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Impaction of Low Vision on Quality of Life

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Abstract:- Visual functional usually play a variety of role on social reciprocity. The primary indication for identifiednumber of people, visual identified also provide crucial non-verbal social information via both facial expressions and body language. One of the results of vision loss is the need to rely on non-visual identified during social coordinate. Although verbal indication can carry a significant amount of information, this information is often not available to an untrained listener. Here, we reviewthe current literature examining potential ways that the loss of social information due to vision loss might impact social functioning. A large number of studies suggest that low vision and blind- ness is a risk factor for anxiety and depression. This relationship has been attributed to multiple factors, including anxiety about disease progression, and impairments to quality of life that include difficulties reading, and a lack of access to work and social activities. However, ourreview suggests a potential additional contributing factor to reduced quality of life that hasbeen hitherto overlooked: blindness may make it more difficult to effectively engage in social interactions, due to a loss of visual information. The current literature suggests it might beworth considering training in voice discrimination and/or recognition when carrying out rehabilitative training in late blind individuals.

I. INTRODUCTION

Low vision is associated with a reduced quality of life, defined as a "complex trait that encompasses vision func- tioning, symptoms, emotional well-being, social relation- ships, concerns, and convenience as they are affected byvision".1 Vision loss can reduce quality of life in a wide vari- ety of ways, including difficulties in reading, restrictions in activities and employment, and limitations in both physical and practical (e.g. driving a car) mobility. As a consequence,it is easy for vision loss to result in reduced engagement in social and pleasurable activities. The effects of vision loss on quality of life are complex and multifaceted, Fig. 1; In this review we focus on one single aspect of quality of lifethat has not been explicitly examined - the potential causal influence of poor face recognition on social isolation, anxiety and depression.

It is now well established that low vision and blindness are risk factors for both anxiety and depression.2,3 However,the relationship between loss of vision and these psychoso- cial impacts is not yet fully understood.

Current models of depression and anxiety emphasize their strong comorbidity. Up to two-thirds of adults with anxiety disorders may also suffer from depression.4 Anxiety and depression share clinical symptoms as well as social, psychological, neurobiological and genetic and risk mechanisms.5.

As far as psychological and social risk factors are con- cerned, it is believed that anhedonia (a reduced ability to feel pleasure) and the withdrawal from pleasurable activi- ties may be a major contributing component for both anxi- ety and depression. The relationship is thought to be bidirectional: depression leads to a withdrawal from plea- surable and/or social activities, and the loss of pleasurableactivities and social contact worsens depressive or anxiety symptoms.6—8Consistent with this model, it has long been recognizedthat the susceptibility to anxiety and depression observed, based on meta-studies, in almost every low vision and blindpopulation9 may be at least partially driven by a lack of access to pleasurable and social activities. The practical impacts of vision loss on quality of life and social function are well recognized. For example, individuals with peripheral field loss can no longer drive safely, which can easily lead to social isolation.10,11 Individuals with central field loss which impacts reading are likely to have restricted employment opportunities.12 This can be exacerbated by worry about disease progression, which contributes to feelings of frustration, fear, and sadness.13,14.

However, another more subtle potential cause of anxiety and depression in blind individuals, that has hitherto been unexplored, may be the loss of important non-verbal social information, such as facial expression and body language.

Facial cues clearly have deep ecological importantance. Processing of these cues is associated with a wide network of subcortical and cortical areas that include the putamen and the cerebellum as well as visual, limbic, temporoparietal and prefrontal cortices.15 Difficulties in recognizing individuals or recognizing emotions makes socialfunctioning more difficult across a wide range of disorders, including prosopagnosia and Autism Spectrum Disorder (ASD),16—20 as described in more detail below. Thus, it seems plausible that low vision that impairs face processing may bea hitherto unexplored additional risk factor for depression, social isolation and anxiety.

In this review, we begin with a selective review of early and late onset blindness as a risk factor for social anxiety and depression. Although quality of life assessments have clearly demonstrated the impact of blindness on social and mental health, and multiple potential contributing factorshave been identified, the causal pathways are still not well understood, and are likely to differ as a function of the typeof vision loss. Next, we discuss a potential relationship between difficulties in understanding visual facial information and social anxiety and depression in individuals with prosopagnosia and ASD. Finally, we discuss evidence that training might improve voice recognition abilities, and thereby lessen social difficulties due to face recognition loss.

