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# 4 methods to assess Alzheimer's with eye tracking

## RESOURCE DETAILS

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A wealth of research demonstrates that eye tracking is a promising tool for supporting early Alzheimer's disease (AD) assessment. Eye movements and cognitive alterations occur at early disease stages and can be gauged through simple, time-efficient eye tracking tasks. This article will present four ways eye tracking could aid early Alzheimer's assessment.

## Eye tracking – an addition to Alzheimer's disease assessment toolkit

Alzheimer's disease (AD) is a progressive neurodegenerative disorder, accounting for up to 70% of all dementia cases ([World Alzheimer Report, 2022 ↗](#)). It is characterized by gradual impairment of memory, thought process, perception, and language. Initially, AD is mostly asymptomatic and begins many years before the onset of clinical symptoms. For instance, individuals with mild cognitive impairment are more likely to progress to AD, with an annual conversion rate of around 15% (Liu et al., 2013).

Currently, there is no cure for AD, but an early diagnosis could improve disease management and slow disease progression to dementia. According to World Alzheimer's Report, 75% of people with dementia are undiagnosed. Existing biomarkers for early AD detection are invasive (e.g., lumbar puncture), costly (e.g., neuroimaging), or lengthy (e.g., neuropsychological cognitive test), making timely screening inaccessible for many affected individuals.

Eye tracking is an accurate, nonintrusive, and cost-effective technology with the potential for volume AD screening (Readman et al., 2021). Eye movement measurements offer language- and culture-independent assessment of [cognitive and oculomotor functions](#). This poses an advantage compared to neuropsychological tests because language and self-expressing abilities can be significantly diminished in AD. Since AD is commonly accompanied by a broad spectrum of oculomotor and viewing behavior alterations (Molitor et al., 2015), specific eye movements and viewing patterns could serve as biomarkers in early AD stages.

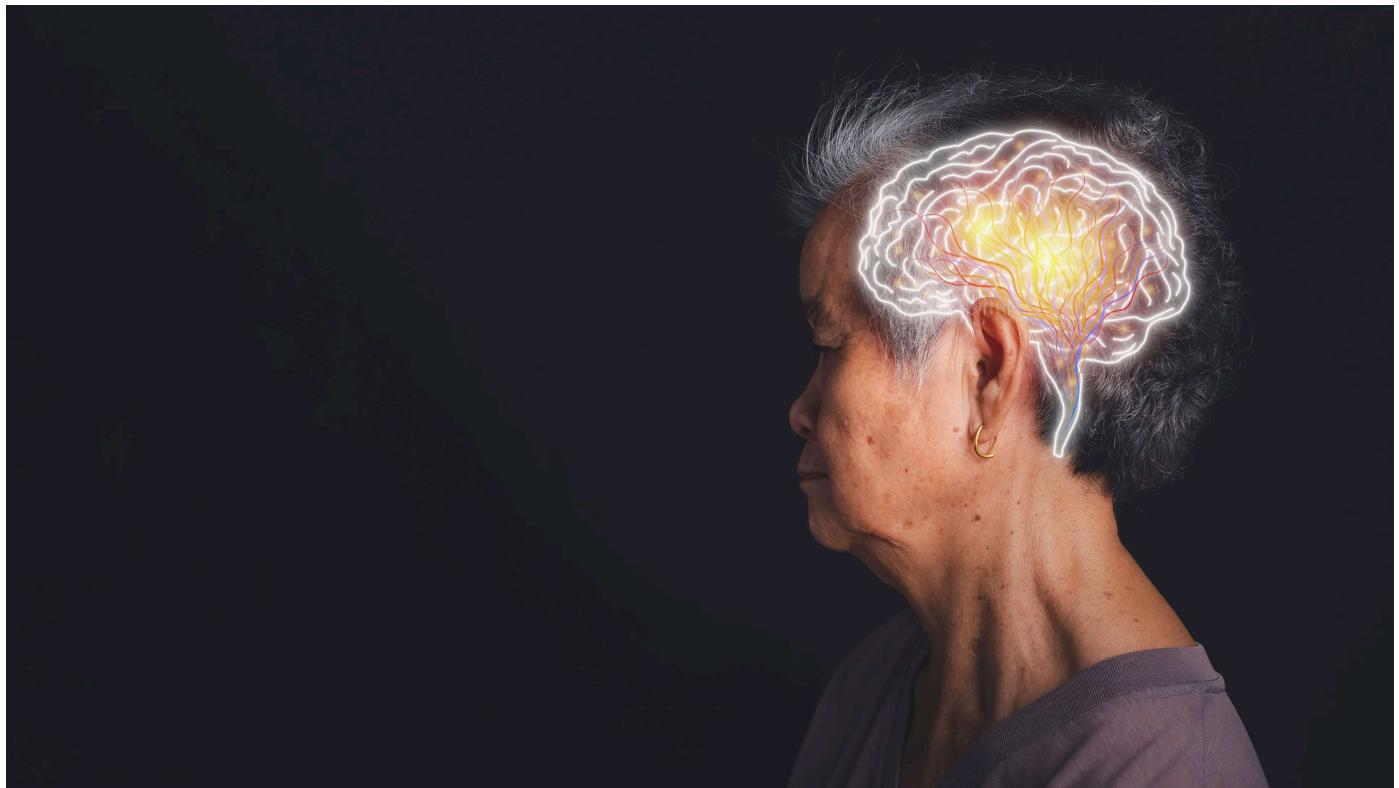
## 4 methods by which eye tracking could aid early Alzheimer's assessment

