37].

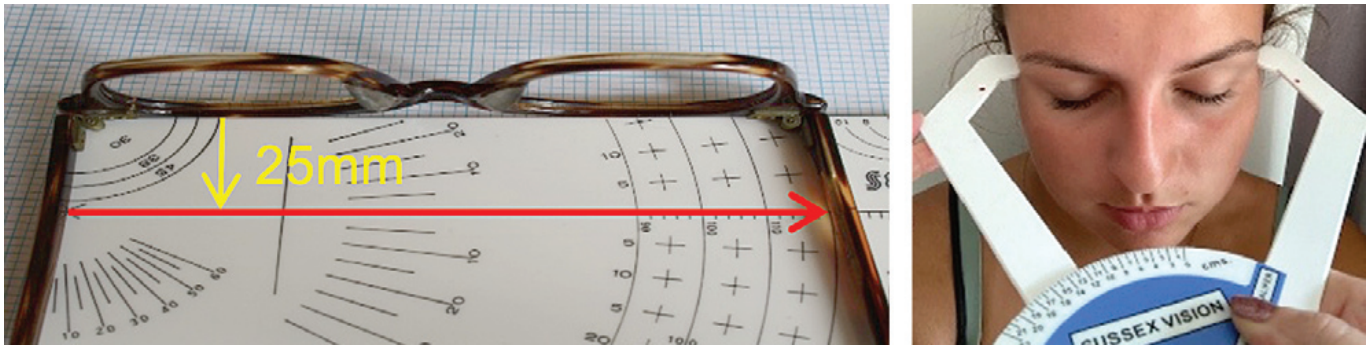


FIGURE 5. *Temple width on a frame and the face*[1]

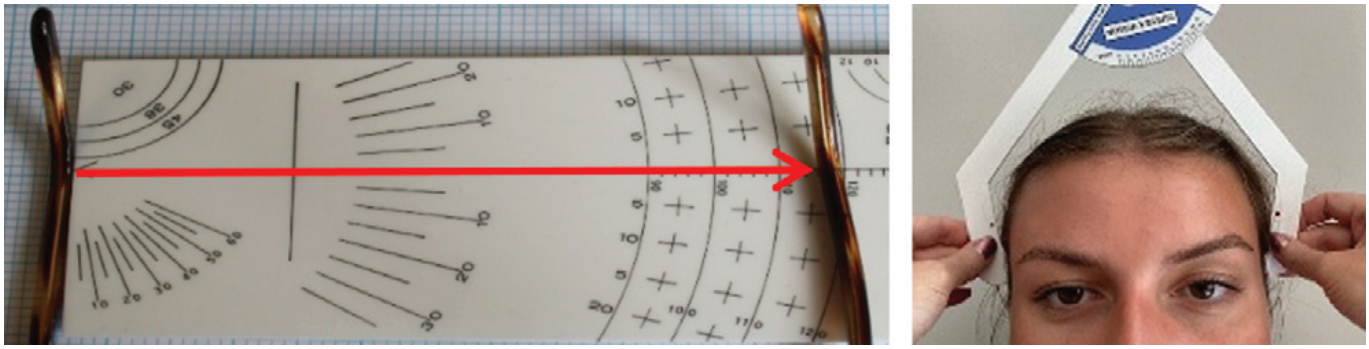


FIGURE 6. *Head width on a frame and the face*[1]

While there should be no contact at this point on the face, it is important to consider that some patients may have a larger temple width[1] than head width and certain frames cannot be adjusted at the lug to accommodate this anatomical feature. Contact at the temple will force the frame front forwards and potentially cause indentations on the side of the head from excessive pressure.

Head width is measured between the 'ear points', this point being defined as where the skin of the head meets the uppermost attachment of the pinna (external ear). On a frame, this point is defined in British Standards as '*the distance between the sides at the ear points*'[37]. Contact with the frame is necessary at this point, creating lateral tension between the frame side and the head to reduce the weight of the spectacles on the bearing surface, although too much tension will again force the frame front forwards, so it is critical to set it up correctly. By measuring the patient's head width, a dispensing optician will then reduce the value found by 10mm, achieve this compensated value with lug adjustment, and reassess this induced tension at the final fit.

Frame bridge and facial considerations

The vertical position of the bridge on a frame is critical in ensuring the child looks through the centre of their lenses and not over the top rim of the frame. On a face, this is determined by the crest height (CH) (**Figure 7**), which is measured from the top of the lower lid to the apex of the nasal bearing surface

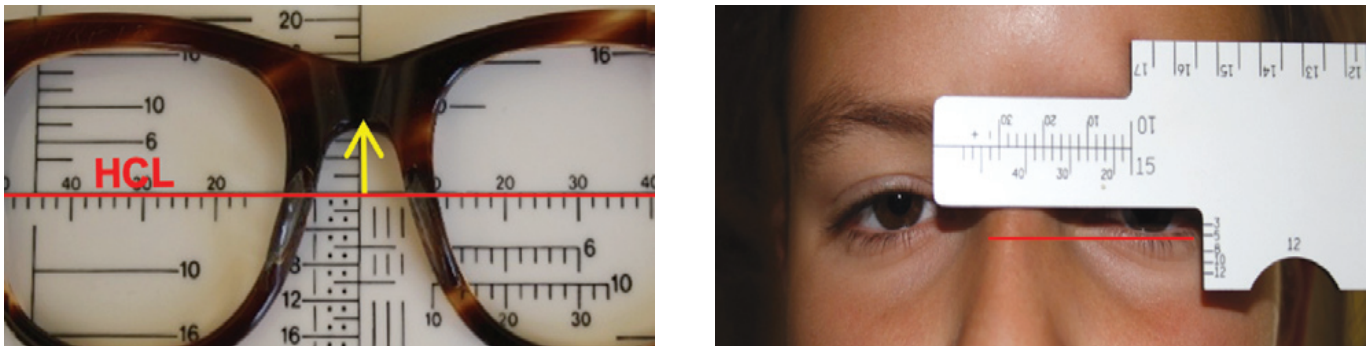


FIGURE 7. *Crest height on a frame and the face*[1]

