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Design of Smart Head-Mounted Display Technology: A convergent mixed methods study

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BACKGROUND

• In 2015, 3.9 million US adults 245 years old had visual impairment (VI) and the annual cost of providing vision-related care to this population was $14.5 billion.1,2 By 2025, the prevalence of blindness and VI is expected to double, and the annual cost may increase to $37.5 billion.2

• Head-mounted displays (HMDs) are image processing systems originally developed for military use more than 25 years ago.3 HMD include 3 main elements: a scene camera, microelectronics to manipulate the video and microdisplays in front of the eye.

• While commercially available HMDs have recently been developed to assist those with low vision, there exists a notable gap in understanding both the range of functional impairments best addressed with HMDs, and the factors impacting preference among low vision users.5

• Understanding these factors will allow for future development of HMDs best suited to assist individuals with low vision, as well as decrease device abandonment.

RESULTS

The purpose of this study was to explore the factors impacting preference for head-mounted display (HMD) technology among individuals with visual impairment. Our hope is this information will be used to further refine HMD design to better assist those with low vision.

METHODS

Participants with a wide range of visual impairments and diagnosis of either: age-related macular degeneration, diabetic retinopathy, glaucoma, or retinitis pigmentosa were recruited from the Kellogg Eye Center (KEL) or Western Michigan University.

General Inclusion Criteria:
• Age ≥18 years and self reported visual impairment

General Exclusion Criteria:
• Diagnosis of cognitive impairment, need for interpreter, or physical disability precluding mobility

Study Visits Involved the Following:
• Impact of Visual Impairment Questionnaire (IVI)
• Study team members taught each participant to use three difference types of HMD. Participants were instructed in using HMDs to look at objects near & far, and to read text.
• Afterwards participants completed a semi-structured interview Interviews were audio recorded, transcribed, and coded by two independent coders. Thematic analysis was conducted using the software MAXQDA 2018.

Figure 1. Head Mounted Displays tested in this study. 1A: eSight Model 3; 1B: NuEyes Pro, 1C: Epson Moverio BT-200

Table 1. Joint display linking vision-related well-being with participant preference for HMD

<table>
<thead>
<tr>
<th>IVI Well Being</th>
<th>Dx</th>
<th>Age</th>
<th>Sex</th>
<th>BCVA</th>
<th>Type of VI</th>
<th>Preference</th>
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<td>36</td>
<td>F</td>
<td>20/80</td>
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<td>M</td>
<td>20/30</td>
<td>central</td>
<td>eSight</td>
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<td>61</td>
<td>F</td>
<td>20/30</td>
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<tr>
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<tr>
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<tr>
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<td>NuEyes</td>
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CONCLUSIONS

• 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.

• Participants with self-reported well-being in the middle tended to prefer NuEyes. Most have peripheral or mixed vision loss. Appearance, wireless capability, and magnification were most cited as reasons for preference.

• 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.

• While majority of participants reported difficulties with mobility, none of them could envision using the HMDs tested to walk or navigate and many cited safety concerns using HMDs in public, future HMD designs should address this disparity.

ACKNOWLEDGEMENTS

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REFERENCES