### Fundamental eye movement assessment

Alzheimer's disease (AD) alters the connectivity between cortical and subcortical brain regions that control eye movements (Armstrong, 2009). Research reports AD-related changes in saccades, fixations, smooth pursuit, and microsaccades (Molitor et al., 2015). The status of the basic [eye movements](#) can be assessed by

implementing simple eye movement tasks. Pavisic and colleagues (Pavisic et al., 2017) elegantly demonstrated that by assessing fixation stability (focus on a dot for 10s), smooth pursuit (follow a moving target), and pro-saccade (looking at the target as it appears) they could classify individuals with AD from healthy peers with 95% accuracy. Individuals with AD show more intrusive saccades and shorter fixation duration in the fixation stability task compared to healthy peers. They follow a moving target for a shorter time and make more interruptive saccades during the smooth pursuit. AD patients are less accurate in the pro-saccade task and take longer to fixate on the target (Pavisic et al., 2017).

Another short and simple fixation task is pupil calibration, in which a participant fixates on a static target for 10 seconds (Jang et al., 2021). The task allows capturing square-wave jerks – involuntary eye movements interrupting fixations and is commonly observed in AD (Nakamagoe et al., 2019). The pupil calibration task has the potential for high-volume AD screening, as it takes only 10 seconds and yields significant results when comparing healthy individuals to those with AD (Jang et al., 2021). During an attempted fixation, microsaccade behavior could help differentiate individuals with mild cognitive impairment from healthy peers, as the former group exhibits more oblique microsaccades (Kapoula et al., 2014).



The connectivity between cortical and subcortical brain regions that control eye movements are altered in Alzheimer's disease.

## Executive function assessment – antisaccade task

Inhibitory dysfunction is one of the first non-memory domains to be affected in Alzheimer's disease (AD) (Wilcockson et al., 2019). In an antisaccade task, a participant has to inhibit a saccade toward the target and make a saccade in the opposite direction. The number of inhibition errors made in this task is significantly higher in individuals with AD and is predictive of AD severity (Opwonya et al., 2022). Healthy individuals typically make antisaccade errors in 20% of trials, while individuals with AD between 50-80% (Garbutt et al., 2008). More antisaccade errors can already be detected in early AD (Kaufman et al., 2012) and even when only mild cognitive impairment starts to show (Chehrehnegar et al., 2022). The antisaccade task reports consistent results in the AD population, making it a strong candidate for assessing executive functions in aging individuals.