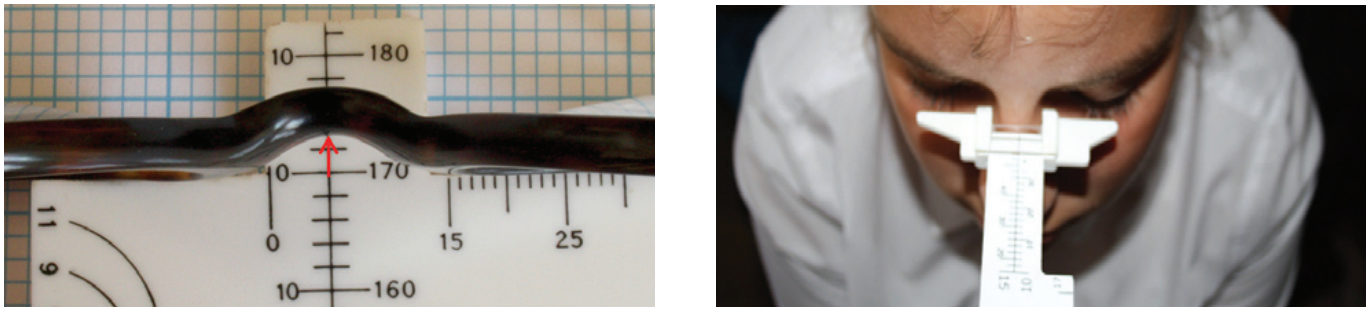


FIGURE 8. *Bridge projection on a frame and the face*[1]

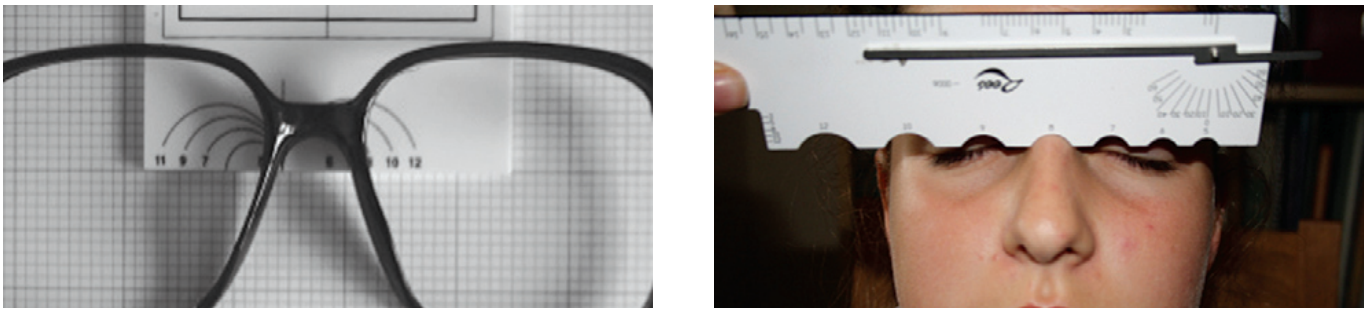


FIGURE 9. *Apical radius on a frame and the face*[1]

FIGURE 10. *Distance between rims at 10mm below crest (upper) and 15mm below crest (lower) on a frame and the face*[1]

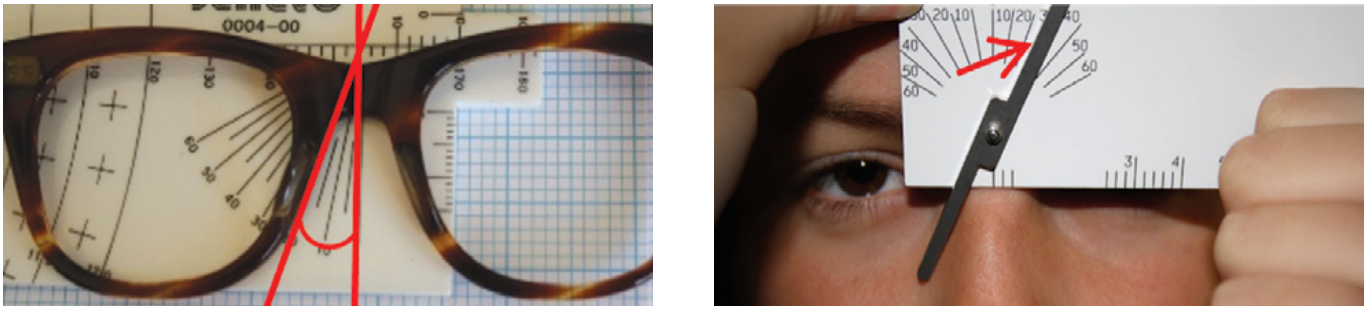


FIGURE 11. *Frontal angle on a frame and the face*[1]

(crest). A positive value is indicated if the crest sits above the lower lid line and a negative value if the crest sits below the lower lid line. The crest height of the frame is defined in British Standards as the *'vertical distance from the centre line of the frame to the midpoint of the lower edge of the bridge'*[37].

The position of the bearing surface on a face can be challenging to determine and measure; a dispensing optician will often appraise this during conversation or play with a child to assist in determining a suitable frame option. While this definition refers to a regular bridge frame, the concept of vertical placement of any type of bridge design is relevant to paediatric dispensing, as often pads on arms or fixed pad bridges are found to be set too high for a child's crest height in relation to the horizontal centre line of the frame.

In the transverse plane of the face, dispensing opticians will assess bridge projection (**Figure 8**) by the sweep of the lashes in relation to the nasal bearing surface. This can be positive if the tip of the lashes stays behind the bearing surface or negative if they sweep in front of the bearing surface. For young children (and adults) where there is generally a lack of bridge prominence, the resulting projection is often found to be negative. This is a critical step in ensuring the lashes can sweep uninhibited behind the back surface of a spectacle lens and will direct the dispensing optician to a suitable bridge design and potentially the need for recalculation of the lens power owing to the increased vertex distance.

The bridge projection of a frame is defined in British Standards as the *'minimum horizontal distance from the back plane of the front to the centre of the back of the bridge'*[37].

Apical radius (AR) (**Figure 9**) and the distance between rims (DBR) taken at two defined points (**Figure 10**) and apply to regular bridge frames, designed to spread the weight of the spectacles evenly across the bearing surface of the nose. While regular bridge frames for children are somewhat scarce, these parameters are relevant to aid understanding in how the development of the nasal parameters in children occur, especially the fact that the relative sizes of the AR and DBR widths are much larger in younger children and therefore all bridge designs need to consider this nasal profile.

The frontal angle (FA) on the face is the angle of the nasal bearing surface where a pad would sit, taken in the frontal plane as shown in **Figure 11**. On a frame, this is defined by British Standards as the *'angle between the vertical and the line of intersection of the pad plane with the back plane of the front'*[37]. Pads can be designed in a variety of forms, and adjustability is a welcome option for paediatric frames where the frontal angle is often found to be larger than the adult form at 51 – 58˚ (**Table 1**). In a fixed pad design, such as the frame in **Figure 11**, the lack of adjustability can mean nasal pressure marks if the length of the pad does not lie in alignment with the FA of the face.

