ELECTRONIC GLASSES

A WALK THROUGH TIME, OUR EXPERIENCES AND BIDS FOR THE FUTURE

WELCOME

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CONTENT

- The history of electronic glasses.
- Literature study with the purpose of examining visual acuity, quality of life, and activities of daily living of visually impaired people using electronic glasses.
- Pilot project with the purpose to clarify whether electronic glasses could improve the visual function and everyday life of a group of 10 people diagnosed with Stargardt disease.
- Through literature searches, and our feel for the market we will give our insights of what is on the rumor mill for the future of electronic glasses.

A COLLABORATION BETWEEN…

Instituttet for Blinde og Svagsynede

REGION H

FINANCIALLY SUPPORTED BY…

Dansk Blindesamfund
Landsforening af blinde og svagsynede i Danmark

UNIVERSITETSHOSPITALERNES CENTER FOR SUNDHEDSFAGLIG FORSKNING
UCSF

HISTORY

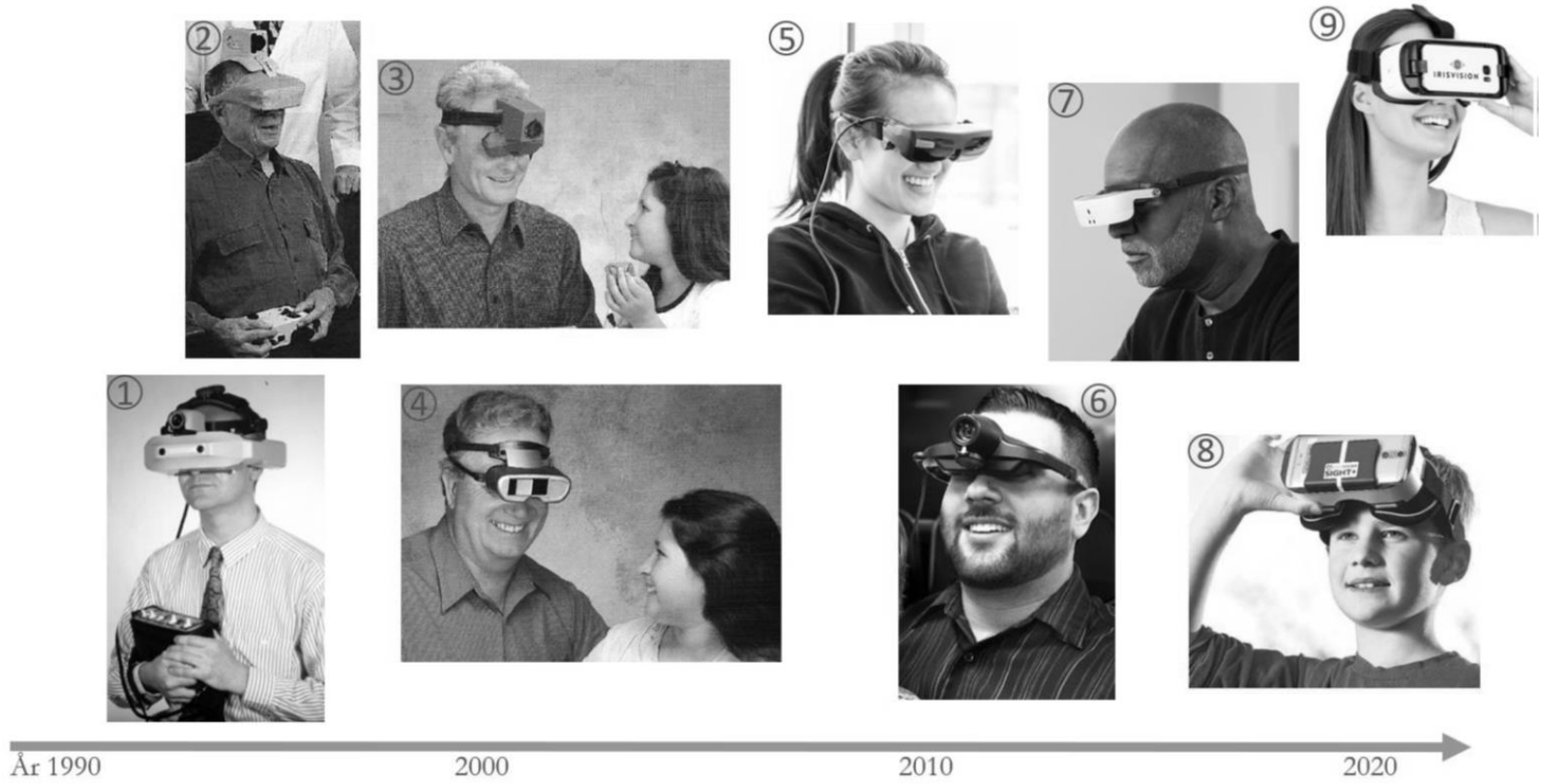
LVES (Low Vision Enhancement System)

- 1994 A collaboration between NASA, John Hopkins Wilmer Eye Institute og Department of Veterans Affairs.
- 3 cameras and two black and white screens.
- 10x magnification.