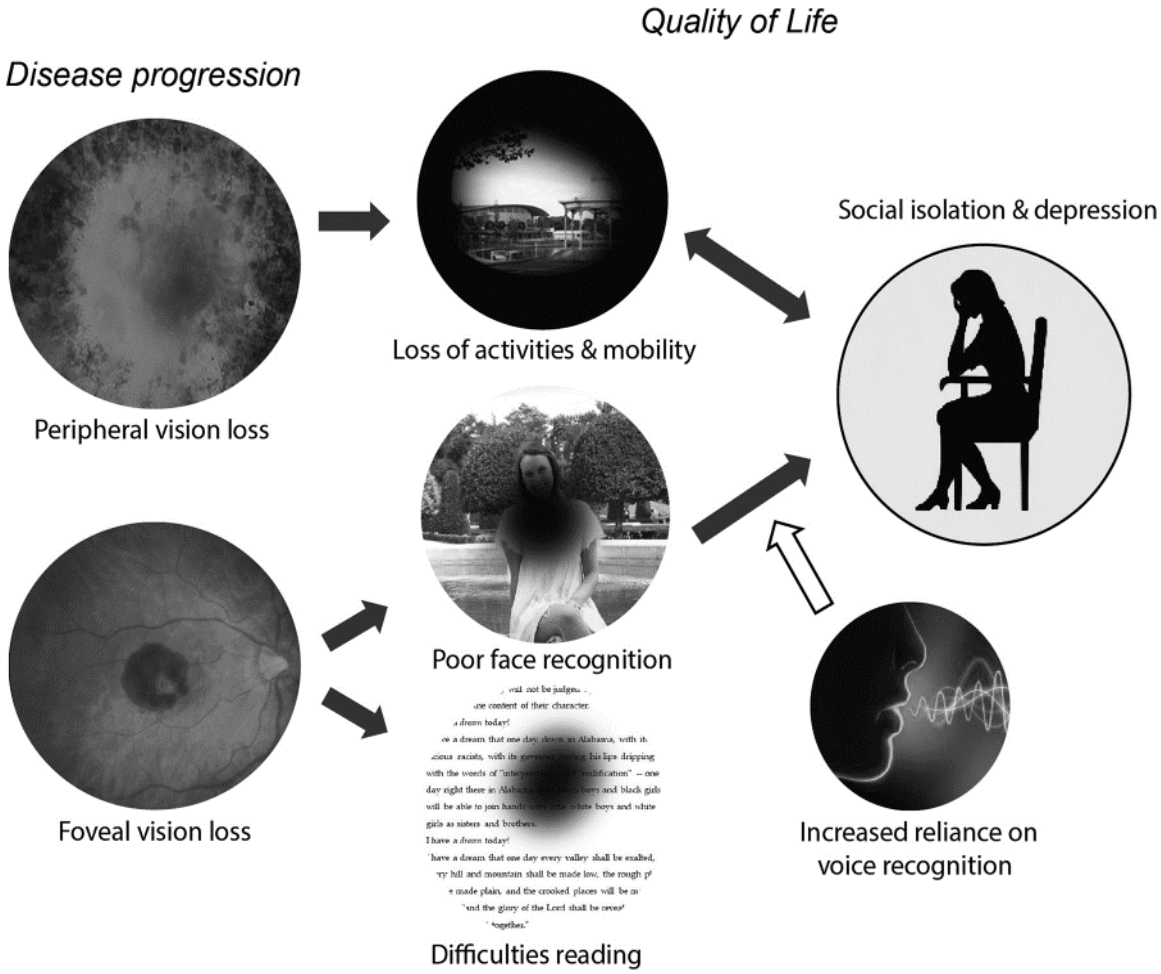

Fig. 1: Schematic model of potential relationships between vision loss and reduced quality of life. Vision loss can reduce quality of life in a wide variety of ways, including restrictions in both physical and practical (e.g. driving a car) mobility and difficulties read- ing. The loss of pleasurable activities and social contact worsens depressive or anxiety symptoms. The relationship is bidirectional: depression can lead to a further withdrawal from pleasurable and/or social activities. In this review we focus on the need for blind and vision impaired individuals to rely more heavily on non visual information to recognize individuals and understand their emo- tions. The resulting difficulties in social processing may provide a causal route to social anxiety and depression

II. PSYCHOSOCIAL CONSEQUENCES OF EARLY ONSET LOW VISION

It is now well established that early vision loss has psychosocial consequences. Children with retinopathy of prematurity (ROP, bilateral abnormal vessel growth and subsequent retinal detachment due to prematurity) perform significantly worse across multiple subscales of the Children's VisualFunction Questionnaire (CVFQ),21,22 with increasing severity of ROP linked to worsening overall quality of life.21 Consistent with our hypothesis that impairments in face recognition has social consequences during development, children with ROP had lower CVFQ personality scores (e.g. “My child likes to visit with relatives.”, “My child gets along well with our other children and friends”, “My child makes new friends easily”, “My child enjoys playing with others (sisters and brothers or friends).”

Psychosocial well-being scores are similarly reduced in children with microphthalmia (ocular malformations in newborns resulting in smaller than average eyes), anophthalmia (the eyes fail to develop prenatally) and coloboma (ocular malformation affecting the eyelid, lens, macula, optic nerve, choroid, iris, or corpus ciliare),23 as well as in children with retinoblastoma (an ocular cancer that can require removal of the eye).24

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At least some of these psychosocial impairments may per- sist into adolescence. One small study using congenitally blind and sighted matched adolescents found that depression and self-concept characteristics of adolescents with visual impairments were similar to those of sighted adolescents; however the anxiety levels of adolescents with visual impairments were significantly higher than those of their sighted peers.25

III. PSYCHOSOCIAL CONSEQUENCES OF LATE ONSET LOW VISION

Visual impairment is associated with reduced social participation, with a recent meta-review finding a strong consensus in the literature that visual impairments results in a with- drawal from social activities. There was also some indication that participation in groupbased activities (e.g. clubs/associations) was more heavily impacted than the quality of relationships with friends or family.26

Depression and anxiety is also common in individuals with late onset visual loss, regardless of whether foveal or peripheral vision is primarily affected. Although the association between visual loss and anxiety is not as clear as the association between visual loss and depression, anxiety is a significant symptom in many individuals.27 Consistent with model where depressive symptoms result in social isolation, which in turn worsen depressive symptoms, agoraphobia and social phobia are the most prevalent anxiety disorders in visually impaired older adults.3

Much less is known about whether psychosocial impairments vary with the type of vision loss. Unfortunately, most studies have focused on a particular type of vision loss, and have rarely clearly differentiated difficulties in social functioning, generalized anxiety and depression. One exceptionis the Michigan Vision-related Anxiety Questionnaire, designed to measure psychosocial outcomes across a variety of inherited retinal degenerations. This work provides one of the few attempts to differentiate different forms of psycho- social impairment based on the form of vision loss. This questionnaire revealed two domains of anxiety in patients with inherited retinal degenerations: cone dysfunction and rod dysfunction related anxiety. Only central vision loss due to cone dysfunction resulted in worries about recognizing faces.28

IV. AGE RELATED MACULAR DEGENERATION (AMD)

In the earlier stages of AMD (a progressive degenerative dis- ease of the macula, the central area in the retina responsible for the high visual acuity required for reading and face recognition) symptoms include difficulty seeing objects clearly and/or apparent distortions. Over time, withouttreatment, vision slowly deteriorates, resulting in the loss of significant regions of central vision.

Unsurprisingly, AMD has been shown to significantlyreduce individuals' sensitivity to faces, to an extent likely toimpact recognition of familiar faces and facial expressions.29 Several quality of life studies examining AMD have included measures of anxiety and depression. Individuals with foveal vision loss due to AMD are more likely to sufferfrom depression and report poorer quality of life than individuals without AMD.30—35 Elderly individuals with AMD scored significantly worse on their quality of life, emotional distress35 and depression, with prevalence levels as high as33%,31,33 especially when the loss of vision was relatively recent35 or there was a perceived lack of social support.36 This depression seems to be related to loss of social function: depressed individuals with AMD reported poorer social functioning as compared to non-depressed individuals with AMD.31.

The association between depression and AMD may be stronger than the relationship with anxiety. One study has demonstrated an association of AMD with both depression and anxiety34; however, in a second study, depression but not anxiety scores were found to be strongly associated with visual acuity loss severity.30 In a later meta-study, preva- lence estimates from nine cross-sectional and cohort studies found that depressive symptoms were more common than anxiety symptoms in individuals with AMD.37.