The splay angle (SA) on the face is the angle of the nasal bearing surface where a pad would sit taken in the transverse plane as shown in **Figure 12**. On a frame, this is defined by British Standards as the *'angle between the pad plane and a normal to the back plane of the front'*[37].

In a perpendicular plane to the FA, the SA needs to also be adjusted to ensure an adequate weight distribution. Fixed pad bridges (**Figure 12**) do not offer any adjustable properties but can be physically removed and replaced, if necessary, with an adjustable nose pad of varying shape and size.

The front to bend (FTB) on a face (**figure 13**) is the side length from a virtual frame front (clearing lash sweep) to the ear point, and on a frame is defined in British Standards as the *'distance between the lug point and the ear point'*[37].

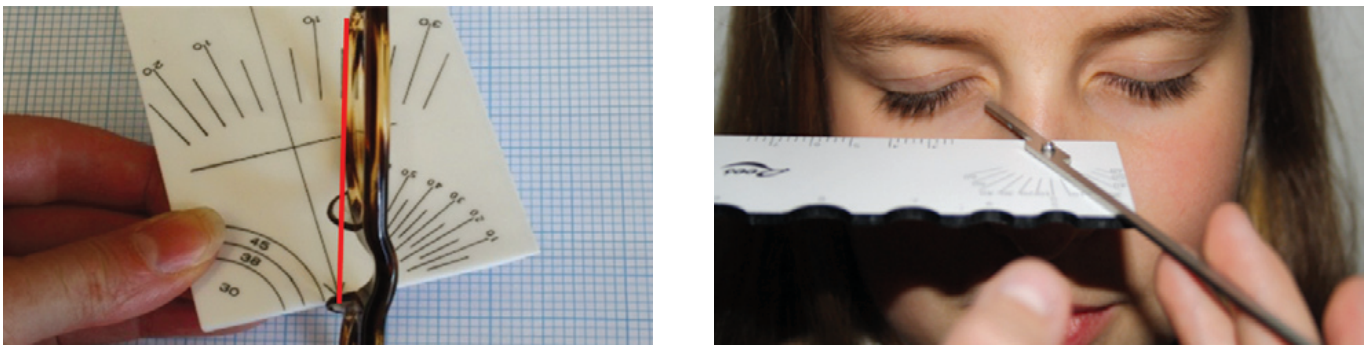


FIGURE 12. *Splay angle on a frame and the face*[1]

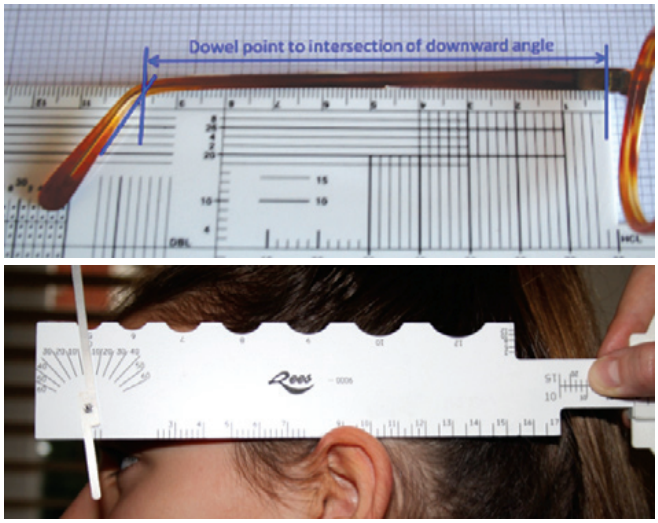


FIGURE 13. *Length to bend on a frame and front to bend of the face*[1]

Measurement (unit)	White British typically developed children					
	4-6 years		8-10 years		12-14 years	
	M	F	M	F	M	F
Frontal angle (deg.)	58	57	53	56	51	52
Splay angle (deg.)	28	28	27	27	26	26
Head width (mm)	144	137	149	143	156	148
Temple width (mm)	100	100	104	100	107	105
DBR@10/15 (mm)	17/22	17/22	16/21	15/21	14/19	15/19
Apical radius (mm)	9	9	8	8	8	8
Crest height (mm)	4	4	6	4	8	8
Front to bend (mm)	79	78	87	83	92	89
Distance between pad centres (mm)	16	16	14	15	14	14
Pupillary distance (mm)	53	53	57	55	60	59

TABLE 1. *50th percentile results for White British typically developed children aged 4-6 years, 8-10 years and 12-14 years.*

In practice, dispensing opticians more commonly refer to the shorter 'length to bend' (LTB) of a frame side, which is defined as the *'distance between the dowel point and the ear point'*[37], typically appraised at the frame selection stage with a frame on the face. The important consideration here is that both right and left sides are measured and appraised to ensure the correct side length can be achieved with an acceptable length of drop behind the ear.

Facial appraisal and related measurement are critical in evidence-based dispensing for all patients. Alteration of any aspect of the frame will naturally have a consequence on the frame fit as a whole and may affect the positioning and comfort of the spectacles for the wearer.

Facial anthropometry for paediatric spectacle wear

As a result of feedback from GOC registrants on how paediatric frames in general were not fitting children adequately[1] and appeared to be 'small adult' in design, ABDO commissioned research in this field to obtain facial data to both inform frame design and aid further understanding about facial development in children[1]. Over 1,300 three-dimensional facial images were acquired by three-dimensional stereophotogrammetry, analysed by sex, ethnicity and whether the child has Down's syndrome.

Fifteen facial parameters were presented as percentile data for typically developed White British Children, Chinese children and White British children with Down's syndrome.

In White British children (**Table 1**) the data show that the nasal bearing surface in younger children is relatively low (CH), flat (FA) and wide (AR and DBR10/DBR15) and we see a distinct narrowing in this area as the child ages and the bearing surface sits progressively higher in relation to the lower lid (**see Figure 14**). At 12 months old, the nasal bearing surface shows a negative crest height and distinctly wider nasal parameters.

