

BACKGROUND

- Head-mounted displays (HMD) have been used for vision enhancement for more than 25 years (1)
- Microelectronic technology provides feature-rich commercial HMD
- HMD provides magnification and/or contrast enhancement (2)
- HMD benefits individuals with visual impairment (VI) (2,3,4)
- Our purpose is to explore the role of HMD in adults with chronic eye disease and VI, perceptions of HMD, and preference for commercial HMD devices

METHODS

- Participants included self-identified VI with a diagnosis of age-related macular degeneration (AMD), diabetic retinopathy (DR), glaucoma (GL), or retinitis pigmentosa (RP)
- Participants completed the Impact of Vision Impairment (IVI) questionnaire
- Participants were taught to use three HMDs: eSight, NuEyes and Epson Moverio
- All HMDs had video, video processing and display
- Semi-structured usability interviews were recorded and transcribed
- Interview data was analyzed with inductive thematic approach in MAXQDA 2018



eSight Model 3 (<https://www.esighteyewear.com>).



NuEyes Pro (<https://nueyes.com/>). The NuEyes ODG headset is no longer available and the platform has changed.



Epson Moverio BT-200 (<https://epson.com/moverio-augmented-reality>).

RESULTS

Table 1: Demographics

Participants	
Age (years)	
median (range)	61 (30-81)
Gender n (%)	
Female	9 (50%)
Visual Acuity ¹	
median (range)	20/40 (20/20-20/150)
Visual Field	
GVF III4e (degrees) ²	11.5 (5-37)
HVF MD (decibels) ³	-18.35 (-27.77- -9.72)

1) Best corrected visual acuity. 2) RP subjects only, widest radius w/ III4e Goldmann visual field. 3) GL subjects only, highest mean deviation Humphrey visual field

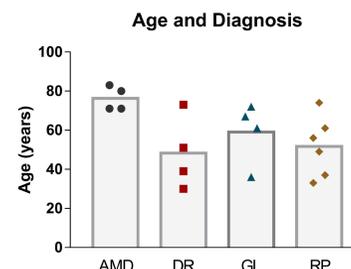


Figure 1: Participants age with ocular diagnosis

Overall HMD Preference

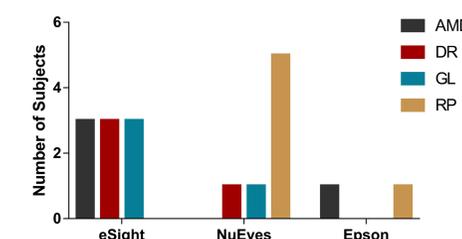


Figure 2: Participants overall HMD preference stratified by diagnosis

Table 2: Joint display linking self-reported well-being with participant preference for HMD

IVI Well-Being	Dx	Age	Sex	BCVA	Type of VI	Preference	Quotes	Meta-Inferences
-1.81	GL	36	F	20/80	mixed	eSight	"It was really great to be able to zoom in as much as I needed. It (eSight) made it really easy to look at things far away. It made my whole picture sight clearer. " -G0003 F, 36	Participants with the lowest self-reported well-being prefer eSight. Most have central or mixed vision loss. Clarity, usability and vision improvement were most cited as reasons for preference.
-1.23	AMD	71	F	20/30	central	eSight	" I could actually see the controls... having to make the adjustments wouldn't be as difficult with the other glasses." -A0004 F, 71	
-0.53	GL	61	F	20/30	mixed	eSight	"I felt like... it (eSight) was me seeing it, not me seeing it through a virtual tour " -D0001 F, 30	
-0.37	GL	72	M	20/20	peripheral	eSight	"You could turn it (eSight) on and use it almost immediately. Ease of use, speed of use. Better features, and it made things very easy to read, very quickly." -D0003 M, 51	
-0.22	DR	30	F	20/50	central	eSight	"You could turn it (eSight) on and use it almost immediately. Ease of use, speed of use. Better features, and it made things very easy to read, very quickly." -D0003 M, 51	Participants with self-reported well-being scores in the middle preferred NuEyes. Most have peripheral or mixed vision loss. Appearance, wireless, and magnification were most cited as reasons for preference
-0.22	RP	61	F	20/40	peripheral	NuEyes	"I loved the... clarity of my vision was the best of the three with the NuEyes. The look of it is more like just a regular pair of glasses I think more than any of the others. It's not as wide... I love that it's a cordless device to control it." -RP0007 F, 61	
-0.04	AMD	83	M	20/50	central	Epson	"The NuEyes, just because it was comfortable and looks more normal, for the magnification. It doesn't magnify as much as eSight, but it was enough magnification that I would be comfortable with that." -RP0005 F, 37	
0.15	AMD	71	F	20/40	mixed	eSight	"The NuEyes because they look closer to something that you will see in society. Second, they're wireless, so I will probably choose NuEyes over the three." -D0002 M, 39	
0.17	RP	49	M	20/40	peripheral	NuEyes	"I like the NuEyes the best because it was a single self-contained unit, the controls were the simplest and most intuitive, and the magnification." -RP0010 M, 56	Those with the highest self-reported well-being tended to have peripheral vision loss and no clear preference for one HMD. Usability was most cited as a reason for preference.
0.35	RP	37	F	20/80	mixed	NuEyes	"I suppose the Epson, probably. It didn't hurt me and there was some help with it, especially with the peripheral vision. " -RP0006 F, 74	
0.69	DR	39	M	20/150	mixed	NuEyes	"The eSight. I liked how you could control it... there was no little screen, you could just see. It was like your regular sight. " -D0004 F, 73	
0.69	RP	33	M	20/40	peripheral	NuEyes	"I prefer the NuEyes... I could see to the side and that is especially important from safety standpoint... you don't get as much magnification as the eSight but I feel it's a happy medium." -G0004 M, 67	
0.93	RP	56	M	20/40	peripheral	NuEyes		
0.93	RP	74	F	20/40	peripheral	Epson		
0.99	AMD	80	M	20/70	central	eSight		
1.11	GL	67	M	20/40	peripheral	NuEyes		
1.84	DR	73	F	20/40	peripheral	eSight		