V. GLAUCOMA

Early symptoms of glaucoma (a disease that damages the optic nerve) include a loss of peripheral vision, but in more severe cases of the disease a large proportion of the visual field can be impacted. Once again, quality of life studiesthat have specifically examined scores associated with psychosocial function have found that glaucoma negativelyaffect psychosocial functioning, with a higher prevalence of generalized anxiety and depression,38—40 especially in those that lack social support.41

Consistent with the idea that difficulties in face recogni- tion may contribute to depression, the psychosocial impacts of glaucoma are correlated with the extent of vision loss;With increasing glaucoma severity, at levels where face rec- ognition is likely to be impaired, quality of life decreases and depression is more common.42 When comparing pro- gressed glaucoma with severe visual field defects to glaucoma patients in general, patients with severe visual fielddeficits had a higher prevalence of both depression and anxi- ety,43 with a linear increase in anxiety as a function of worsening acuity.38

VI. RETINITIS PIGMENTOSA (RP)

In the earlier stages of Retinitis Pigmentosa (a progressive degenerative disease of the eye characterized by loss of photoreceptors that starts in the periphery of the visual field) symptoms include trouble seeing at night and decreased peripheral vision. As peripheral vision worsens,people may experience "tunnel vision". Once again, multiple studies show that RP is a strong risk factor for depression and anxiety.44—50 Prevalence estimates suggest that approximately 37% of RP patients suffer from anxiety and 15

However, for most of the diseases described above, correlations are found between the extent of vision loss and psychosocial symptoms, suggesting that the vision loss caused by disease progression worsens psychosocial health.

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Whilemost studies have not specifically examined social functioning, within at least four diseases (ROP, glaucoma AMD, RP)correlations been found between vision loss, depression and impaired social function.21,28,31,38,47

The link between difficulties in face processing and anxiety and depression - prosopagnosia and autism Another reason for suspecting that difficulties understanding visual facial information might lead to social anxiety anddepression is that analogous phenomena have been observed in the context of prosopagnosia and ASD. Challenges in social interaction due to difficulties processing social information leads to social anxiety, avoidance and depression in individu- als with both prosopagnosia and ASD.

The link between prosopagnosia and social anxiety Prosopagnosia, also known as face blindness, is an impairment in the ability to recognize faces in the absence of lower-level visual deficits. Individuals with prosopagnosia tend to rely on non-facial visual cues (such as hair or clothingor voice) to identify others.51 Both for acquired and developmental prosopagnosia, impairments in the ability to recognize faces often leads to social anxiety and depression.20,52,53

Individuals with prosopagnosia often feel unable to recognize faces in social settings, leading to significant difficulties in social interactions along with feelings of anxietyabout offending others.20 One study using the Cambridgesuffer from depressive symptoms.46,49—26%Face Memory Test (CFMT) suggests that difficulties with facerecognition abilities specifically results in social rather thanOnce again a correlation is seen between quality of life scores, including social life, anxiety and depression, and the degree of visual impairment, as measured by visual acuity and the residual visual field.46,47,49Given that individuals with RP retain the ability to recognize faces until very late stages of the disease, difficulties in face recognition are unlikely to be causally responsible for psychosocial distress. Indeed, the causal link may work inthe other direction. Worry about disease progression or restricted mobility may be the primary causes of depression which may in turn reduce social activity. Consistent with this proposed reversed directional relationship, objective visual function does not predict depression scores in individuals with RP (unlike MD), but depressed RP individuals have significantly worse social functioning than non-depressed individuals47, independent of visual loss.

VII. SUMMARY

Thus, regardless of the age of disease onset or type of vision loss, visual impairments carry a heavy psychological burden, with a significantly elevated risk of anxiety and depression. This is likely to be driven by multiple factors that includedirect visual loss, a fear of worsening vision, loss of employment opportunities, restricted activities and mobility, and difficulties in accessing health care. Even with minimal visual loss, the mere knowledge of having a disease predictive of progressive vision loss can have a negative effect onquality of life.11general anxiety.16

Prosopagnosia causes long-lasting psychosocial consequences, including changes to behavior to avoid situations in which recognition failure can occur. These can include avoiding social situations, relying on social support to assist in face recognition, stress, social anxiety, personalitychanges, changes in social relationships and networks, lack of confidence and isolation, and trouble with careers.20 Children with prosopagnosia frequently encounter psychosocial challenges in their lives, including feelings of embarrassment, anxiety, depression, and developing atypical socialskills.51,53

VIII. THE LINK BETWEEN ASD AND SOCIAL ANXIETY

ASD (a developmental disorder that impairs social behavior) results in subtle specific visual difficulties. ASD leads to altered activity within the cortical temporal face recognition area (fusiform gyrus) and the amygdala - a subcortical area known to be involved in the processing of visual emotional information. Altered connectivity among within a wide distribution of cortical areas associated with face processing has also been observed.54,55 One study found that 36% of individuals with ASD also had prosopagnosia, further worsening social function and potentially increasing social anxiety.56

Unlike individuals with prosopagnosia, individuals with ASD have difficulty with a broad range of social cues. ASD individuals typically also have difficulties in understandingvocal social cues, such as responding to their name being called.17,57 Individuals with ASD also often have difficulties assessing and interpreting language exchange, facial and bodily gestures, posture and body movement.18

These general difficulties in processing social interactions result in social anxiety58, and depression; in a recent meta- analysis of adults with ASD, prevalence estimates of socialanxiety were 29%, which included comorbid depression in 23% of individuals.59 This relationship is thought to be bidirectional: The social anxiety of individuals with ASD may cause them to avoid social situations,57,60 thereby furthercontributing to their social difficulties and depression.61

IX. THE POTENTIAL OF AUDITORY REHABILITATION TRAINING

Training in use of auditory cues is now standard practice for individuals who are blind or have very poor vision. Currently this training focuses primarily on mobility and on screen reading; helping blind individuals orient themselves in the world or navigate a computer using auditory cues.62,63

Blind and low-vision individuals generally have faster listening rates than sighted individuals,64—67 and training in using fast listening rates with screen readers (for example JAWS, VoiceOver) is now becoming commonplace.