This area remains wide even as the nasal bone gain facial prominence and the crest becomes more positive in value. The onset of peak facial growth

FIGURE 14. *Nasal development in a White British typically developed female*[1]

Measurement (unit)	Chinese typically developed children					
	4-6 years		8-10 years		12-14 years	
	M	F	M	F	M	F
Frontal angle (deg.)	68	66	66	66	68	72
Splay angle (deg.)	29	28	30	28	31	32
Head width (mm)	147	145	154	150	161	155
Temple width (mm)	110	109	113	112	118	124
DBR@10/15 (mm)	22/28	22/28	19/26	19/25	20/25	21/29
Apical radius (mm)	11	11	10	10	10	11
Crest height (mm)	1	0	2	0	2	2
Front to bend (mm)	78	72	82	78	83	87
Distance between pad centres (mm)	15	14	16	15	18	19
Pupillary distance (mm)	55	54	60	58	61	62

TABLE 2. *50th percentile results for Chinese typically developed children aged 4-6 years, 8-10 years and 12-14 years.*

Measurement (unit)	White British children with Down's syndrome					
	4-6 years		8-10 years		12-14 years	
	M	F	M	F	M	F
Frontal angle (deg.)	64	68	57	58	60	56
Splay angle (deg.)	29	25	27	27	29	27
Head width (mm)	139	135	141	136	143	151
Temple width (mm)	99	102	97	104	100	104
DBR@10/15 (mm)	20/24	20/24	16/21	19/24	17/22	16/22
Apical radius (mm)	10	10	8	10	9	8
Crest height (mm)	0	1	-2	4	-1	8
Front to bend (mm)	77	68	78	66	80	84
Distance between pad centres (mm)	15	12	15	13	15	16
Pupillary distance (mm)	52	49	55	52	59	57

TABLE 3. *50th percentile results for White British children with Down's syndrome aged 4-6 years, 8-10 years and 12-14 years.*

occurs in females around the age of 9.8 years, peaking at 11.5 years[38] when the bearing surface appears to start to narrow in terms of the FA, DBRs and AR. An overall indication of facial growth patterns for White British children shows the highest rate of change across the head width, front to bend and pupillary distance, and the least amount of change for the apical radius and the distance between pad centres.

In contrast are the facial data results for children of Chinese ethnicity, where we see similarities in SA and PD but larger parameters for HW/TW/AR/DBR and a lower crest and slightly shorter FTB (**Table 2**). This indicates a different pattern of growth, as we do not see the expected eruption of the bearing surface from the face, so the crest remains relatively low and associated parameters remain wide in comparison with White British children of the same age[1]. As expected, distance between pad centres and crest height show the lowest rate of change per year, whereas temple width shows the highest rate of growth in Chinese children, suggesting a different head shape that is relevant to consider when dispensing frames that have the capability to accommodate this parameter adequately.

Children with Down's syndrome were recruited for this study as they tend to have a high prevalence of refractive error[39] and often are prescribed bifocals[40], therefore vertical positioning and stability of the frame fit is particularly important to ensure the bifocal can be located and used as intended. In comparison with typically developed children of the same ethnicity, the data show that children with Down's syndrome tend to have a lower crest height, which remains low as the child ages and therefore the associated parameters of AR/DBR and FA remain larger (**Table 3**). The front to bend data are relatively shorter and the temple and head width are larger initially in value, which agrees with a previous study[39]. The rate of growth shows the largest change per year for temple width, followed by front to bend, with a relatively slower rate of growth for PD.

The full study into paediatric facial anthropometry also gives an indication of the spread of data found for each of the facial parameters[1]. This is useful information for frame designers to be able to incorporate adjustable features into paediatric frames such as altering the crest height with vertical positioning, bridges that can be interchanged with varying size and shapes of pads, lugs that can be adjusted for temple and head width, and sides that can be physically shortened. The facial differences reported here from three groups of children shows how facial parameters vary across the population; however, with more evidence-based frame designs that incorporate adjustable features, all children can potentially be offered the same frame ranges.

The data, along with growth information, confirm that a child's facial parameters related to spectacle wear are not that of a small adult[1,3,41], especially the nasal parameters that are relatively much lower and larger[1,42], and therefore frame design for the paediatric market needs to move away from scaling down adult models.

Communication and familiarisation

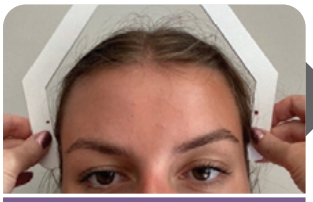
Tell me about your child

Handover:

- Explain prescribing decisions
- Introduce DO as expert in spectacles

Prescription analysis

- Visual task analysis
- Discuss lens design
- Lens material - safety weight, thickness and cosmesis
- Manufacture methods
- Tints and coatings
- Sports and hobbies
- UV protection



Facial appraisal

- PD, CH, PRO,TW, HW
- Assess length to bend and pantoscopic angle
- Curate selection of frames that will fit the parameters above
- Encourage child to have ownership of selection
- Record all measurements

Collection appointment

- Pre-adjust frame prior to collection appointment
- Discuss cleaning, care and maintenance
- Adherence strategies if required
- Return for fit checks

The practice journey

The previous section shows that spectacle frames for children need to be designed with their developing facial anatomy in mind and that a scaled-down version of an adult frame will rarely be acceptable, especially for younger children. This section will offer advice on how this knowledge may fit into the child's overall experience in an optical practice and steps that can be considered to make the entire journey the most positive experience for the child and their family, along with successful outcomes.

Pre-appointment communication

All children are unique individuals with differing characteristics, growing and learning at their own pace[43]. Getting to know that child as an individual is a critical part of effective communication in the practice and therefore any advance information can be a powerful tool to help achieve a positive experience for all parties. This can be achieved in the form of the 'NHS health and care passport', which captures information to help the child receive the right care and treatment and to help the practice team make reasonable adjustments to ensure the child's voice is always heard[44]. A practice may equally consider providing to parents/caregivers a simple, digital 'tell me about your child' form (GDPR compliant), which could be a summary of what is important to that child, their likes and dislikes, and how best to help and support them in providing patient-centred care[45].

This information will allow the practice to be more proactive in facilitating the most positive experience for all children attending the practice. It may be necessary to schedule appointments at a sensory-friendly[46] time for any child who struggles with noise or crowds of people, or to be aware that the child has a facial difference so strategies for frame fitting and potential modification can be considered and prepared. Even basic knowledge about the child's favourite colour or cartoon character in advance can help to prepare activities such as colouring sheets that could enhance initial communication and the overall experience.

Familiarisation tools can also help to create a more inclusive practice[47] where all children and their families can feel more relaxed, reducing uncertainty and stress about visiting a practice, especially for the first time[45]. This structured introduction could be in the form of a brochure, social story to view online and/or in-person pre-appointment visits to meet the team and have a look around, depending on the needs of the individual child.