## Advanced viewing behavior assessment

Along with changes in basic eye movements, individuals with Alzheimer's disease (AD) experience difficulties in advanced visual perception scenarios, such as visual search and scene exploration (Molitor et al., 2015). Difficulties in performing these tasks are associated with short-term and working memory deficiencies, which are already evident in preclinical AD stages.

Visual paired comparison task is a recognition memory task in which participants are scored on the proportion of time spent viewing a novel versus previously seen pictures. Individuals with AD and mild cognitive impairment show poor novelty recognition (Crutcher et al., 2009; Nie et al., 2020; Zola et al., 2013). The scores in this eye tracking task can reliably predict further cognitive decline in a 1-year follow-up (Nie et al., 2020) and the conversion from mild cognitive impairment to AD up to three years before the clinical diagnosis (Zola et al., 2013).

Visual search is a goal-directed search behavior aimed at finding a target among distractors. Individuals with AD showed longer response times in visual search tasks, and their search patterns are more disorganized and stochastic than controls (Barral et al., 2020; Pereira et al., 2020). Individuals with AD have

increased difficulties detecting salient objects in a visual scene; they take longer to shift attention from central to peripheral regions of the visual scene (Pereira et al., 2020).

Try out our [demo of a visual search task ↗](#) with a [free version of our eye tracking software Tobii Pro Lab.](#)



Individuals with Alzheimer's take longer to find a target in a visual search task, their search patterns are more disorganized, and they have difficulties detecting salient objects.

## Reading assessment

Reading requires integrating several cognitive systems, such as attention, word perception, and comprehension. Changes in reading behavior are observed in early Alzheimer's disease (AD) stages, and research shows it is possible to capture these changes with an eye tracker during a reading task (Fernández et al., 2015). Individuals in an early AD stage read fewer words per fixation and show an increase in total number and duration of fixations compared to healthy peers (Fernández et al., 2016). Moreover, AD patients take more time to read a text, are

more likely to re-read the text, and are less likely to skip uninformative parts of a text, again compared to healthy peers (MacAskill and Anderson, 2016).

Reading tests (e.g., the King-Devick test) can detect individuals with mild cognitive impairments before they develop any apparent clinical symptoms, primarily based on saccade amplitude and duration during the reading task (Hannonen et al., 2022). The mild cognitive impairment group shows shorter saccade duration and amplitude compared to healthy controls. Eye movement characteristics collected during a reading task can classify individuals with AD with 89.8% accuracy (Biondi et al., 2018).

An example of a typical eye movement pattern during reading. Individuals with Alzheimer's show changes in regular reading patterns.

## Conclusion

Increasing research-based evidence shows that people in early Alzheimer's stages display measurable alterations in basic eye movements and cognitive functions. In this article, we have highlighted a few simple and quick eye tracking tasks which could aid the early Alzheimer's screening process. Overall, eye tracking could serve as a noninvasive dementia risk assessment tool for volume screening in primary care centers. With further development and research, eye movement metrics may

become reliable biomarkers for AD that could complement other neuropsychological and physiological measurements.

***Additional note on the importance of remote eye tracking in assessing the elderly population:***

Assessing elderly populations requires comfortable settings, preferably without head fixation, as they often suffer from tremors or degenerative cervical spine changes. The eye tracker should be easy and fast to calibrate and robustly track eye movements without a chinrest. Researchers report a positive experience with plug-and-play eye trackers when testing elderly patients (Barral et al., 2020; Jang et al., 2021). In one such study, participants filled out a post-assessment survey about their experience with the assessment. They evaluated the ease of use, acceptability, and attitude toward eye tracking. Most participants perceived remote eye tracking assessment positively: 93% felt comfortable, and 91% felt relaxed during the evaluation. Additionally, 96% of the participants reported being willing to repeat the assessment in the future, and 93% were willing to repeat the assessment monthly (Barral et al., 2020).

Tobii offers several nonintrusive [eye tracking solutions](#) designed to capture high-quality eye tracking data while allowing for natural head movements. For more information, check out our free guide on [how to choose an eye tracker](#).

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