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Interactive Web Application for Reaction Time Measurement of Humans

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Abstract
Precise measurement of human reaction time (RT) and cognitive function is critical for both neuroscience research and early detection of neurological disorders. Modern digital approaches – especially web-based self-tests – offer a scalable way to assess these functions outside the clinic. Recent work has shown that brief, browser-based cognitive assessments can be feasible and well-accepted by users. Building on this trend, we developed a lightweight, web-native application (using HTML, CSS, and JavaScript) to evaluate multiple aspects of cognitive and motor response. The app includes five interactive modules (color recognition, a neurocognitive/attention test, an animal-sound auditory response test, a multi-test reaction suite, and a Parkinson's-related motor control test) that together probe various perceptual and decision-making abilities. Each task is designed to emphasize different skills (for example, visual processing speed or fine motor control) while using high-precision timing. We use the browser's high-resolution performance API to timestamp user actions with millisecond accuracy, which is important because device and hardware differences can otherwise introduce sizable timing errors. In summary, this platform demonstrates how web technologies can deliver rapid, remote cognitive assessments: it is user-friendly, device-flexible, and well-suited for large-scale or home-based screening of brain health.

Keywords *— Test, Web Technology, Disease detection, Neuro congnitive, Reaction time*

I. INTRODUCTION

Reaction time – the interval between a stimulus and a person's response – is a fundamental measure of neural processing speed and efficiency. It reflects how quickly the brain perceives, interprets, and acts on information, making RT a valuable indicator of attention, motor coordination, and cognitive flexibility. In clinical and research settings, reaction time tasks are widely used to evaluate functions ranging from simple vigilance to complex executive control, and they can reveal subtle impairments due to aging or disease. For example, slowed or inconsistent RTs may signal early cognitive decline or neurological conditions such as ADHD or Parkinson's disease. Over the decades, RT testing has evolved from rudimentary stopwatch-based experiments to sophisticated computer-driven tasks, greatly improving measurement precision. Precise timing is important because even small delays can be meaningful; indeed, recent studies emphasize that web-based RT measurements must account for hardware timing variations to avoid bias.

In parallel with these advances, the rise of ubiquitous web and mobile technologies has opened new possibilities for cognitive assessment. Researchers are increasingly exploring brief, self-administered tests delivered online or via apps to monitor brain function in everyday settings. Notably, the SMART test (Survey for Memory, Attention, and Reaction Time) is a four-task, web-based battery for older adults that was found to be both feasible and well-accepted by users. Participants reported high willingness to repeat the SMART assessment, indicating that such digital tests can fit easily into people's lives. Importantly, these online tools correlate reasonably well with traditional neuropsychological tests and show good reliability, suggesting they can be trusted for tracking cognitive status over time. These findings motivate expanding web-based testing beyond labs and clinics: with proper design, remote self-tests could enable frequent, large-scale monitoring of attention, memory, and processing speed.

Despite the promise, researchers have noted several challenges. One issue is device heterogeneity: touchscreen tablets and phones can exhibit systematic timing delays relative to desktop computers, so that reaction times measured on different devices are not directly comparable. Another concern is sampling bias: for example, a large UK study found that individuals who volunteered for a home-based online RT test were disproportionately younger, better-educated, and of higher literacy than non-participants. Inadequate health literacy was linked both to more errors on the test and to higher likelihood of not completing the task properly. These selection effects mean that web tests risk excluding the very groups (such as the elderly or less tech-savvy individuals) who might benefit most from early cognitive screening. Moreover, while novel paradigms like virtual reality (VR) are being explored for cognitive testing, evidence suggests that well-designed VR tasks yield similar performance to conventional tests – although they require careful attention to technical factors like input hardware.

In this context, our work aims to harness the advantages of web deployment while addressing its pitfalls. We developed a browser-based reaction time app that consolidates multiple brief exercises targeting both cognitive and motor skills. The interface is kept simple and engaging to accommodate users of various ages and abilities. Each of the five test modules focuses on a specific function (for example, quickly identifying a color change, responding to directional cues, matching animal sounds to images, performing timed clicking/memory tasks, or drawing shapes to detect motor tremor). We built in quality controls to reduce spurious inputs (filtering out accidental clicks or extremely delayed responses). High-resolution timing performance ensures that even small differences in response latency are captured reliably.