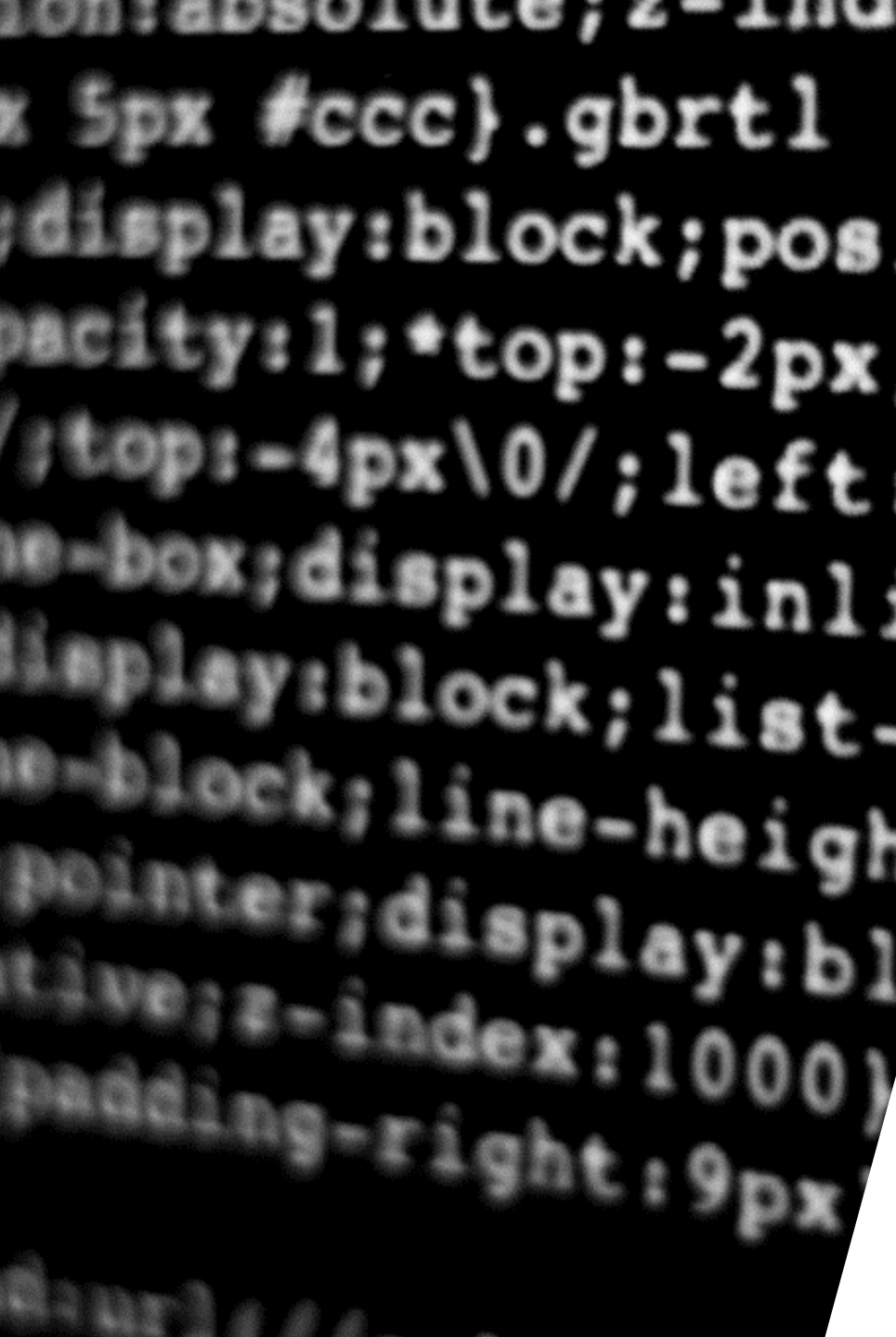
Heavy, big, low solution, small field of view latency.

Past Present Future

TIMELINE FOR THE DEVELOPMENT OF ELECTRONIC GLASSES



1	2	3	4	5	6	7	8	9
LVES, Visionics	VMax, Enhanced Vision	Jordy 1, Enhanced Vision	Jordy 2, Enhanced Vision	eSight 1, eSight Corp	Jordy 3, Enhanced Vision	eSight 3, eSight Corp.	SightPlus, GiveVision	IrisVision, IrisVision Global



ELECTRONIC GLASSES FOR THE VISUALLY IMPAIRED

A literature study of the effect on vision (visual acuity), quality of life (QOL) and activities of daily living (ADL).

PURPOSE

- Kennedy Centers Eye Clinic for optical rehabilitation.
- Overview of the optical rehabilitation market.
- Could be an obvious rehabilitation aid for visually impaired:
  - Several magnification options
  - Great flexibility for both distance and close-up tasks
- Not much literature.
- My hypothesis is that the electronic glasses improve vision, but ADL and quality of life will probably depend on practicality and aesthetic appearance.

Focused question:

WHAT IS THE EFFECT ON VISUALLY IMPAIRED PEOPLE'S VISION, ACTIVITIES OF DAILY LIVING AND QUALITY OF LIFE WHEN USING ELECTRONIC GLASSES.

METHOD

Publications concerning adults and teenagers, published within the last 3 years.

Vision enhancement systems
LVES
LVA
EVES
E-LVA
HMD
Head-mounted
Head-mounted devices
Head-mounted display
Wearable electronic devices
Augmented reality
Smart glasses