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For people with typical auditory and visual capacities, voice recognition is far worse than face recognition68,69 face stimuli must be significantly blurred before visual performance is matched to that of auditory performance.70—75

Furthermore, voice recognition is worse after presentingvoice distractor items, whereas the ability to recognize faces is robust to the inclusion of visual face distractors.76

Voice recognition relies on a network of brain areas thought to include the caudate and the inferior frontal gyrus (IFG) within the left hemisphere, and the posterior superior temporal gyrus (pSTG), inferior/middle frontal gyrus (IFG/MFG), and the medial frontal gyrus in the right hemisphere.77,78

These voice selective areas are separate from the visual face-processing network, but these two networks show rapid and powerful interactions79—81 during multimodal person recognition.82 For example, interactions between face andvoice processing areas occur within 200 ms, response times are shorter for congruent face-voice pairs than for incongruent ones,83 and recognizing familiar voices strongly activates fusiform face regions in sighted listeners.84 In the case of auditory voice training in sighted individuals, auditory voices that were paired with faces during training were recognized with more accuracy. Pairing faces with voices during training also produced an increased functional coupling between face and voice areas.85

Fortunately, in individuals who are habituated to a loss of visual face information, voice recognition does not seem to be impaired by the absence of face information. For example, most individuals with acquired prosopagnosia do notshow voice recognition deficits.86,87 Nor does a lack of visual information developmentally impair voice recognitionvoice recognition in individuals with developmental prosopagnosia does not differ from controls.88

Moreover, individuals who become profoundly blind or suffer from low vision prelingually are better at voice processing than sighted individuals across a wide range of tasks:They show better voice recognition,89,90 learn new voices faster, and their reaction time in a voice discrimination task is shorter.91,92.

One interesting possibility is that enhanced voice recognition as a result of visual loss may be mediated by the recruitment of cortical visual face recognition areas.93,94 Activity within regions of the STS and regions of the fusiform cortex, areas associated with visual face recognition in normally sighted individuals, show task-dependent activityto voices in both early and late blind but not sighted subjects.79,91,92,95—97

As far as rehabilitation training is concerned, it seems plausible that the ability to decode social cues like identity and emotion from voice alone could be improved furtherwith training. Indeed, experts trained in forensic speaker identification, are better at voice identification than non- experts.98,99

X. THE ANALOGY WITH SPEECH-READING FOR HEARING LOSS

When deafness results in a deterioration in the ability to communicate there are substantial psychosocial consequences. As a result, training in speech-reading (training in the effective use of visual clues of the speaker's lip and facial movements, gestures, posture and body language100, has become increasingly popular as a rehabilitation strategy forhearing loss,101—104 for review see.105,106 Visual speech- reading training improves speech recognition,107 in bothearly deaf individuals100 and individuals who have lost hearing later in life.108,109 Furthermore, speech-reading, by improving communication skills, improves aspects of psycho- social functioning.108,110 It seems plausible that an analogous approach, training blind individuals in voice recognition, might lessen social difficulties and anxiety due to blindness.

XI. CONCLUSION

As described above, it is now well-established that low vision and blindness is a risk factor for anxiety and depression. This relationship has been attributed to multiple factors, includ- ing anxiety about disease progression, and a lack of access to work and social activities. However, we believe a potential additional contributing factor, that has been hithertooverlooked, is that blindness may make it more difficult to effectively engage in social interactions, due to a loss ofvisual information about facial identity and expression.

As described above, several studies in the literature suggest an association between blindness and impairments in social function.21,28,31,38,47 However a critical gap in the literature is that all of these studies have tended to focus onspecific blind populations, have used a wide variety of instruments to measure visual impairment,111 and have useda wide variety of quality of life instruments, that vary in their measurement of social function, social anxiety and depression. This heterogeneity precludes collating quantitative data across studies to infer the effects of different types of vision loss on social anxiety and depression. Previousmeta-reviews have similarly noted the need for a unified definition for quality of life, and studies better targeted towards understanding the specific associations between particular types vision impairment and varied measures ofwell-being.9

Generally, rehabilitation for low vision and blindness has focused on112 improving reading speeds,113 training in the use of assistive technologies such as magnifiers, orientation and mobility skills,114 and developing assistivecomputer skills (e.g.JAWS).115,116 In this review, we sug- gest that the additional inclusion of rehabilitative training in voice recognition might lessen social difficulties and anxiety due to blindness.

It has already been demonstrated that early blind individuals have enhanced voice recognition compared to sighted individuals. In the case of early blind individuals this enhanced voice recognition may be the result of develop- mental cross-modal plasticity. However, work in adult sighted individuals shows that voice discrimination can improve with training, even in adulthood. Rehabilitation training in voice recognition and processing vocal social cues is therefore likely to be effective in late blind individuals, even if these improvements have a different neural basis from the enhanced performance observed in early blind individuals.

Finally, we believe an important future direction will be developing better models of how blindness impacts mental health. To date, most studies of depression, anxiety, emotional distress and social anxiety in early blind individuals have had an ophthalmological perspective. As a result, these studies have tended to focus on assessing the prevalence of psychosocial symptoms via relatively broad psychiatric sub- scales. This approach leaves the causal relationshipsbetween vision loss and psychosocial impairments a mystery, making it difficult to effectively target psychosocial treatment. Individuals with AMD and RP may both suffer from similar levels of depression and social isolation but the causal pathways may be very different.

A closer examination of how different kinds of vision loss impair different types of activities and have varied psycho- social consequences has the potential to provide important new insights. With richer and more detailed data sets, it would be possible to use more sophisticated models, such as dynamic latent variable analyses,1 network analyses, and structural equation models, to generate a better under- standing of comorbidities, risk factors, and potential media- tors of the psychosocial distress caused by blindness. More informed models could be used to better guide both rehabilitative intervention and the clinical treatment of psychosocial distress.

REFERENCES

[1.] Lamoureux E, Pesudovs K. Vision-specific quality-of-life research: a need to improve the quality. Am J Ophthalmol. 2011;151: 195 197e192. https://doi.org/10.1016/j.ajo.2010.09.020.

[2.] Heesterbeek TJ, van der Aa HPA, van Rens GHMB, Twisk JWR, van Nispen RMA. The incidence and predictors of depressive and anxiety symptoms in older adults with vision impairment: a longitudinal prospective cohort study. Ophthalmic Physiol Opt. 2017;37:385 398.

[3.] van der Aa HPA, Comijs HC, Penninx BWJH, van Rens GHMB, van Nispen RMA. Major depressive and anxiety disorders in visually impaired older adults. Invest Ophthalmol Vis Sci. 2015;56:849 854. https://doi.org/10.1167/iovs.14-15848.

[4.] Lamers F, van Oppen P, Comijs HC, et al. Comorbidity patterns of anxiety and depressive disorders in a large cohort study: the Netherlands study of depression and anxiety (NESDA). J Clin Psychiatry. 2011;72:341 348. https://doi.org/10.4088/ JCP.10m06176blu.