The practice environment

A child will have a different view of the practice than an adult patient; from a lower height perspective a busy practice can be quite overwhelming to a small child. In addition, a clinical environment may cause feelings of apprehension in a child who has possibly experienced many medical procedures in their lifetime and is unsure of the procedures in an optical practice.

Designing a quiet space area with neurodiversity in mind such as reduced noise, softer lighting and a relaxing space would also be beneficial to the wider population such as patients with hearing impairments, anxiety or those who just prefer a

quieter environment[46]. Having quiet activities on hand such as reading books or colouring may be useful in keeping the child busy while they wait for the dispensing optician to be available, or during the appointment when attention needs to be dedicated to their parents/caregivers.

Careful consideration should be made as to whether it is prudent to display paediatric frames for young children, as this runs the risk of pre-selection by either the child or their parent/caregiver of a potentially unsuitable frame with no professional input. It is a more positive experience if the dispensing optician selects a small, appropriate range of frames based on both a facial appraisal and lens considerations and then the child is encouraged to make their own choice[48], rather than having to cause disappointment and upset by saying 'no' to either party.

The appearance of practitioners

How practitioners dress and behave can influence the opinion the child forms of them in terms of friendliness and trustworthiness. Most practices have adopted a suitable uniform that is functional and professional but not too clinical in appearance and therefore frightening for a child[47]. Equally, it is worth noting that overly bright and colourful garments and strong smells may be too much for some children, and untied hair or accessories such as ties and necklaces should be avoided.

Initial communication with children and their parents/caregivers

In an ideal practice setting the dispensing optician will be introduced by the optometrist at the handover, a critical time where there is important information exchanged regarding the intended prescription or intervention[30] in front of the child and the parents/caregivers. This useful step may be omitted if the prescription comes from a hospital or alternative practice, and rather than just rely on the information retained by parents/caregivers, the dispensing optician may seek clarification by communicating with the prescriber to aid supporting the process and outcomes more effectively.

If not already known to the child, the dispensing optician will introduce themselves[49] and their role to the child and their family in a friendly way, so there is professional trust established that the child will benefit from their skill and expertise in recommending and fitting spectacles.

Initial interaction with the child should be guided by their body language and reaction to the introduction[30]. Being aware that there are two parties in this interaction with very differing needs means utilising all communication skills in keeping the child as the patient, at the heart of the consultation[50], as well as recognising the needs of the parents/caregivers[50,51].

Approaching children of any age should be in a smiling, friendly manner, gauging their reaction and giving them sufficient time to feel comfortable[52]; this is where pre-visit information about the child can help for the first interaction. The dispensing optician will need to be on the same height[41] as the young child to make an accurate facial appraisal, so either having the child sat on the parent's lap or being on the floor in a 'play' situation can often help achieve this whilst also making it a fun interaction. Understanding basic social development stages[53] in children is also a useful tool, especially how at a young age the only influence and approval sought is that of parents/caregivers; then there is a shift as peer approval gains more importance to the child as they age[53–55]. A useful strategy in older children may be to direct conversation more towards fashion, trend and what their peers may be wearing.

Being guided by the child as an individual is the most important strategy, looking for signs that they are happy, comfortable and both understand and most importantly consent[56] to any interactions if appropriate. Timing of appointments in young children can also influence their experience; it is best to avoid times when the child may be tired, hungry or not feeling well[47]. Encouraging an open dialogue with parents/caregivers to show support and to offer rescheduling appointments where necessary may be helpful.

Parents/caregivers may find it difficult to initially accept the diagnosis that their child needs to wear spectacles and will often experience several emotional phases leading to acceptance[30]. Often 'denial' is the first phase where several professional opinions may be sought; this is followed by guilt, with questions such as 'why did I not notice?' being commonplace. The 'origin' phase is described as an attempt to find out where this has come from, so family history can be very relevant to help accept a diagnosis. In the 'reality' phase, parents/caregivers will notice lots of children wearing spectacles and then more guilt may follow related to their initial reaction

to the diagnosis; this is followed by the need for reassurance before acceptance can finally be achieved[30]. During this reassuring phase, which can be heavily influenced by their own experience of spectacle wear as a child, it is crucial to support parents/caregivers and re-emphasise the fact that this will be a much more positive experience than they themselves may have encountered[57] and highly beneficial for their child's overall development.

It is important to acknowledge these phases and explore how further support may be demonstrated by listening carefully, offering reassurance and advice, and utilising supporting materials and references. It may be apparent that the parent is initially too overwhelmed with information and that it is more appropriate to reschedule the dispensing appointment for a later date, assuring them to make contact with any questions that may arise.

Obtaining relevant lifestyle factors

The dispensing optician will ask questions of the child and their family prior to considering the current dispense. It is recommended to review any previous spectacles and ask how the child felt about those in order to ascertain if any issues arose with adherence, comfort, appearance etc to assess suitability, gain insights and look for ways to improve.

It is also important to explore any hobbies and activities the child may participate in with a view to ensuring that eye protection can be recommended where necessary, including specific designs for certain sports, such as prescription swimming goggles.

Lens considerations

A dispensing optician will consider various elements of the lenses prior to giving advice and options that are tailored around that individual child. Considerations will be guided by lens power, including power along each meridian, lens type, form and material, with safety being of paramount importance for paediatric patients[35]. Due to their extensive knowledge of spectacle lens design and manufacturing processes[58], a dispensing optician has the ability to visualise the finished cosmesis of the lenses, which helps to determine if there is any potential impact of the lens size and shape to be selected, or if an alternative lens form or material would be beneficial. Lens materials and their properties commonly dispensed for children are shown in **Table 4**. The highest refractive index considered in the table is polycarbonate at 1.586, although any thickness saving is often negated by the fact that these lenses are usually made slightly thicker in comparison[34]. The Abbe number (v-value or constringence) indicates the optical property of the lens material, with the higher value of 58 for CR-39 indicating superior optical performance in terms of colour fringing or off-axis blur[34]; however, the material is heavier with a density of 1.32g/cm^3 and, in terms of safety, has a significantly lower impact resistance than that of polycarbonate and Trivex lens materials[34].

Material	Refractive Index (nd)	Abbe number	Density
Trivex™	1.532	46	1.11 g/cm^3
Polycarbonate	1.586	30	1.22 g/cm^3
CR-39	1.498	58	1.32 g/cm^3

TABLE 4. *Plastics materials commonly dispensed to children*

Weight and thickness are important factors for a dispensing optician to contemplate as the finished weight on the child's developing bearing surface or the cosmetic appearance of the lenses may influence adherence to spectacle wear in how comfortable the fit of the spectacles feels[57] to the child.