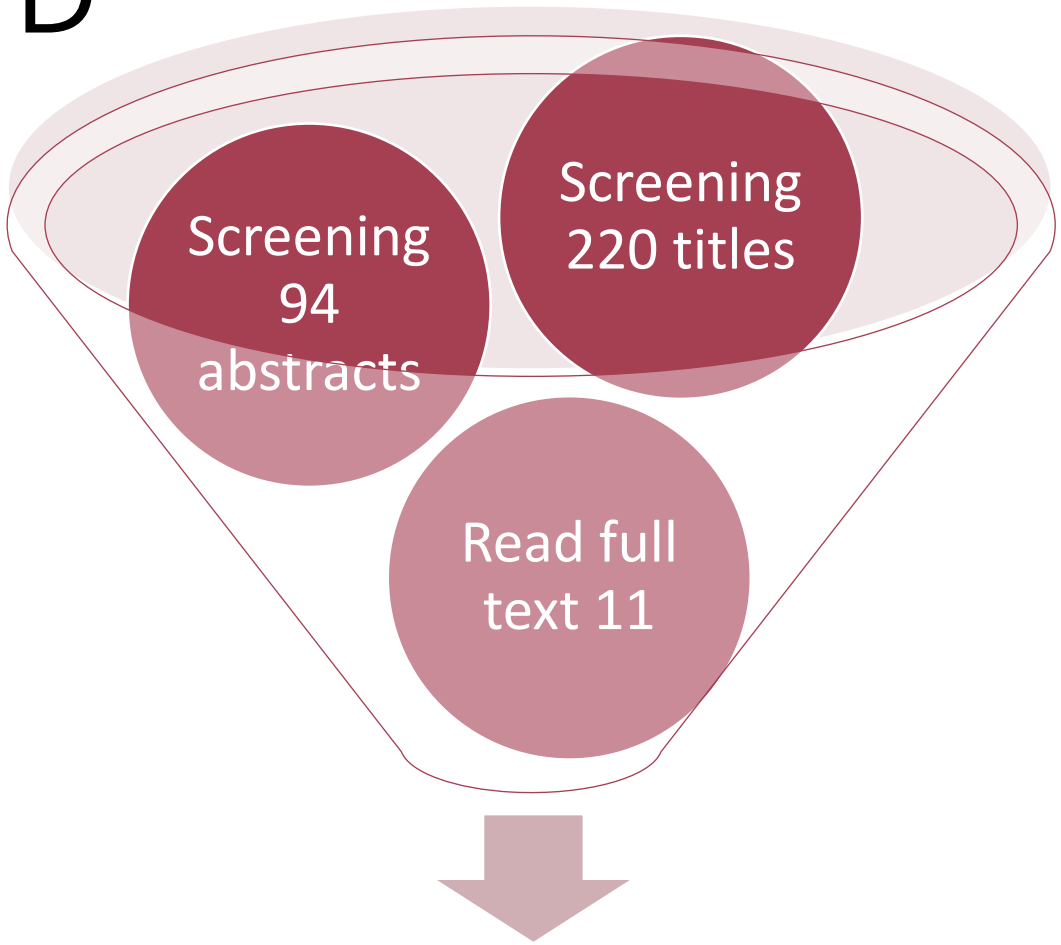
→

PubMed (n=57)
Cinahl (n=22)
Embase (n=62)
Scopus (n=126)
Web of science (n=46)

→

After removing duplicates: 220 studies

METHOD



The included were quality assessed using a structured summary of the checklists recommended by the National Institute for Health and Care Excellence.

4 studies included

Prospektivt observationelt study / Casestudy / Cross-sectional study / Multicenter prospektivt study

FINAL 4

Article	Electronic glasses
Wittich W, Lorenzini MC, Markowitz SN, Tolentino M, Gartner SA, Goldstein JE, et al. The Effect of a Head-mounted Low Vision Device on Visual Function. Optom Vis Sci. 2018;95(9):774–84	eSight
Crossland MD, Starke SD, Imielski P, Wolffsohn JS, Webster AR. Benefit of an electronic head-mounted low vision aid. Ophthalmic Physiol Opt. 2019;39(6):422–31	SightPlus 
Deemer AD, Swenor BK, Fujiwara K, Deremeik JT, Ross NC, Natale DM, et al. Preliminary evaluation of two digital image processing strategies for head-mounted magnification for low vision patients. Transl Vis Sci Technol. 2019;8(1)	Irisvision 
Lorenzini MC, Hämäläinen AM, Wittich W. Factors related to the use of a head-mounted display for individuals with low vision. Disabil Rehabil. 2019	eSight 

RESULTS

The studies show improvement in visual acuity, activities of daily living and quality of life, but also describe a lack of willingness to use electronic glasses, as they are impractical and aesthetically challenging.

DISCUSSION

Improvement of visual acuity

Worsening or no difference on reading speed

Improved facial recognition

Worsening og no difference on mobility

Improved activities of daily living

Improved quality of life

Unwillingness to wear the aid

The results correspond to what you would expect from conventional magnifying aids.

G. Virgili, R. Acosta, S. A. Bentley, G. Giacomelli, C. Allcock, and J. R. Evans, “Reading aids for adults with low vision,” *Cochrane Database of Systematic Reviews*, vol. 2018, no. 4. 2018, doi: 10.1002/14651858.CD003303.pub4.

R. C. Peterson, J. S. Wolffsohn, M. Rubinstein, and J. Lowe, “Benefits of electronic vision enhancement systems (EVES) for the visually impaired,” *Am. J. Ophthalmol.*, vol. 136, no. 6, pp. 1129–1135, 2003, doi: 10.1016/S0002-9394(03)00567-1.

J. S. Wolffsohn and R. C. Peterson, “A review of current knowledge on Electronic Vision Enhancement Systems for the visually impaired,” *Ophthalmic and Physiological Optics*, vol. 23, no. 1. pp. 35–42, 2003, doi: 10.1046/j.1475-1313.2003.00087.x.

DISCUSSION

Improvement of visual acuity

Worsening or no difference on reading speed

Improved facial recognition

Worsening og no difference on mobility

Improved activities of daily living

Improved quality of life

Unwillingness to wear the aid

Surprising, as several studies have shown that reading speed increases with the use of other electronic aids such as CCTV and electronic magnifiers.

Virgili G, Acosta R, Bentley SA, Giacomelli G, Allcock C, Evans JR. Reading aids for adults with low vision. Vol. 2018, Cochrane Database of Systematic Reviews. 2018.

Peterson RC, Wolffsohn JS, Rubinstein M, Lowe J. Benefits of electronic vision enhancement systems (EVES) for the visually impaired. Am J Ophthalmol. 2003;136(6):1129–35.

Wolffsohn JS, Peterson RC. A review of current knowledge on Electronic Vision Enhancement Systems for the visually impaired. Vol. 23, Ophthalmic and Physiological Optics. 2003. p. 35–42.

Bray N, Brand A, Taylor J, Hoare Z, Dickinson C, Edwards RT. Portable electronic vision enhancement systems in comparison with optical magnifiers for near vision activities: an economic evaluation alongside a randomized crossover trial. Acta Ophthalmol. 2017;95(5):e415–23.