[5.] Kalin NHMD. The critical relationship between anxiety and depression. Am J Psychiatry. 2020;177:365 367. https://doi. org/10.1176/appi.ajp.2020.20030305.

[6.] Alma MA, van der Mei SF, Melis-Dankers BJ, van Tilburg TG, Groothoff JW, Suurmeijer TP. Participation of the elderly after vision loss. DisabilRehabil. 2011;33:63 72. https://doi.org/ 10.3109/09638288.2010.488711.

[7.] Elmer T, Stadtfeld C. Depressive symptoms are associated with social isolation in face-to-face interaction networks. Sci Rep. 2020;10:1444. https://doi.org/10.1038/s41598-020-58297-9.

[8.] Nezlek JB, Imbrie M, Shean GD. Depression and everyday social interaction. J Personal Soc Psychol. 1994;67:1101 1111. https://doi.org/10.1037/0022-3514.67.6.1101.

[9.] Assi L, Chamseddine F, Ibrahim P, et al. A global assessment of eye health and quality of life: a systematic review of system- atic reviews. JAMA Ophthalmol. 2021;139:526 541. https:// doi.org/10.1001/jamaophthalmol.2021.0146.

[10.] Lange R, Kumagai A, Weiss S, et al. Vision-related quality of life in adults with severe peripheral vision loss: a qualitative interview study. J Patient Rep Outcomes. 2021;5:7. https:// doi.org/10.1186/s41687-020-00281-y.

[11.] Quaranta L, Riva I, Gerardi C, Oddone F, Floriani I, Konstas AGP. Quality of life in glaucoma: a review of the literature. Adv Ther. 2016;33:959 981.

[12.] Sivakumar P, Vedachalam R, Kannusamy V, et al. Barriers in utilisation of low vision assistive products. Eye. 2020;34: 344 351. https://doi.org/10.1038/s41433-019-0545-5. (London, England).

[13.] Bennion AE, Shaw RL, Gibson JM. What do we know about the experience of age related macular degeneration? A systematic review and meta-synthesis of qualitative research. Soc Sci Med. 2012;75:976 985.

[14.] Garip G, Kamal A. Systematic review and meta-synthesis of coping with retinitis pigmentosa: implications for improving quality of life. BMC Ophthalmol. 2019;19:1 16.

[15.] Fusar-Poli P, Placentino A, Carletti F, et al. Functional atlas of emotional faces processing: a voxel-based meta-analysis of 105 functional magnetic resonance imaging studies. J Psychia- try Neurosci. 2009;34:418 432.

[16.] Davis JM, McKone E, Dennett H, O'Connor KB, O'Kearney R, PalermoR. Individual differences in the ability to recognise facial identity are associated with social anxiety. PLoS ONE. 2011;6:e28800. https://doi.org/10.1371/journal.pone.0028800.

[17.] Dawson G, Meltzoff AN, Osterling J, Rinaldi J, Brown E. Chil- dren with autism fail to orient to naturally occurring social stimuli. J Autism Dev Disord. 1998;28:479 485. https://doi. org/10.1023/a:1026043926488.

[18.] Klin A, Jones W, Schultz R, Volkmar F. The enactive mind, or from actions to cognition: lessons from autism. Philos Trans RSoc Lond B Biol Sci. 2003;358:345 360. https://doi.org/ 10.1098/rstb.2002.1202.

[19.] Russell NCC, Luke SG, Lundwall RA, South M. Not so fast: autis- tic traits and anxious apprehension in real-world visual search scenarios. J Autism Dev Disord. 2019;49:1795 1806. https:// doi.org/10.1007/s10803-018-03874-1.

[20.] Yardley L, McDermott L, Pisarski S, Duchaine B, Nakayama K. Psychosocial consequences of developmental prosopagnosia: a problem of recognition. J Psychosom Res. 2008;65:445 451.

[21.] Kesarwani P, Narang S, Chawla D, Jain S, Chandel M, Sood S. Vision-related quality of life in children with treated retinopathy of prematurity. Indian J Ophthalmol. 2019;67: 932 935.

[22.] Messa AA, Mattos RB, Areco KCN, Sallum JMF. Vision-related quality of life in children with retinopathy of prematurity. Arq Bras Oftalmol. 2015;78:224 228.

[23.] Dahlmann-Noor A, Tailor V, Abou-Rayyah Y, et al. Functional vision and quality of life in children with microphthalmia/ anophthalmia/coloboma-a cross-sectional study. J AAPOS.2018;22:281 285.e281. the official publication of the Ameri- can Association for Pediatric Ophthalmology and Strabismus.

[24.] Sheppard L, Eiser C, Kingston J. Mothers' perceptions of children's quality of life following early diagnosis and treatment for retino- blastoma (Rb). Child Care Health Dev. 2005;31:137 142.

[25.] Bolat N, Dog˘angu€n B, Yavuz M, Demir T, Kayaalp L. Depressionand anxiety levels and self-concept characteristics of adoles- cents with congenital complete visual impairment. Turk PsikiyatriDerg. 2011;22:77 82.

[26.] Shah K, Frank CR, Ehrlich JR. The association between vision impairment and social participation in community-dwelling adults: a systematic review. Eye (Lond). 2020;34:290 298. https://doi.org/10.1038/s41433-019-0712-8.

[27.] Demmin DL, Silverstein SM. Visual impairment and mental health: unmet needs and treatment options. Clin Ophthalmol. 2020;14:4229 4251. https://doi.org/10.2147/OPTH.S258783.

[28.] Lacy GD, Abalem MF, Andrews CA, et al. The Michigan vision-related anxiety questionnaire: a psychosocial outcomes measure for inher- ited retinal degenerations. Am J Ophthalmol. 2021;225:137 146. https://doi.org/10.1016/j.ajo.2020.12.001.

[29.] Logan AJ, Gordon GE, Loffler G. The Effect of age-related macular degeneration on components of face perception.Invest Ophthalmol Vis Sci. 2020;61:38. https://doi.org/ 10.1167/iovs.61.6.38. -38.

[30.] Augustin A, Sahel JA, Bandello F, et al. Anxiety and depression prevalence rates in age-related macular degeneration. Invest Ophthalmol Vis Sci. 2007;48:1498 1503.

[31.] Brody BL, Gamst AC, Williams RA, et al. Depression, visual acu- ity, comorbidity, and disability associated with age-related macular degeneration. Ophthalmology. 2001;108:1893 1900. discussion 1900-1891.

[32.] Eramudugolla R, Wood J, Anstey KJ. Co-morbidity of depres- sion and anxiety in common age-related eye diseases: a popu- lation-based study of 662 adults. Front Aging Neurosci. 2013;5:56. https://doi.org/10.3389/fnagi.2013.00056.