The process of surfacing a positive lens can have a dramatic effect on the finished appearance of the spectacles. With paediatric dispensing, the effective diameter of the lenses required is often relatively small and therefore to glaze a standard 70mm diameter finished lens will result in unnecessary thick, bulbous lens that could impede adequate fitting of nose pads on the frame (**see Figure 15**).

FIGURE 15. *Both lenses are the same power – the lens on the left of the image is surfaced to a smaller diameter, the lens on the right glazed from a larger stock lens (note the nose pad splay angle).*

Even lower positive powered lenses will benefit in thickness saving from being surfaced to the minimum sized uncut[34] as calculated by the dispensing optician (***see steps below***). Negative lenses do not benefit from being surfaced to a small diameter as the centre thickness is fixed at 1–2mm, the resultant edge thickness is determined by the effective diameter from the optical centre so the dispensing optician will incorporate this knowledge into advising on the optimal lens shape and size for their patient.

1. ***Calculate total decentration in mm (boxed centre distance of the frame minus the relevant centration distance)***
2. ***Measure the widest diameter of the lens aperture (note this is not always the horizontal diameter of the lens) and add this to the value found in step 1***
3. ***Add 2mm to your calculation to allow for the bevel edge***

Aspheric lens surfaces can also benefit those who are looking to improve the cosmesis of lenses or optical performance as they will be relatively flatter in comparison with spherical equivalents. High-powered positive lenses are often prescribed in aphakic children, and these cases will usually benefit from a lenticular design being dispensed as they will be thinner, lighter and the margin or carrier is often cut away by the smaller effective diameter required, without the need for a blended lenticular lens.

Frequency of change and/or additional cost are relevant factors that may influence parents/caregivers, however the dispensing optician will ensure that the child and their parent/caregiver have information on all options (with associated costs) to allow them to make an informed choice[49] on elements that will significantly benefit the performance or appearance of a child's spectacles. Similarly, if the practice already has policies in place such as to surface all positive lenses or to supply all children with higher impact resistance lenses for example, then it is good practice to communicate these benefits, so the child and their family know exactly what service or products are being provided.

Where most paediatric prescriptions will be single vision, there are children who will benefit from a prescribed addition power due to reduced accommodative function[40], alignment and binocular vision issues[59]. A large diameter bifocal segment is usually selected and set relatively high at the lower pupil margin, with a straight top dividing line[35] which makes it easier for the child to find the near segment and an immediate, wide field for reading comfort.

Lenses designed to slow the rate of progression of myopia are available in several types of design, such as those with peripheral defocus, altering contrast or power variation lenses[12]. All designs require accurate centration to ensure the child looks through the correct part of the lens and, in the case of the peripheral defocus designs, this clear portion can be from 5–9.4mm depending on design.

Where lenses are designed with an addition power or a treatment zone, they will require adequate depth to the frame (B measurement) to allow a substantial near portion for bifocals, and an adequate treatment zone in all peripheral gaze directions for myopia management lenses. However, the B measurement alone is not an indicator of frame suitability as the dispensing optician will make this recommendation based on where the crest height of the frame places the pupil in the vertical plane.

Tints and UV protection

Several plastic lens materials have some degree of natural ultraviolet (UV) inhibiting properties[41], and a coating can also be added to increase absorption to 400nm, providing full protection and leaving no residual colour to the lens. The World Health Organization (WHO) lists children and adolescents as 'particularly vulnerable' to the harmful effects of UV radiation. This is because a significantly larger amount of UV radiation, up to 70% more[60] can reach and potentially damage the retina.[61]. This is due to children tending to have a natural upward gaze of around 20 degrees[31] along with larger pupils and clearer media. It is important that the message of UV protection is extended, along with sunscreen and sunhats, with the eyes being 10 times more sensitive to UV than skin[62]. There are many ways of adding protection and comfort from glare in the form of tints. A separate pair may work well for some children so that they equate going out in high UV conditions with sunglasses, or it can be incorporated into their prescription spectacles in the form of plastic photochromic lenses or adding a clip-on tinted filter to their spectacles. UV protection should be recommended to all children, whether they have a prescription or not, and a dispensing optician will ensure a well-fitting frame to ensure the intended protection is achieved.

Lens coatings
Anti-reflection coatings may be considered by the dispensing optician for a child who is struggling with glare or who may be more sensitive to reflections and/or their appearance in digital images. This could relate to older children who are often more active on social media, and a demonstration or simulation can help to offer an informed choice, especially if they are initially reluctant to share how they feel about themselves in spectacles or admit that they remove their spectacles when taking photographs. Most comments regarding anti-reflection coatings are associated with difficulty in keeping the lenses clean[34]; this is usually in conjunction with a lack of attention to the bridge projection, so lashes could be touching the back surface of the lenses, causing lens smearing. The latest advances in coating technology include multiple layers with a scratch-resistant function, hydrophobic (water repellent) and oleophobic (oil repellent) to make cleaning easier and less frequent.

Durability may be a concern for some parents and therefore scratch-resistant coatings may help, although it should be made clear that these do not make any plastics material 'scratch-proof' and all lens coatings can impede impact resistance. Scratching lenses by young children is inevitable; however, with good advice regarding usage, care and maintenance, scratches and repairs to frames can be minimalised.

Frame considerations

If the frame is not designed for a child's facial anatomy it will be unlikely to fit correctly, remain stable or feel comfortable for the child. A poor frame fit can affect the resultant prescription[63], the effectiveness of any intervention, and adherence[57] to spectacle wear.

Parental attitudes towards dispensing frames can be hugely impactful on the outcome for a child[64], and indeed any patient in practice. The patient will have differing priorities relating to frames, which may be the appearance, how fashionable the spectacles are, the weight and subsequent comfort of the spectacles, or simply the delivery of clear vision. Children now view spectacle wear more positively[41] and the frequent appearance of spectacles in books, cartoons, films and fashion has normalised wear and raised their profile in a positive manner. This change is most helpful for adherence[57], and the skill of a dispensing optician will help to balance the fun and fashion needs of the child with the medical device function of the frame as the scaffolding to deliver the prescribed refractive correction and/or interventions[63].

After analysing the prescription, the dispensing optician will have determined any lens impact on the frame choice and will now turn their attention to appraise the child's face to determine required frame parameters and characteristics. Parents/caregivers inherently want the best for their child, so providing an explanation to them during this process on the importance of achieving facial data and how this informs frame selection builds confidence and professional trust, so parents/caregivers are more likely to accept professional recommendations.