DISCUSSION

Improvement of visual acuity

Worsening or no difference on reading speed

Improved facial recognition

Worsening og no difference on mobility

Improved activities of daily living

Improved quality of life

Unwillingness to wear the aid

One study concludes that the ability to see and distinguish facial expressions may be more important than the ability to see and identify people.

M. A. Bullimore, I. L. Bailey, and R. T. Wacker, “Face recognition in age-related maculopathy,” in *Investigative Ophthalmology and Visual Science*, 1991, vol. 32, no. 7, pp. 2020–2029.

DISCUSSION

Improvement of visual acuity

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Improved quality of life

Unwillingness to wear the aid

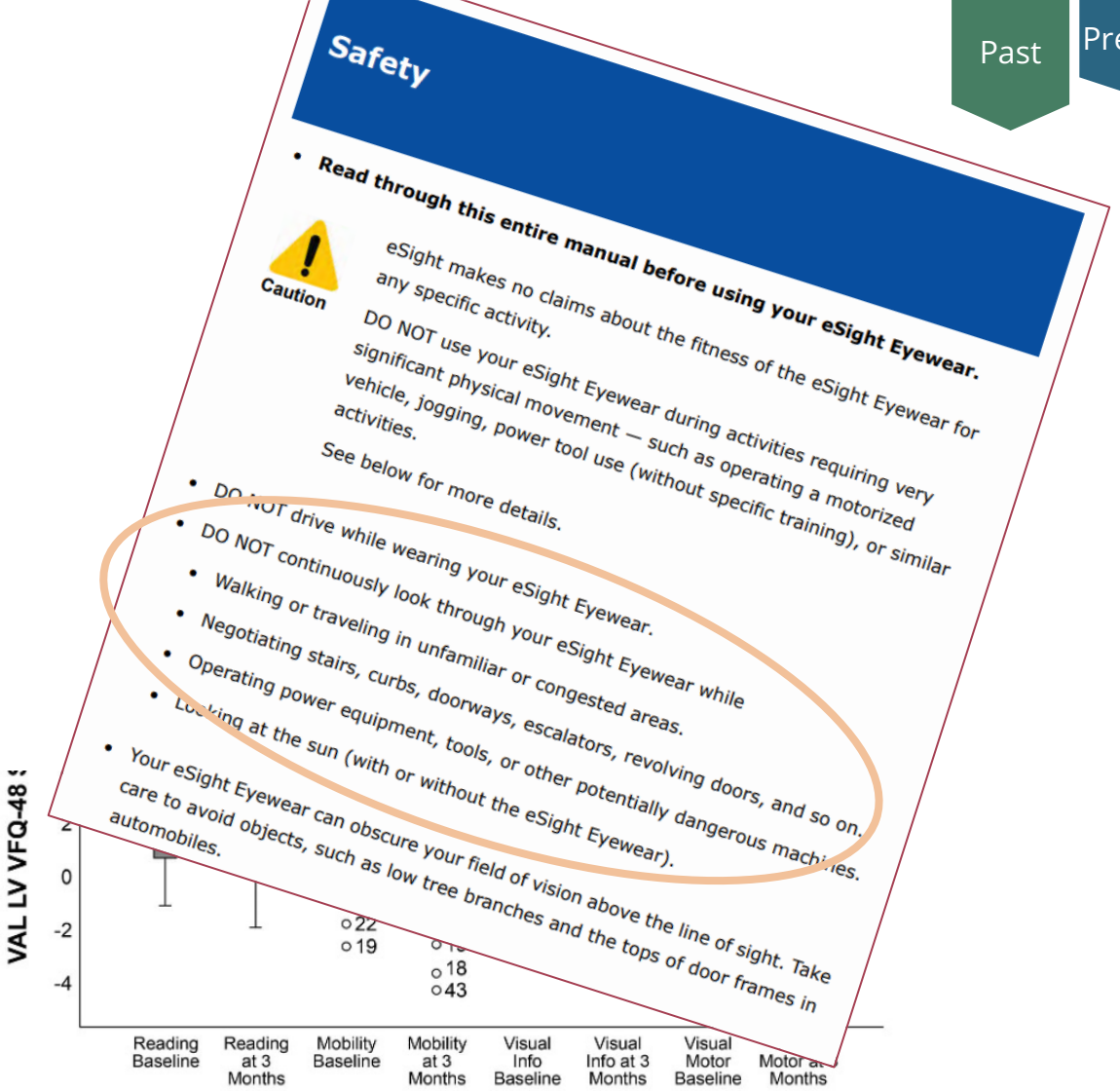

FIGURE 11. Results of four domains of the Veterans Affairs Low Vision Visual Functioning Questionnaire at baseline and after 3 months of device use. For the reading items, the mean baseline reading score without device was 1.75 logit units (SD, 1.43), which improved to 4.33 logits (SD, 2.68). For visual information items, the mean score without device was 1.21 logit units (SD, 0.91), which improved to 2.29 logits (SD, 1.19). The mean baseline visual motor score without device was 1.05 logit units (SD, 0.81), which improved to 1.42 logits (SD, 1.38) with the device after 3 months of device use and training. Scores on the mobility items did not demonstrate a significant change after 3 months. ID numbers of outliers correspond to participant IDs in Table 3. *Statistically significant differences.

DISCUSSION

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Worsening or no difference on reading speed

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Improved quality of life

Unwillingness to wear the aid

Lorenzini et al. concluded that ADL and QoL were predictors of whether participants willingness to use the aid.

Lorenzini et al. Finds that 82,5% were willing to use the aid.
But at Lorenzini et al. the participants already own the aid, which 80% of them have paid for on whole or in part.