[33.] Rovner BW, Casten RJ, Tasman WS. Effect of depression on vision function in age-related macular degeneration. Arch Ophthalmol. 2002;120:1041 1044.

[34.] Soubrane G, Cruess A, Lotery A, et al. Burden and health care resource utilization in neovascular age-related macular degen- eration: findings of a multicountry study. Arch Ophthalmol. 2007;125:1249 1254. (Chicago, Ill. : 1960).

[35.] Williams RA, Brody BL, Thomas RG, Kaplan RM, Brown SI. The psychosocial impact of macular degeneration. Arch Ophthal- mol. 1998;116:514 520.

[36.] Herna´ndez-Moreno L, Senra H, Moreno N, Macedo AF. Is perceived social support more important than visual acuity for clinical depression and anxiety in patients with age-related macular degenerationand diabetic retinopathy? Clin Rehabil. 2021;35:1341 1347. https://doi.org/10.1177/0269215521997991.

[37.] Dawson SR, Mallen CD, Gouldstone MB, Yarham R, Mansell G. The prevalence of anxiety and depression in people with age- related macular degeneration: a systematic review of observational study data. BMC Ophthalmol. 2014;14:78.

[38.] Chan EW, Chiang PPC, Liao J, et al. Glaucoma and associated visual acuity and field loss significantly affect glaucoma-specific psychosocial functioning. Ophthalmology. 2015;122:494 501.

[39.] Mabuchi F, Yoshimura K, Kashiwagi K, et al. High prevalence of anxiety and depression in patients with primary open-angle glaucoma. J Glaucoma. 2008;17:552 557. https://doi.org/ 10.1097/IJG.0b013e31816299d4.

[40.] Zhang X, Olson DJ, Le P, Lin FC, Fleischman D, Davis RM. The association between glaucoma, anxiety, and depression in a large population. Am J Ophthalmol. 2017;183:37 41.

[41.] Wang Y, Zhao Y, Xie S, Wang X, Chen Q, Xia X. Resilience medi- ates the relationship between social support and quality of life in patients with primary glaucoma. Front Psychiatry. 2019;10:22. https://doi.org/10.3389/fpsyt.2019.00022. -22.

[42.] Skalicky S, Goldberg I. Depression and quality of life in patients with glaucoma: a cross-sectional analysis using the geriatric depression scale-15, assessment of function related to vision, and the glaucoma quality of life-15. J Glaucoma. 2008;17:546 551.

[43.] Agorastos A, Skevas C, Matthaei M, et al. Depression, anxiety, and disturbed sleep in glaucoma. J Neuropsychiatry Clin Neu- rosci.

2013;25:205 213. https://doi.org/10.1176/appi.neuro-psych.12020030.

[44.] Adhami-Moghadam F, Iran-Pour E. Psychological disorders in patients with retinitis pigmentosa in iran. Iran J Public Health. 2014;43:523 528.

[45.] Berson EL. Long-term visual prognoses in patients with retinitis pigmentosa: the Ludwig von Sallmann lecture. Exp Eye Res. 2007;85:7 14.

[46.] Chaumet-Riffaud AE, Chaumet-Riffaud P, Cariou A, et al. Impact of retinitis pigmentosa on quality of life, mental health, and employment among young adults. Am J Ophthal- mol. 2017;177:169 174.

[47.] Hahm BJ, Shin YW, Shim EJ, et al. Depression and the vision- related quality of life in patients with retinitis pigmentosa. Br J Ophthalmol. 2008;92:650 654.

[48.] Moschos M, Chatzirallis A, Chatziralli I. Psychological aspects and depression in patients with retinitis pigmentosa. Eur J Ophthalmol. 2015;25:459 462.

[49.] Sainohira M, Yamashita T, Terasaki H, et al. Quantitative analy- ses of factors related to anxiety and depression in patients with retinitis pigmentosa. PLoS ONE. 2018;13: e0195983.

[50.] Strougo Z, Badoux A, Duchanel D. Psycho-affective problems associated with retinitis pigmentosa. J Fr Ophtalmol. 1997;20: 111 116.

[51.] Dalrymple KA, Fletcher K, Corrow S, et al. A room full of strangers every day": the psychosocial impact of developmental prosopagnosia on children and their families. J Psychosom Res. 2014;77:144 150. https://doi.org/10.1016/j.jpsychores.2014.06.001.

[52.] Barton JJS. Disorders of face perception and recognition. Neu- rol Clin. 2003;21:521 548. https://doi.org/10.1016/S0733- 8619(02)00106-8.

[53.] Diaz AL. Do I know you? A case study of prosopagnosia (face blindness). J SchNurs. 2008;24:284 289.

[54.] Hendriks MHA, Dillen C, Vettori S, et al. Neural processing of facial identity and expression in adults with and without autism: a multi-method approach. Neuroimage Clin. 2021;29: 102520. https://doi.org/10.1016/j.nicl.2020.102520.

[55.] Samaey, C., Van der Donck, S., van Winkel, R., &Boets, B. (2020). Facial expression processing across the autism-psycho- sis spectra: a review of neural findings and associations withadverse childhood events. Front Psychiatry, 11, 592937. doi: 10.3389/fpsyt.2020.592937.

[56.] Minio-Paluello I, Porciello G, Pascual-Leone A, Baron-Cohen S. Face individual identity recognition: a potential endopheno- type in autism. Mol Autism. 2020;11:81. https://doi.org/ 10.1186/s13229-020-00371-0.

[57.] van Steensel FJA, Bo€gels SM, Perrin S. Anxiety disorders in children and adolescents with autistic spectrum disorders: a meta- analysis. Clin Child Fam Psychol Rev. 2011;14:302 317. https://doi.org/10.1007/s10567-011-0097-0.

[58.] Attwood T. Strategies for improving the social integration of children with Asperger syndrome. Autism. 2000;4: 85 100.

[59.] Hollocks MJ, Lerh JW, Magiati I, Meiser-Stedman R, Brugha TS. Anxi- ety and depression in adults with autism spectrum disorder: a sys- tematic review and meta-analysis. Psychol Med. 2019;49:559 572. https://doi.org/10.1017/s0033291718002283.

[60.] Myles BS, Barnhill GP, Hagiwara T, Griswold DE, Simpson RL. A syn- thesis of studies on the intellectual, academic, social/emotional and sensory characteristics of children and youth with Asperger syndrome. Educ Train Ment Retard Dev Disabil. 2001;36 (3):304 311.