When physically measuring a child's face or head, it can be helpful to demonstrate the measurement on a parent or teddy bear so that the child can observe and have some understanding of the procedure to enable this to be carried out safely and effectively with appropriate consent. Having all required instrumentation to hand is useful as the young child will often have a very short attention span[65], along with interesting items such as pen toppers to gain and maintain the child's attention while achieving the required measurement. The Fairbank's facial gauge is not recommended for use on young children as the swinging metal pointer could pose a risk of injury, and a negative crest height cannot be physically measured with this device.

The following five facial parameters will provide basic information to allow a suitable selection of frames to be presented, based on anatomical evidence:

- pupillary distance
- crest height
- bridge projection
- head width
- temple width

FIGURE 16. *Taking a pupillary distance*

The pupillary distance will usually be taken using a transparent rule or similar device conducive to the small values found in children. Transparent rules (**Figure 16**) tend to be less intimidating for a young child compared with solid alternatives.

Recording monocular pupillary distances will give a higher degree of accuracy for placing optical centres directly in front of the pupil centre.

Covering the fixating eye will be necessary in the presence of strabismus, and monocular centres will be recorded as necessary. The dispensing optician may need to compensate the value to take into account the large difference between their own pupillary distance and that of the child. The binocular pupillary distance gives an indication of the frame's boxed centre distance, to keep the pupils central in the lens, and avoid excessive decentration which causes lens edge thickness that may impact on the fit.

FIGURE 17. *Appraising a negative crest height*

Crest heights are taken from the lower lid to the bearing surface of the nose and can often be a negative value in children[1]. While on the same eye level as the child, the dispensing optician will make a visual appraisal of this vertical difference and whether it is positive or negative. The crest height indicates where the bridge of the frame should be situated in the vertical plane. The child in **Figure 17** shows a –4mm negative crest which will indicate to the dispensing optician that the bridge of the frame needs to be set 4mm lower than the horizontal centre line of the frame. This ensures that the vertical position of the pupils will be central to the lens, allowing an adequate field at all directions of gaze.

Bridge projection will be assessed by the dispensing optician asking the child to keep their head still and follow an object with their eyes to assess the sweep of the lashes as shown in **Figure 18**. Bridge projection indicates the lateral position of the required frame bridge and whether the frame needs to be sited further forward on the face to accommodate a negative bridge projection, as is commonly found in young children. This can often be achieved with a block bridge or pads on arms but can affect the vertex distance of the final fit therefore may also require a change in ordered lens power due to effectivity.

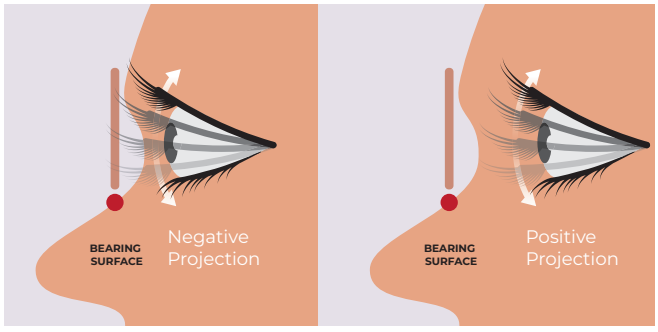


FIGURE 18. *Appraising the bridge projection*

FIGURE 19. *Measuring the head width*

FIGURE 20. *Measuring the temple width*

The head width will be measured with callipers as shown in **Figure 19**. The dispensing optician will be in front of the child for this measurement to ensure that the callipers are positioned at the ear points. The head width on the frame will be compensated by 10mm to ensure the lateral pressure on the head is correct, taking some of the weight away from the bearing surface but not creating too much tension that will drive the frame front forwards. Frames will need to achieve the correct head width so the dispensing optician will be looking at both measuring this value on frames and assessing whether lugs can be adjusted to facilitate the required head width.

The temple width will be measured with callipers as shown in **Figure 20**. The dispensing optician will be higher than the child for this measurement to ensure the 25mm marker is in line with the front of the cornea. There should not be any tension at the temples caused by the frame sides, and since some children have a larger temple width[1] than head width, it needs to be considered at this time to ensure the selected frame can accommodate this with lug adjustment and side manipulation.

Frame presentation and further frame considerations

The lens shape can be critical in delivering an adequate field of view for the child, especially very young children who will spend a great deal of time with an upwards gaze. The dispensing optician may

therefore recommend a rounder eye shape[31] to accommodate this natural behaviour, ensuring that the child is still looking through the lens.

By gathering the data listed, the dispensing optician will have guidance of lens size and shape, frame width, bridge position in the vertical plane, and temple and head width requirements. Several models can then be selected and presented to the child with confidence that they will be suitable, removing any negativity of having to say 'no' and having parents/caregivers understand more about why those frames have been selected. The child can then take ownership of the curated frame selection, with input and support from their parents/caregivers. This will help the child feel as though they are taking control in their choices[66], which has been shown to help with adherence to spectacle wear[67].

There is little value in measuring the front to bend measurement on a child owing to variation in the distance between the back plane of the frame front and the dowel point. The dispensing optician will often assess the external ear while measuring the head width to assess if there are any external ear differences, such as microtia, or if there is any type of hearing support present which may factor into the choice of side material and design. The side length is often appraised and measured with a prospective frame *in situ*, ensuring the desired length to bend can be achieved.

The side angle of the frame is also appraised at this time, and it is important to appreciate that regardless of what angle of side the frame is set at, the resultant pantoscopic angle is determined by the relative ear height of the individual child. The dispensing optician will regard the angle and determine if adjustment is possible, to ensure the angle follows the anatomy of the developing face, considering facial movements such as smiling, for example.