Crossland et al. finds that 47% were willing to use the aid. These participants were tested in clinic (Moorefields Eye Hospital)

DISCUSSION

Improvement of visual acuity

Worsening or no difference on reading speed

Improved facial recognition

Worsening og no difference on mobility

Improved activities of daily living

Improved quality of life

Unwillingness to wear the aid

Embarrasment

Practical use

Discomfort

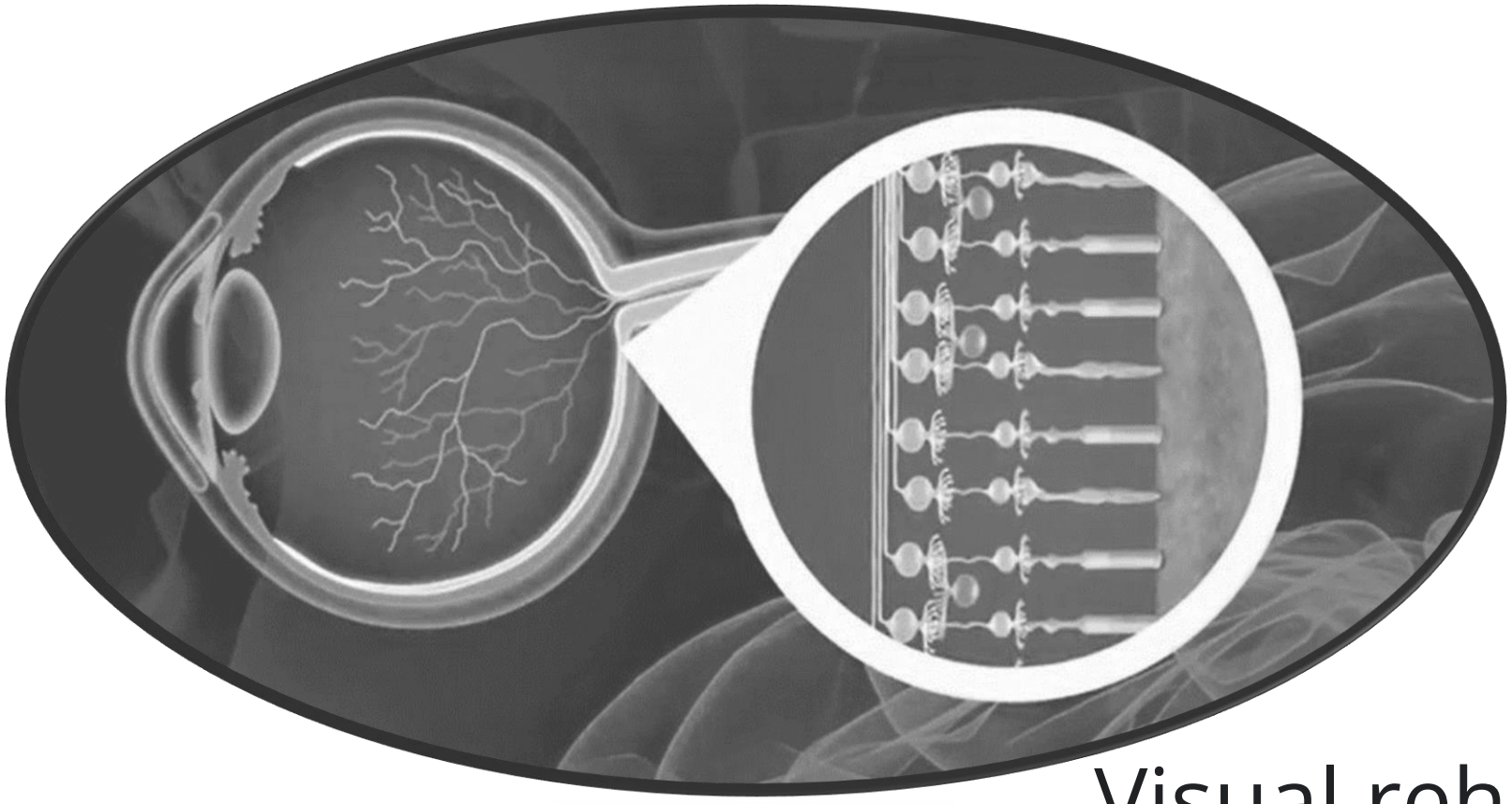
Battery life
Weight
Working distance

Dizziness
Double vision
Headache
Nausea
Tired eyes
Neck pain

CONCLUSION

The external validity is questionable. The included studies do not provide clear answers and are characterized by bias and weak methodology. The articles alone cannot create a basis for concluding on the task's focused questions or a basis for evidence-based rehabilitation

There a need for larger and better conducted studies before clear recommendations can be made in relation to the use of electronic glasses for the visually impaired



A prospektive pilot study

Visual rehabilitation potential of electronic glasses in people with Stargardt disease

– Preliminary results

The Eye Clinic Kennedy Center:

Line Kessel, Opthalmologist, Clinical Research Lecturer, Ph.d.
Joaquim Torner Jordana, Optometrist, MSc
Vibeke Spange, Optometrist
Christine Kjølholm, Optometrist

Institute for the Blind and Visually Impaired, IBOS:

Bo Schack Larsen, Information and Communication Technology Consultant
Pernille Duelund Højstrup, Occupational Therapist and Mobility Instructor

PURPOSE

Electronic glasses can be an obvious visual rehabilitation aid for the visually impaired.

Not much recent litterature about them.

This pilot project aims to:

Clarify how a group of patients with Stargardt disease evaluates electronic glasses.

Whether the electronic glasses honors the vision-enhancing effect as expected.

The effect of the electronic glasses will be assessed on the participants' subjective experiences with electronic glasses, by measurable performance and qualitative interviews.

These experiences will equip us better to be able to assess the effect of electronic glasses in relation to the cost, to be able to advise our colleagues in the same field and to pave the way for an extended study at a later date.

PURPOSE

Our hypotheses were that electronic glasses can do more than the current electronic and optical aids, that they can make everyday life easier for the participants and that they can replace several aids.

But we assume that there will be aesthetically and stigmatizing challenges in relation to wearing electronic glasses in public, that they may be impractical and that all electronic glasses can do roughly the same.