[61.] Milleret C, Houzel JC, Buser P. Pattern of development of the callosal transfer of visual information to cortical areas 17 and 18 in the cat. Eur J Neurosci. 1994;6:193 202.

[62.] Collignon O, Voss P, Lassonde M, Lepore F. Cross-modal plastic- ity for the spatial processing of sounds in visually deprived sub- jects. Exp Brain Res. 2009;192:343 358. https://doi.org/ 10.1007/s00221-008-1553-z.

[63.] Fiehler K, Ro€sler F. Plasticity of multisensory dorsal stream functions: evidence from congenitally blind and sighted adults. RestorNeurolNeurosci. 2010;28:193 205.

[64.] Bragg D, Bennett C, Reinecke K, Ladner R. A large inclusive study of human listening rates. Paper presented at the. In: Proceedings of the CHI conference on human factors in com- puting systems. Montreal QC, Canada; 2018. https://doi.org/ 10.1145/3173574.3174018.

[65.] Hertrich I, Dietrich S, Moos A, Trouvain J, Ackermann H. Enhanced speech perception capabilities in a blind listener are associated with activation of fusiform gyrus and primary visual cortex. Neurocase. 2009;15:163 170. https://doi.org/10. 1080/13554790802709054.

[66.] Moos A, Trouvain J. Comprehension of ultra-fast speech-blind vs." normally hearing" persons. In: Proceedings of the 16th International Congress of Phonetic Sciences. 2007.

[67.] Moos A, &Trouvain J. (2007). Comprehension of ultra-fast speech-blind vs. 'Normally Hearing' Persons. In Proceedings of the 16th International Congress of Phonetic Sciences (Vol. 1, pp. 677 680). Saarbru€cken, Germany: Saarland University.

[68.] Damjanovic L, Hanley JR. Recalling episodic and semantic information about famous faces and voices. Mem Cognit. 2007;35:1205 1210. https://doi.org/10.3758/bf03193594.

[69.] Legge GE, Grosmann C, Pieper CM. Learning unfamiliar voices. J Exp Psychol Learn Mem Cognit. 1984;10:298 303. https:// doi.org/10.1037/0278-7393.10.2.298.

[70.] Braun A. The Speaker Identification Ability of Blind and Sighted listeners: An empirical Investigation. Springer; 2016.

[71.] Clifford BR. Voice identification by human listeners: on earwit- ness reliability. Law Hum Behav. 1980;4:373.
[72.] Gainotti G. What the study of voice recognition in normal subjects and brain-damaged patients tells us about models of familiar people recognition. Neuropsychologia. 2011;49:2273 2282. https://doi.org/10.1016/j.neuropsychologia.2011.04. 027.
[73.] Hanley JR, Damjanovic L. It is more difficult to retrieve a familiar person's name and occupation from their voice thanfrom their blurred face. Memory. 2009;17:830 839. https:// doi.org/10.1080/09658210903264175.
[74.] Hanley JR, Smith ST, Hadfield J. I recognise you but I can not place you: an investigation of familiar-only experiences during tests of voice and face recognition. Q J Exp Psychol Sect Hum Exp Psychol.1998;51:179 195. https://doi.org/10.1080/713755751.
[75.] Richard Hanley J, Turner JM. Why are familiar-only experien- ces more frequent for voices than for faces? Q J Exp Psychol Sect A. 2000;53:1105 1116.
[76.] Stevenage SV, Neil GJ, Barlow J, Dyson A, Eaton-Brown C, Par- sons B. The effect of distraction on face and voice recognition. Psychol Res. 2013;77:167 175. https://doi.org/10.1007/ s00426-012-0450-z.
[77.] Aglieri V, Chaminade T, Takerkart S, Belin P. Functional connec- tivity within the voice perception network and its behavioural relevance. Neuroimage. 2018;183:356 365. https://doi.org/ 10.1016/j.neuroimage.2018.08.011.
[78.] Zaske R, AwwadShiekh Hasan B, Belin P. It does not matter what you say: FMRI correlates of voice learning and recognition indepen- dent of speech content. Cortex. 2017;94:100 112. https://doi. org/10.1016/j.cortex.2017.06.005.
[79.] Focker J, Holig C, Best A, Roder B. Crossmodal interaction of facial and vocal person identity information: an event-related potential study. Brain Res. 2011;1385:229 245. https://doi. org/10.1016/j.brainres.2011.02.021.
[80.] Gonza´lez IQ, Leo´n MA, Belin P, Martínez-Quintana Y, García LG, Castillo MS. Person identification through faces and voices: an ERP study. Brain Res. 2011;1407:13 26. https://doi.org/10.1016/j.brainres.2011.03.029.
[81.] von Kriegstein K, Kleinschmidt A, Sterzer P, Giraud AL. Interac- tion of face and voice areas during speaker recognition. J CognNeurosci. 2005;17:367 376. https://doi.org/10.1162/ 0898929053279577.
[82.] Maguinness C, Roswandowitz C, von Kriegstein K. Under- standing the mechanisms of familiar voice-identity recogni- tion in the human brain. Neuropsychologia. 2018;116:179 193. https://doi.org/10.1016/j.neuropsychologia. 2018.03.039.
[83.] O'Mahony C, Newell FN. Integration of faces and voices, but not faces and names, in person recognition. Br J Psychol. 2012;103:73 82. https://doi.org/10.1111/j.2044- 8295.2011.02044.x.
[84.] Blank H, Kiebel SJ, von Kriegstein K. How the human brain exchanges information across sensory modalities to recognize other people. Hum Brain Mapp. 2015;36:324 339. https:// doi.org/10.1002/hbm.22631.
[85.] von Kriegstein K, Giraud AL. Implicit multisensory associations influence voice recognition. PLoS Biol. 2006;4:e326. https:// doi.org/10.1371/journal.pbio.0040326.
[86.] Barton JJS, Corrow SL. The problem of being bad at faces. Neuropsychologia. 2016;89:119 124. https://doi.org/ 10.1016/j.neuropsychologia.2016.06.008.
[87.] Liu RR, Pancaroglu R, Hills CS, Duchaine B, Barton JJS. Voice recogni- tion in face-blind patients. Cereb Cortex. 2016;26:1473 1487. https://doi.org/10.1093/cercor/bhu240.
[88.] Tsantani M, Cook R. Normal recognition of famous voices in developmental prosopagnosia. Sci Rep. 2020;10:19757. https://doi.org/10.1038/s41598-020-76819-3.
[89.] Bull R, Rathborn H, Clifford BR. The voice-recognition accu- racy of blind listeners. Perception. 1983;12:223 226. https:// doi.org/10.1068/p120223.
[90.] Pang W, Xing H, Zhang L, Shu H, Zhang Y. Superiority of blind over sighted listeners in voice recognition. J Acoust Soc Am. 2020;148:EL208. https://doi.org/10.1121/10.0001804.
[91.] Focker J, Best A, Holig C, Roder B. The superiority in voice processing of the blind arises from neural plasticity at sensory processing stages. Neuropsychologia. 2012;50:2056 2067. https://doi.org/10.1016/j.neuropsychologia.2012.05 .006.
[92.] Holig C, Focker J, Best A, Roder B, Buchel C. Brain systems mediating voice identity processing in blind humans. HumBrain Mapp. 2014;35:4607 4619. https://doi.org/10.1002/ hbm.22498.
[93.] Fine I, Park JM. Blindness and human brain plasticity. Annu Rev Vis Sci. 2018;4:337 356. https://doi.org/10.1146/annurev- vision-102016-061241.
[94.] Frasnelli J, Collignon O, Voss P, Lepore F. Crossmodal plasticity in sensory loss. Prog Brain Res. 2011;191:233 249. https:// doi.org/10.1016/B978-0-444-53752-2.00002-3.
[95.] Focker J, Holig C, Best A, Roder B. Neural plasticity of voice processing: evidence from event-related potentials in late- onset blind and sighted individuals. RestorNeurolNeurosci. 2015;33:15 30. https://doi.org/10.3233/RNN-140406.
[96.] Gougoux F, Belin P, Voss P, Lepore F, Lassonde M, Zatorre RJ. Voice perception in blind persons: a functional magnetic reso- nance imaging study. Neuropsychologia. 2009;47:2967 2974. https://doi.org/10.1016/j.neuropsychologia.2009.06 .027.
[97.] Holig C, Focker J, Best A, Roder B, Buchel C. Crossmodalplas- ticity in the fusiform gyrus of late