By combining these elements, our platform aims to be a flexible tool for remote cognitive screening and monitoring. It could support research on attention and processing speed across diverse populations and potentially flag early signs of conditions like ADHD or Parkinson's. Our design draws on human-computer interaction principles (such as Keystroke-Level Modeling to estimate user task time) and input from neuropsychology experts to align with clinical standards. In sum, this browser app exemplifies how modern web technology can enable convenient, scalable self-assessment of reaction time and cognition, potentially extending regular brain health check-ups beyond the clinic.

II. LITERATURE REVIEW

Reaction time (RT) is commonly known to be an elementary indicator of neural processing speed, attention, and movement coordination. As web technologies have evolved, the measurement of RT evolved from laboratory settings to web-based techniques that are scalable and ubiquitous. The following review integrates the earlier literature pertaining to our project, Interactive Web Application for Reaction Time Measurement of Humans. McKay et al. [1] also illustrated the SMART platform, an online battery of memory, attention, and reaction time testing, and provided evidence for its feasibility and high acceptability in older adults. The importance of user-friendly design in cognitive evaluation was highlighted by the research. McKay et al. [2] also cross-validated SMART with gold standard neuropsychological measures and proved its reliability and convergent validity, even in mildly cognitively impaired individuals. This supports the use of web-based materials as clinical and research instruments.

Inconsistency of the device in measurement in RT came into question in the Archives of Clinical Neuropsychology [3] when performance varied considerably on touchscreen, laptop, and mobile devices. This indicates that it needs calibration or device-independent timing alternatives to make it standardized. Likewise, Brown et al. [4] observed that those with poor health literacy could not complete web-based cognitive tests while their RT performance was equal, illustrating the importance of accessible and usable designs.

New modalities like virtual reality (VR) open up new possibilities for cognitive testing. Vahle et al. [5] showed that VR tests of RT could be employed to enhance immersion at the cost of usability in older groups. This provides a balance between ecological validity and usability, which guides our web-based solution towards device inclusiveness with the flexibility to incorporate future immersive enhancements.

Human-computer interaction (HCI) models give us predictive models of RT task analysis. Bottino and Traina [6] utilized Keystroke-Level Model (KLM) variations to predict performance on RT, while Mottola et al. [7] suggested adaptive KLM strategies for dynamic cognitive load analysis of real-time interfaces. These models directly guide our system's modeling of typing, pointing, and switching tasks as speed and workload.

The first GOMS model, as defined by John and Kieras [8], breaks down user activity into cognitive and motor operations, furnishing a theory for RT task analysis. Its variant, for example, in Gong and Tarasewich [9], utilized the KLM-based predictions for mobile handheld devices and furnished interface design suggestions strongly applicable to our system that is mobile-friendly.

Usability testing is still a top priority for digital RT systems. Ryu and Smith-Jackson [10] created the Mobile Phone Usability Questionnaire (MPUQ) that put the importance of KLM in maintaining the dependability of the device. Fu and Gray [11] also created the "active user paradox," as users continue to employ non-ideal task strategies. This creates the necessity of adaptive feedback in multi-test RT suites to make optimal user interaction.

Finally, Hornof [12] demonstrated that visual search and pointing performance are influenced by labeling, interface layout, and the extensive support of KLM modeling. This validates our decision to use uncluttered, labeled, and intuitive layouts to limit excess cognitive load when testing with RT.

Technical dependability of web platforms has also been researched quite extensively. Anwyl-Irvine et al. [13] showed that online experimental platforms and modern browsers can provide millisecond-order accuracy in reaction time measurement, while Reimers and Stewart [14] showed evidence that JavaScript-based experiments can provide dependable presentation and response timing. Schatz et al. [15] cross-cultural validation of tablet-based measures of RT, and Abbasi-Kesbi et al. [16] novel algorithms for visual RT estimation. Crowdsourcing approaches, such as Bazilinskyy and de Winter [17], have been used to estimate audiovisual RT at scale, which has implications for the online recruitment potential. Miller et al. [18] contrasted smartphone and computer RT tasks and discovered device and screen size effects, and Plant and Quinlan [19] warned that experimental apparatus timing errors could be a cause of replication failure.