Frame area	Adjustment/Modification	Outcome	Desirable frame feature
Bridge	Alter bridge/pad position in the vertical plane	Crest height can be adjusted to fit more children	Bridges set lower overall according to data with variable height positions
Bridge	Change size, shape and design of pads to match facial anatomy and ensure weight distribution	Frontal, splay and distance between pad centres can be adjusted	Interchangeable pad options for varying facial anatomy, including strap silicon bridges and teardrop shaped pads, and frontal and splay angles can be adjusted
Bridge	Changing fixed pad to pads on arms bridge	A lower, adjustable bridge option can be achieved to fit more children	Cellulose acetate material with substantial rim thickness, removable fixed pads, symmetrical drill locations pre-marked
Lugs	Adjust temple and head widths by filing, heat or pliers depending on material	Creating the correct tension at the ear point, accommodating wide temple widths	Ensure all frame designs and materials have the capability to adjust at the lugs, including those with sprung sides
Joints	Adjust angle of side	Achieve the desired pantoscopic angle	Ensure all frame materials have the capability to adjust the joint or lug depending on design
Sides	Shorten/extend length to bend Accommodate larger temple width Create angle of drop <60° Create inward angle of drop based on anatomy	Sides fit the wider population of children with an acceptable length of drop <35mm	Shorten all sides as indicated by the data and then include a range of adjustability for physical shortening in both plastics and metal (round core wire) materials

TABLE 5. *Adjustments and modifications*

Recording measurements

All measurements regarding lens positioning will be taken and recorded when the frame is adjusted to fit the individual patient, as subsequent frame adjustments can alter the position of the lens in front of the eye. All facial measurements, including appraisal, should be recorded on the patient's record, along with all dispensing details[49]. It is a critical step in adherence success that the frame is set to the required parameters prior to the collection appointment, especially if a new frame is ordered. This is beneficial to the child, to feel as though their spectacles belong to them at the first fit, without the need for multiple adjustments to be made, which can erode confidence and professional trust. It also brings benefits to the dispensing optician to be able to make all the necessary checks, adjustments and potential modifications with the luxury of time and less pressure. Finally, in the case of loss or breakage, a replacement pair can be easily duplicated.

Adjustments and common modifications

Table 5 shows a list of common frame adjustments and modifications with outcomes and ideal frame features to facilitate population variations.

The order of adjustments is relevant to the desired outcome of a well-fitting, comfortable frame. The dispensing optician will start by aligning a frame to the bench, thus ensuring they are starting from a point of symmetry. The 'fitting triangle' is then applied with the bridge fitted first, ensuring that the weight of the spectacles is distributed across the largest surface area possible for a developing bearing surface, paying attention to the frontal and splay angles of any nose pads. The front will then be appraised from above to ensure matching vertex distances are achieved and then from the front to assess if it is sitting horizontally across the face. The lugs will determine the temple and head widths and can be filed, heated or altered with half-covered pliers, depending on the material. At the ear points, the lateral tension is achieved by compensating the head width; the bend at the ear point needs to be a gentle downward angle of drop, following the anatomy of the external ear. The drop should not be excessive in length due to the side being too long and needs to be tucked in towards the head with a gentle inward angle of drop.

Maintenance and care of spectacles

It is useful to teach a child how to take care of their spectacles themselves. Even young children enjoy taking a degree of responsibility and will follow simple rules such as using two hands to put them on and take them off, which will invariably help to keep the joints and sides aligned. Keeping them in a hard case when not used and not placing them with lenses facing down on a surface can also reduce scratches forming at the peak of lens curvature. Washing lenses rather than dry rubbing can also prevent particle-related scratches[34]. Children can feel very proud of carrying out instructions, and so looking after their spectacles with positive reinforcement, such as a reward sticker given at the next visit, can reinforce success.

Some children's spectacles will invariably need more frequent realignment or repairs, therefore the dispensing optician will alert parents what to look for with alignment and encourage return visits to realign, or explain the support that is available for repairs under General Ophthalmic Services[68], to ensure that spectacles are always available.

In line with the GOC standards of practice[49], dispensing opticians will also offer holistic advice relating to the child's eye health and may advise on a wide range of lifestyle factors such as the benefits of regular outdoor time[69], eye protection for hobbies and sports[70,71], and nutrition and the eye[72].

Adherence to spectacle wear

There are key elements to achieving success in a child wearing their spectacles as advised. From the child's perspective, it is very important that they have felt an important part of the process, with ownership of the frame choice[66,67]. How the frame feels to the child when they first have their spectacles placed on their face by the dispensing optician is critical to them forming their first impression, ideally fitting well so they feel that they belong to them and are comfortable.

It is often helpful to distract the child once the fit is completed, such as taking the child for a walk around the practice or letting them choose a case, rather than making a fuss and the child removing their spectacles immediately as the cause of this sometimes unwanted attention.

The parent/caregiver's reaction to their child in spectacles is equally as important, considering the emotional journey the parent/caregiver may have undergone from the initial diagnosis. Parents can take 'full-time wear' very literally and put themselves, and their child, under a great deal of pressure to achieve this status immediately. It can then become a 'battle of wills' with their child, which will then result in one or both parties feeling negative towards wearing spectacles and the child learning that removing spectacles gains them attention.

The dispensing optician can support the parent in this adjustment, making them feel that they are all on the same team[52], taking away some pressure and advising them to celebrate small wins. Even a few moments wear at first should be seen as positive while the child makes the connection between seeing clearly and wearing their spectacles. Associating spectacle wear with a fun, positive activity and utilising spectacle-wearing peers and media characters will help to extend wearing time and a routine is then more easily established.

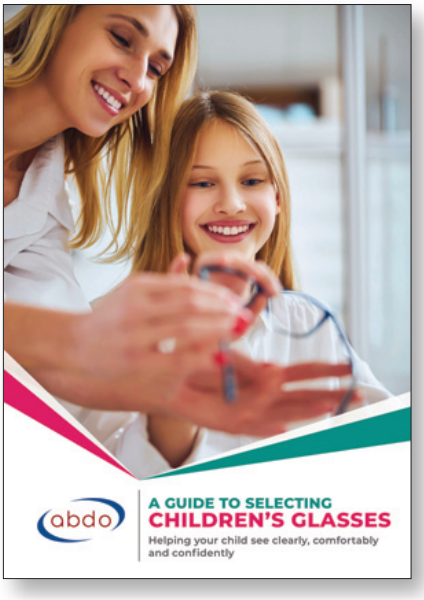
It is important that all parties, such as teachers[73], involved in the daily routine of that child understand what the spectacles are for and when they should be worn, with an emphasis on positive reinforcement rather than negative reaction/attention given to spectacles being removed[30]. Keeping a spare pair of spectacles at school or in the school bag is a useful strategy to ensure learning is not disrupted in case the child forgets or breaks their usual spectacles.

Further resources

ABDO has produced a Level 7 Paediatric Eyecare course for GOC-registered practitioners who wish to develop further knowledge and skill in the areas covered by this paper.

Find out more information at the link below:
www.abdo.org.uk/diploma-in-paediatric-eyecare/

ABDO has also produced a patient leaflet for members to share in practice, offering advice and guidance on caring for children's vision.



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