blind individuals during voice recognition. Neuroimage. 2014;103:374 382. https:// doi.org/10.1016/j.neuroimage.2014.09.050.

[98.] Bartle A, Dellwo V. Auditory speaker discrimination by forensic phoneticians and naive listeners in voiced and whispered speech. Int J Speech Lang Law. 2015;22(2):229 248. https:// doi.org/10.1558/ijsll.v22i2.23101.

[99.] Schiller NO, Ko€ster O. The ability of expert witnesses to identify voices: a comparison between trained and untrained lis- teners. Int J Speech Lang Law. 1998;5:9.

[100.] Bernstein LE, Auer ET, Tucker PE. Enhanced speechreading in deaf adults: can short-term training/practice close the gap for hearing adults? J Speech Lang Hear Res. 2001;44:5 18. https://doi.org/10.1044/1092-4388(2001/001.

[101.] Grant KW, Walden BE, Seitz PF. Auditory-visual speech recogni- tion by hearing-impaired subjects: consonant recognition, sen- tence recognition, and auditory-visual integration. J Acoust Soc Am. 1998;103:2677 2690.

[102.] McCarthy P, Schau N. Adult audiologic rehabilitation: a review of contemporary practices. Contemp Issues Commun Sci Disord. 2008;35:168 177. https://doi.org/10.1044/cicsd_35_F_168. Fall.

[103.] Middelweerd M, Plomp R. The effect of speechreading on the speech-reception threshold of sentences in noise. J Acoust Soc Am. 1987;82:2145 2147.

[104.] Tye-Murray N, Sommers MS, Spehar B. Audiovisual integration and lipreading abilities of older adults with normal and impaired hearing. Ear Hear. 2007;28(5):656 668. https://doi. org/10.1097/AUD.0b013e31812f7185.

[105.] Glick H, Sharma A. Cross-modal plasticity in developmental and age- related hearing loss: clinical implications. Hear Res. 2017;343: 191 201. https://doi.org/10.1016/j.heares.2016.08.012.

[106.] Woodhouse L, Hickson L, Dodd B. Review of visual speech per- ception by hearing and hearing-impaired people: clinical implications. Int J Lang CommunDisord. 2009;44:253 270. https://doi.org/10.1080/13682820802090281.

[107.] Summerfield Q. Use of visual information for phonetic percep- tion. Phonetica. 1979;36:314 331. https://doi.org/10.1159/000259969.

[108.] Kricos PB, Holmes AE. Efficacy of audiologic rehabilitation for older adults. J Am AcadAudiol. 1996;7:219 229.

[109.] Yu L, Rao A, Zhang Y, Burton PC, Rishiq D, Abrams H. Neuromo- dulatory effects of auditory training and hearing aid use on audiovisual speech perception in elderly individuals. Front Aging Neurosci. 2017;9:30. https://doi.org/10.3389/fnagi. 2017.00030.

[110.] Michaud HN, Duchesne L. Aural rehabilitation for older adults with hearing loss: impacts on quality of life-a systematic review of randomized controlled trials. J Am AcadAudiol. 2017;28:596 609. https://doi.org/10.3766/jaaa.15090.

[111.] Margolis MK, Coyne K, Kennedy-Martin T, Baker T, Schein O, Revicki DA. Vision-specific instruments for the assessment of health-related quality of life and visual functioning. Pharma-coeconomics. 2002;20:791 812.

[112.] Meyniel C, Bodaghi B, Robert PY. Revisiting vision rehabilita- tion. Front SystNeurosci. 2017;11:82. https://doi.org/10. 3389/fnsys.2017.00082.

[113.] Hamade N, Hodge WG, Rakibuz-Zaman M, Malvankar-Mehta MS. The effects of low-vision rehabilitation on reading speed and depression in age related macular degeneration: a meta- analysis. PLoS ONE. 2016;11:e0159254. https://doi.org/ 10.1371/journal.pone.0159254.

[114.] Virgili G, Rubin G. Orientation and mobility training for adults with low vision. Cochrane Database Syst Rev. 2010;2010: CD003925. https://doi.org/10.1002/14651858.CD003925.pub3.

[115.] Parker B. A description of an advanced computer skills training program designed to prepare individuals who are visually impaired for the modern workplace. J Vis Impair Blind. 2020;114:57 62.

[116.] Shaw, N.T., Boudreau, S., &Issaoui, M. (2021). Digital Assistive Technologies to support remote working by people with dis- abilities: A Scoping Review. Publisher: Social Sciences and Humanities Research Council and the Government of Canada's Future Skills program.