METHOD

Electronic glasses

Acesight

eSight 3

IrisVision

Jordy 2

Model / Specifikationer	AceSight	eSight3	IrisVision	Jordy2
Pris	34.500,- ex. Moms	59,500,- ex. Moms	29.500,- ex. Moms	19.988,- ex. Moms
Forstørrelse	15x	24x	12x	30 x (på 2 m afstand)
Autofokus	Ja (kan låses i indstillinger)	Ja	Ja	Ja
Opløsning Kamera	8 megapixel	21,5 megapixel	12 megapixel	720P (ca.1.3 mp)
Opløsning skærme	1920x1080	1024x768 OLED	2560x1440 OLED	1280×720
Kontrast	Fuldfarve Inverteret Sort/hvid Blå/hvid Sort/gul Grøn/sort		Sort/hvid Negativ Grøn Gul	Fuldfarve Sort/ hvid Hvid/sort Grøn/sort Gul/sort Gul/blå Sort/hvid
Find funktion Overblik i zoom	Ja	Ja	Nej	Ja
Navigere i "frossent billede"	Ja, med hovedbevægelser	Ja, med hovedbevægelser	Nej	Ja, dog kun centralt zoom
Justerbar lysstyrke	Ja	Ja	Ja	Ja
Fjernbetjening	Ja, med ledning	Ja, med ledning	Nej	Ja, med ledning
Batterilevetid	4 timer	6 timer	3,5 timer	8 timer
Mulighed for tilslutning af HDMI	Nej	Ja	Nej (streaming er snart en mulighed)	Ja
Vægt	360 g	113 g	907 g	723 g
Ekstra	Kan optegne konturer/ Outline Formindsket billede, kan anbringes hvor som helst i synsfeltet.	Tablet ved instruktion.	Læselineal Forstørrelses-bobbel	Blændings-værn Brilleglas-indsats HDMI kabel, 6 meter
Korrektion	Egen brille indenunder	Inderbrille (multilens)	Egen brille indenunder	Inderbrille (Essilor)
Indstilling af PD	Ja	Ja	Ja (kan indstilles i softwaren)	Nej
Tilbehør			Fjernbetjening kan tilkøbes	CCTV stand (11.200,- inkl moms)

IN SEPTEMBER 2022 ONLY JORDY 2 IS LEFT ON THE DANISH MARKET!

METHOD

Population and recruitment

- 12 patients with clinically and genetically verified Stargardt disease
- From the capital region
- Best-seeing eye with best correction between 6/18 to 3/60
- Peripheral field of vision of at least 30 degrees

Brøk (Meter)	Brøk (Fod)	ETDRS (bogstaver)	Decimal	Logmar
6/3	20/10	100	2,00	-0,3
6/3,75	20/12,2	95	1,60	-0,2
6/4,75	20/16	90	1,25	-0,1
6/6	20/20	85	1,00	0,0
6/7,5	20/25	80	0,80	0,1
6/9	20/30	75	0,67	0,2
6/12	20/40	70	0,50	0,3
6/15	20/50	65	0,40	0,4
6/18	**20/60**	**60**	**0,33**	**0,5**
6/24	**20/80**	**55**	**0,25**	**0,6**
6/30	**20/100**	**50**	**0,20**	**0,7**
6/38	**20/125**	**45**	**0,16**	**0,8**
6/48	**20/160**	**40**	**0,125**	**0,9**
6/60	**20/200**	**35**	**0,10**	**1,0**
6/75	**20/250**	**30**	**0,08**	**1,1**
6/95	**20/320**	**25**	**0,063**	**1,2**
6/120	**20/400**	**20**	**0,05**	**1,3**
6/150	20/500	15	0,04	1,4
6/190	20/630	10	0,032	1,5
6/240	20/800	5	0,025	1,6
6/300	20/1000		0,020	1,7
6/380	20/1250		0,016	1,8
6/480	20/1600		0,013	1,9
6/600	20/2000		0,01	2,0

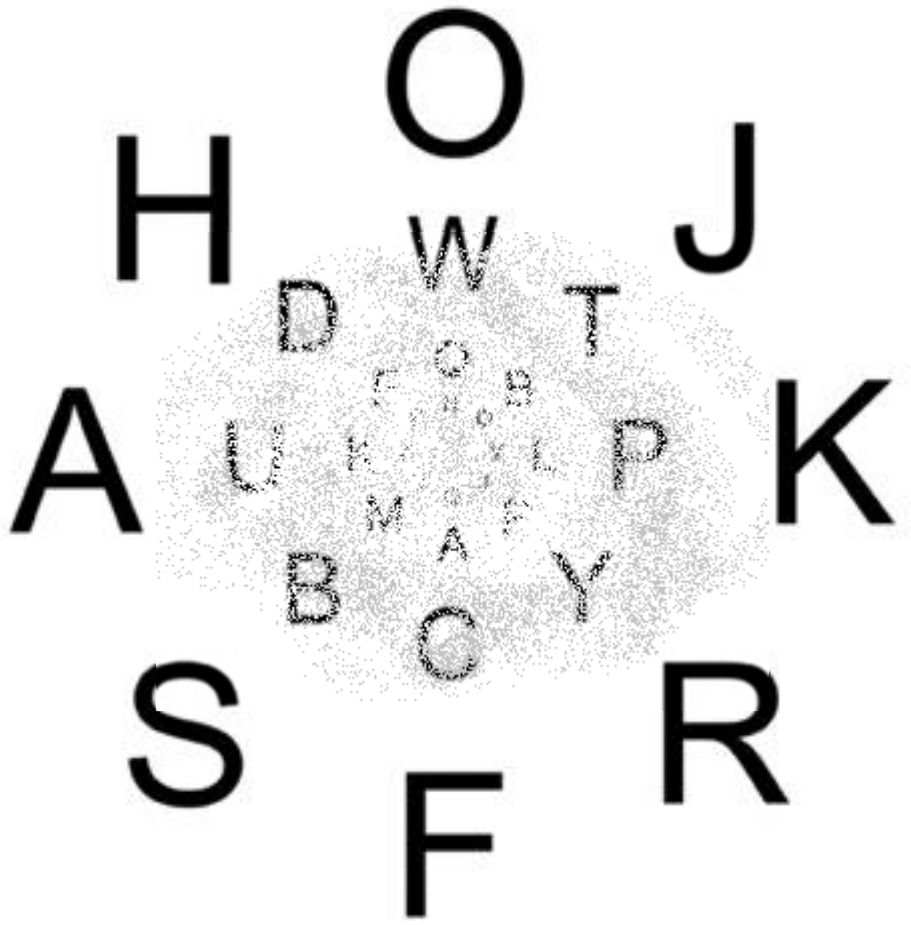
WHO definition of low vision	
Mild	<6/12 to 6/18
Moderate	**<6/18 to 6/60**
Severe	**<6/60 to 3/60**
Blindness	<3/60