Kosinski's review [20] is an example of foundational work that has listed decades of RT research and shown how important it is in psychology and neuroscience. Vairagade et al. [21] recently confirmed that app-based RT tools can be used in medicine, which shows that they are valid in applied sciences. Large sample testing was employed by Goldhammer et al. [22] to establish the validity of RT as a test of general cognitive speed, while Benedict et al. [23] established computerized testing as validity in multiple sclerosis, establishing clinical utility of digital RT measures. General health implications of measuring RT are widely reported. Thompson et al. [24] associated greater RT with poor quality of life in older subjects with functional disability.

Fino et al. [25] presented the application of RT testing to balance control in neurological patients and showed clinical usefulness in rehabilitation. Whelan [26] emphasized the necessity of precise statistical methods in RT data analysis to avoid misleading interpretation, and Lin et al. [27] constructed a system for RT monitoring on a smartphone to monitor cognitive health, so it can be implemented at scale and in mobile form in everyday environments. In summary, these experiments provide evidence that web-based RT tasks can be HCI valid and clinically reliable. Yet there is still potential for enhancement concerning device variability, literacy universality, and coverage of multimodal tasks for early neurological screening. Our project builds on this effort by combining established cognitive models (KLM, GOMS) with interactive, game-based modules (color identification, auditory response, ADHD screening, and Parkinson's detection) in order to increase precision and accessibility.

III. Methodology/Experimental

This web application is browser-based and tests how fast an individual responds and how good his or her brain is. It uses simple and fun tests to do so. The app is coded in HTML, CSS, and JavaScript. It is light, speedy, and quick to respond, which is crucial to accurately measure reaction time.

The app has five main tests. Each test tests a different brain or response capability:

1. Color Recognition Test

This test involves a screen or color change suddenly. The user is required to click the instant it changes. This helps test the speed with which the hands and brain respond.The **Color Test** is a cognitive assessment tool used to measure an individual's ability to perceive, differentiate, and respond to various colors accurately and quickly. It typically involves identifying or matching colours under timed conditions. This test evaluates visual attention, processing speed, and sometimes memory. It is often used in psychological evaluations, vision screening, and user-interface studies. Variants include Stroop tests, which assess cognitive control by using conflicting color-word stimuli. The test can reveal issues like color blindness or cognitive processing delays. It is commonly administered on digital platforms for precision and scalability. FIG. 1 is the main flowchart of working of this test.