IVI: Impact of Vision Impairment Questionnaire, BCVA: best corrected visual acuity

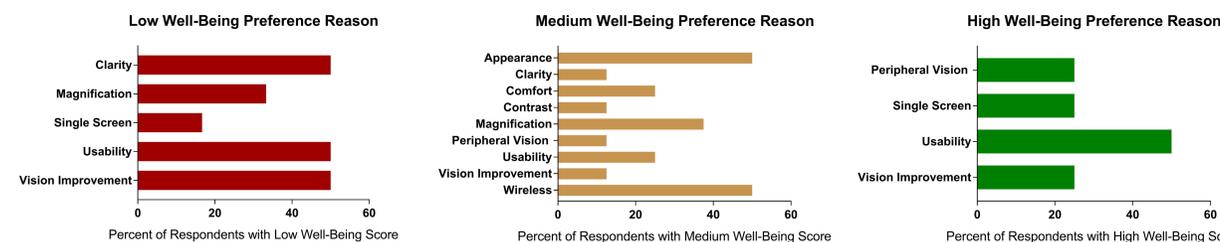


Figure 3: Reasons for HMD Preference by Low, Medium and High IVI Well-Being Domain Score

Reasons for HMD Preference

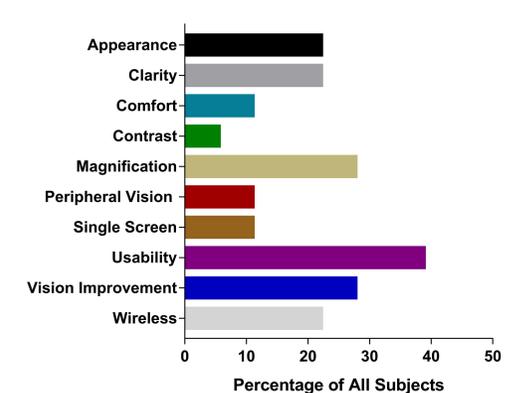


Figure 4: Reasons participants stated for their HMD preference

CONCLUSION / DISCUSSION

- Individuals with different types of vision loss (e.g. central and peripheral) and levels of vision-related quality of life may have different HMD preferences
- Participants with low self-reported well-being preferred eSight for the clarity, usability and vision improvement it provided. Those with slightly higher self-reported well-being primarily preferred NuEyes for its appearance, wireless design, and magnification provided. Participants who scored highest in well-being were most concerned with usability and didn't have one clear preference for HMD
- Though the majority of participants noted they had difficulty in certain mobility scenarios, zero participants could imagine using current HMD to walk or navigate
- Qualitative interviewing was beneficial for identifying features participants found challenging or useful in usability testing
- Results from this study can inform the design of HMD tailored to the visual needs and usability concerns of individuals with VI

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