				Distance				Near			
Participant	Sex	Age (years)	Occupation	Visual acuity distance (ETDRS number of letters)	Eccentric viewing	Distance low vision aids	Contrast sensitivity distance (Pelli Robson, LogCS)	Visual acuity near (Colenbrander high, number of letters)	Contrast sensitivity (Colenbrander low, number of letters)	Near low vision aids	Other aids
P1	F	16	Student	41	Yes	Binocular telescope	1,20	95	87	High-plus spectacles, built-in magnification on PC, Ipad og smartphone	
P2	F	50	Self employed	39	N/A	Binocular telescope	1,65	97	80	High-plus spectacles, hand-held magnifier, built-in magnification on PC.	
P3	M	37	Employed	58	No	Monocular telescope	0,90	100	70	High-plus spectacles, built-in magnification on PC and smartphone.	
P4	F	30	Employed	45	Yes	Binocular telescope	1,65	83	78	Hand-held magnifier, dome magnifier, built-in magnification on PC and Ipad.	White cane, reading lamp
P5	M	46	Employed	41	Yes	Monocular and Binocular telescope	1,80	88	86	High-plus spectacles, hand-held magnifier	
P6	F	51	Employed	26	Yes	Binocular telescope	0,75	84	47	High-plus spectacles hand-held magnifier, CCTV, Zoomtext	White cane, home care
P7	M	53	Employed	41	Yes		1,50	72	69	High-plus spectacles hand-held magnifier, built-in magnification on smartphone.	
P8	M	22	Student	39	Yes	Monocular telescope	1,35	96	89	High-plus spectacles hand-held magnifier, mini CCTV, Zoomtext, built-in magnification on smartphone.	Nota*
P9	M	43	Employed	45	Yes	Binocular telescope, head-mounted telescope	1,35	85	75	High-plus spectacles dome magnifier, built-in magnification on PC and smartphone.	
P 10	F	28	Employed	35	Yes	Monocular telescope	1,00	84	63	Hand-held magnifier	
P 11	F	28	Unemployed	23	No		1,05	70	60	CCTV	
P 12	M	27	Employed	24	No		0,75	72	56	Built-in magnification on PC	Flashlight, headlamp

METHOD

Population and recruitment

STARGARDT DISEASE



METHOD

Overview of the phases of the project

Phase 1:	Phase 2:	Phase 3:	Phase 4:	Phase 5:	Phase 6:	Phase 7:	Phase 8
Performed with all 4 electronic glasses		Repeated with the 2 preferred electronic glasses					Performed with the final preferred electronic glasses
Clinical results	Immediate product experience	COPM-interview	Instruction in use for everyday activities	Home-loans	Servicecalls	Re-COPM + additional questions	Closing interviews
Performed at The Eye Clinic Kennedy Center		Performed at IBOS		Performed at home	By telephone		

DROP-OUT

Phase 1:	Phase 2:	Phase 3:	Phase 4:	Phase 5:	Phase 6:	Phase 7:	Phase 8
12 participants completed		6 participants completed					

2 because they can't see themselves using the glasses
2 due to busyness/lack of motivation
1 due to dizziness and discomfort
1 due to double vision and difficulty using his eccentric viewing

Please no photos during the presentation of the results since we haven’t published them.

Thank you!

WEAKNESS AND BIAS

Participants are screened for high motivation – selection bias

Trust relationship to the researcher – motivational bias

Support and training can increase compliance and effectiveness of the device. *

Few participants – no statistics or general recommendations

High dropout 50%

We don’t know how the effect would be in other eye diseases.

* K. K, E. A, A. C, C. G, G. E, S. T-K. Reading training in dry AMD improves reading ability and prevents secondary depression. Investig Ophthalmol Vis Sci [Internet]. 2016;57(12):5168. Available from:

http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L616039274
Sasso P, Silvestri V, Sulfaro M, Scupola A, Fasciani R, Amore F. Perceptual learning in patients with Stargardt disease. Can J Ophthalmol. 2019;54(6):708–16.

Kaltenegger K, Kuester S, Altpeter-Ott E, Eschweiler GW, Cordey A, Ivanov I V., et al. Effects of home reading training on reading and quality of life in AMD—a randomized and controlled study. Graefe’s Arch Clin Exp Ophthalmol. 2019;257(7):1499–512.

THE FUTURE IS BRIGHT…

SEE FAR

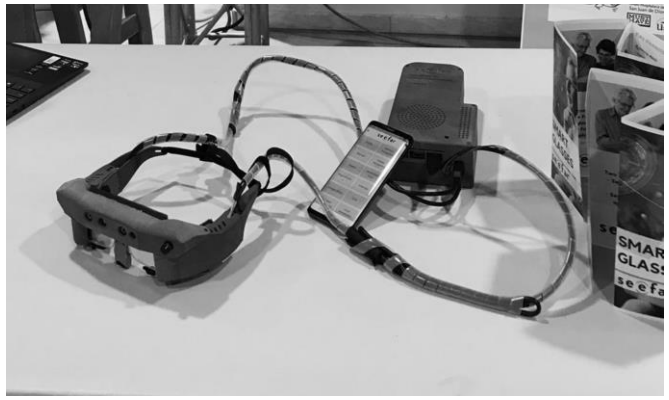
An EU project with danish participation from Aarhus University Hospital (AUH) and Aarhus University (AU)

- www.see-far.eu

Hardware:
Development of smartglasses as a visual aid.