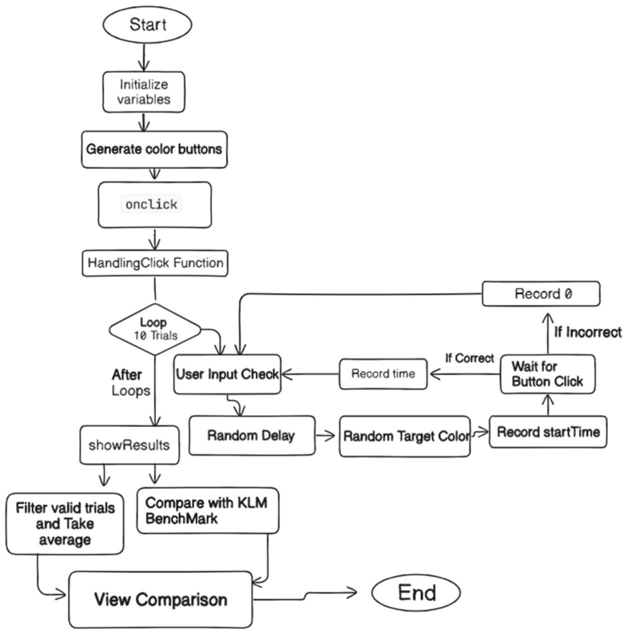

FIG 1. COLOR RECOGNITION TEST FLOWCHART

2. ADHD Test

This test involves arrows appearing one after another on the screen. The user is required to click on the right arrow key. This test is for focus, response time, and swift decision-making. The **Reaction Time Test for ADHD patients** is designed to assess the speed and consistency of an individual's responses to stimuli, helping identify attention-related impairments. It typically involves pressing a key or tapping a screen as quickly as possible when a specific visual or auditory cue appears. This test evaluates sustained attention, impulsivity, and processing speed—key areas often affected in individuals with ADHD. Delays or high variability in reaction times may indicate difficulty maintaining focus or controlling impulses. The test is non-invasive, easy to administer digitally, and useful for both diagnosis and treatment monitoring. It is often used alongside broader neuropsychological assessments. Below in Fig. 2, the flowchart clarifies entire process.

3. Animal Sound Test

The application is played with an animal sound. The subject clicks on the proper animal picture then. This is a test of hearing, memory, and reaction time by both sense of sight and sense of hearing. The **Reaction Time Test based on Animal Sounds** is a cognitive assessment tool that measures how quickly and accurately a person can respond to auditory stimuli, specifically animal noises. Participants are instructed to listen for specific animal sounds (e.g., dog bark, cat meow) and respond by pressing a button or selecting when a target sound is heard. This test evaluates auditory processing, selective attention, and reaction speed. It is especially useful for children or individuals with attention difficulties, such as ADHD, due to its engaging and familiar content. Delayed or incorrect responses can indicate attentional lapses or slower cognitive processing. The test is often used in educational and clinical settings. Below, in Fig. 3, the flowchart clarifies entire process.