The smartglasses consist of: a camera, screens and sensors to register how your head moves

Software:
Development of AI technology that will be able to analyse images of the retina captured by a cellphone camera at home and be able to discover and follow your eye disease.



AL-EYE

DTU based multidisciplinary team developing software for future smart glasses and multiple platforms. Using Eye tracking, Machine learning and AI technology to tailor the software for the individual need and make ongoing analysis to predict optimal settings.

Furthermore they acknowledge the importance of perception to avoid cognitive load and unnecessary distractions.

The project is carried out in collaboration with Rigshospitalet Glostrup, Kennedy Center, IBOS, a user advisory board and several advisors from the industry.

BUT WHAT ABOUT…

GDPR: Should it only be streamed in real time? A high noise when a picture is taken? A badge that states this is a necessity?

Social interactions: Eye contact? Pass through video? Insecurity amo others?

Price: Will it change from special equipment to consumer products?

Grants: How to get grants from the municipalities? Who should be considered?

Testing: How will the professionals stay updated, how should we test these?

Branding and social media: Commercials/information in the headset? Social media fake stories ”blind sees again”.

Security: Mobility, Traffic, policework, identification (§134 b)

THE FUTURE IS BRIGHT...

Thanks to the rapid development in technology, projects like Seefar Al-eye and many others are now possible and within reach.

We have much more portable proccesing power now than before, which means less lack and delay and fewer cables.

Thanks to the gaming industry we have cross platform solutions, fast development in XR technology and lighter and more comfortable hardware.

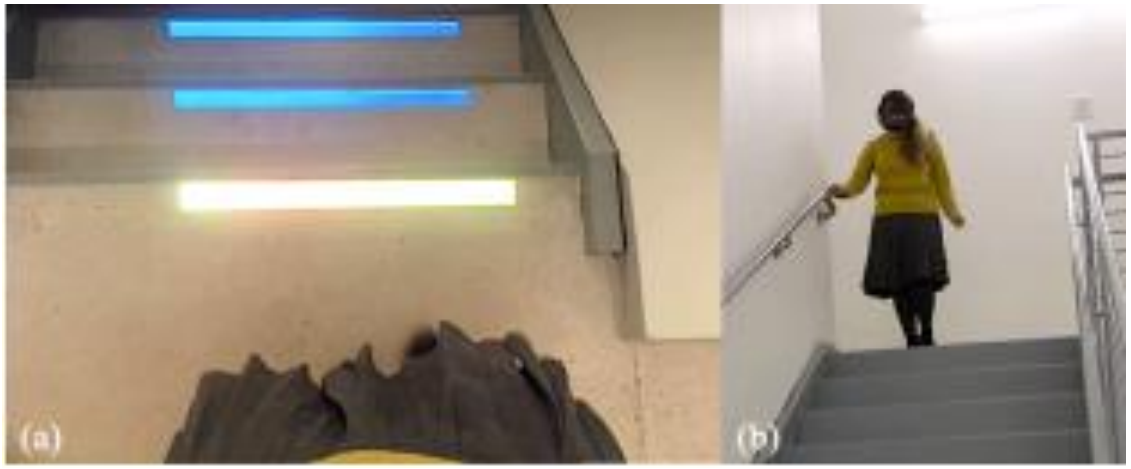
THE FUTURE IS BRIGHT…

XR is an umbrella phrase for next-level digital content.

XR = Extended reality or cross reality
AR = Augmented reality
VR = Virtual reality
MR = Mixed or Merged reality

THE FUTURE IS BRIGHT…

Project from New York designing AR visualizations to facilitate stair navigation for people with low vision



Yuhang Zhao et al (2019): Designing AR Visualizations to Facilitate Stair Navigation for People with Low Vision. DOI: https://doi.org/10.1145/3332165.3347906

THE FUTURE IS BRIGHT…

Smartphones as assistive technology

- Build in accessibility
- More than 67 low vison apps on the android platform (In the US)
- More than 50 low vision apps on the apple iTunes store (In the US)

Envision Glasses combines Google Glasses with an app

WE BELIEVE....

We are seeing a tendency that the development in entertainment technology also becomes useful in medical technology (MedTech) and can help improve the everyday life of people with low vision.

Smart glasses will very soon have more focus on comfort and aesthetics. There are plenty of rumors online that big companies like Apple, Samsung and Meta are developing smart glasses for the consumer market and hopefully the competition will keep the prices low.

Past Present Future

IMAGINE IF YOUR SMARTGLASSES COULD…

- Help you read books, magazines, signs.
- Recognize people or find objects in your surroundings.
- Help you detect obstacles in mobility.
- Assist you with navigation when you are in a new environment.
- Help you monitor your eye disease and other health related issues.
- Gamify exercises, such as training eccentric viewing or visual scanning techniques in a safe environment.

Would you use them???

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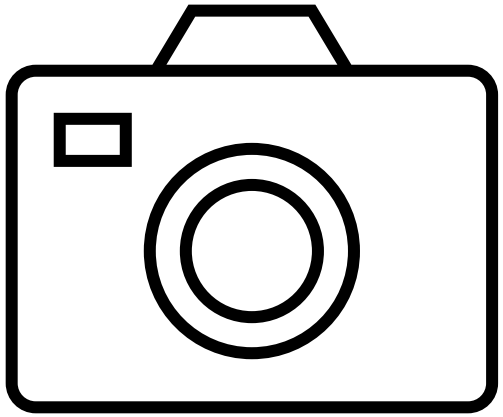

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