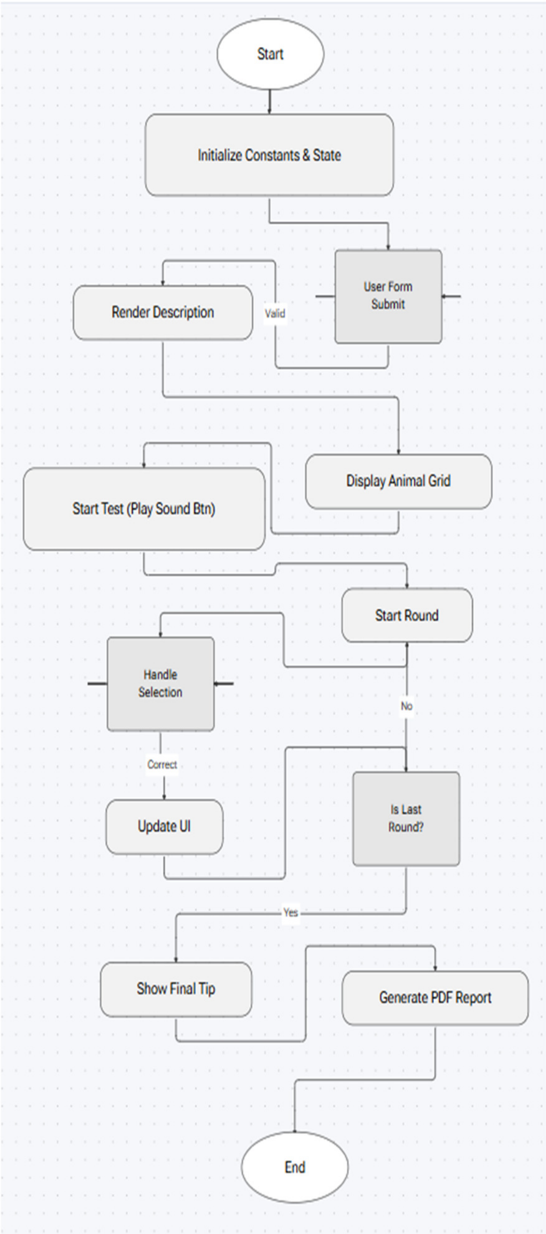

FIG 2. ANIMAL TEST FLOWCHART

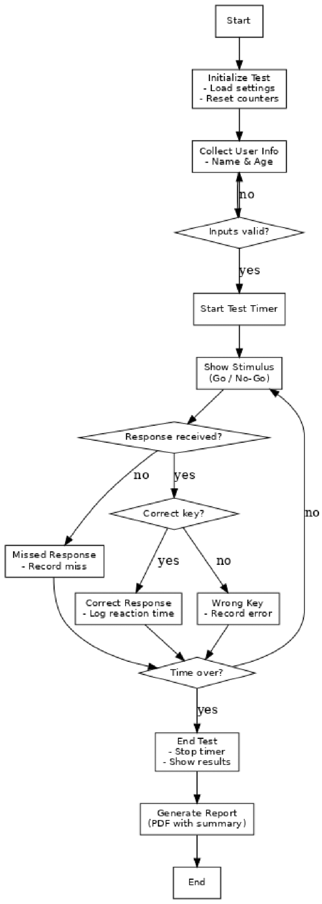

FIG 3.ADHD TEST FLOWCHART

4. Multi-Test Reaction Time Suite

It's a mixture of brief tests:

Click Test – Amount of clicks the subject can perform in 5 seconds. Mouse Test – Record p [illegible] r moving targets across the screen. Memory Test – Recall and pick items seen only a few seconds ago. Shape Test – React to specific shapes on the screen. Distraction Test – Switch tasks when suddenly change of rules. The **Emotional Stroop Test** measures cognitive control and emotional interference by asking users to identify the color of emotionally charged words. Participants must click the correct color button (Red, Green, Blue, or Yellow) as quickly as possible. The challenge arises when the emotional content of the word distracts from its font color. This test helps assess attention, emotional regulation, and reaction speed. It is widely used in psychological evaluations for anxiety, depression, and ADHD. The clean, user-friendly interface supports intuitive interactions. Results contribute to broader cognitive and emotional health assessments. These mini tests give more detailed information regarding the speed, accuracy, and switch ability of attention of the user. FIG. 4 shows the clear understanding and flowchart of the process of this test.

5. Parkinson's Detection Test

This test identifies the early symptoms of Parkinson's disease. It includes:
Drawing Spirals – The user draws spirals. The app searches for wobbly or shaky lines.
Typing Test (KLM) – This evaluates how difficult typing or clicking is.
Pressure Test – The user makes quick decisions with time pressure.
Correct Test – Checks if the user chooses the correct option every time.
Hand Control Test – Checks the smoothness and control with which the hands are moving. The application uses JavaScript to track all that is operated by the user. Reaction time is measured to very high accuracy by the application using an in-built timer performance. FIG. 5 shows the clear understanding and flowchart of the process of this test.

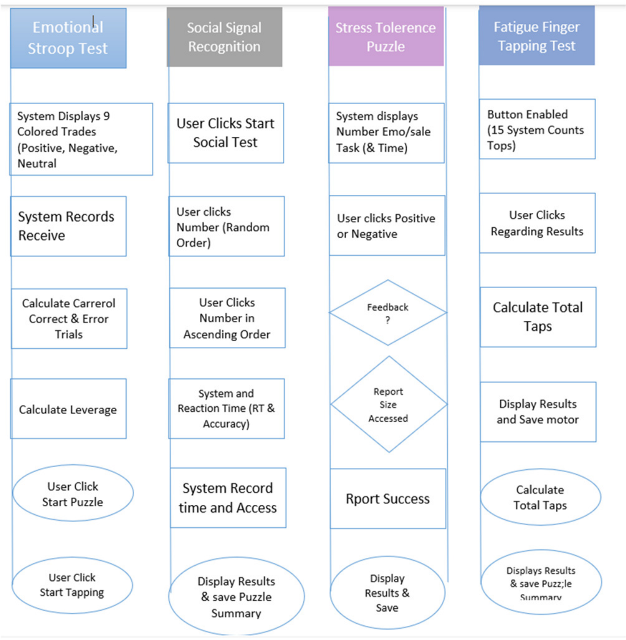

FIG 4. MULTI-TEST REACTION TIME SUITE FLOWCHART

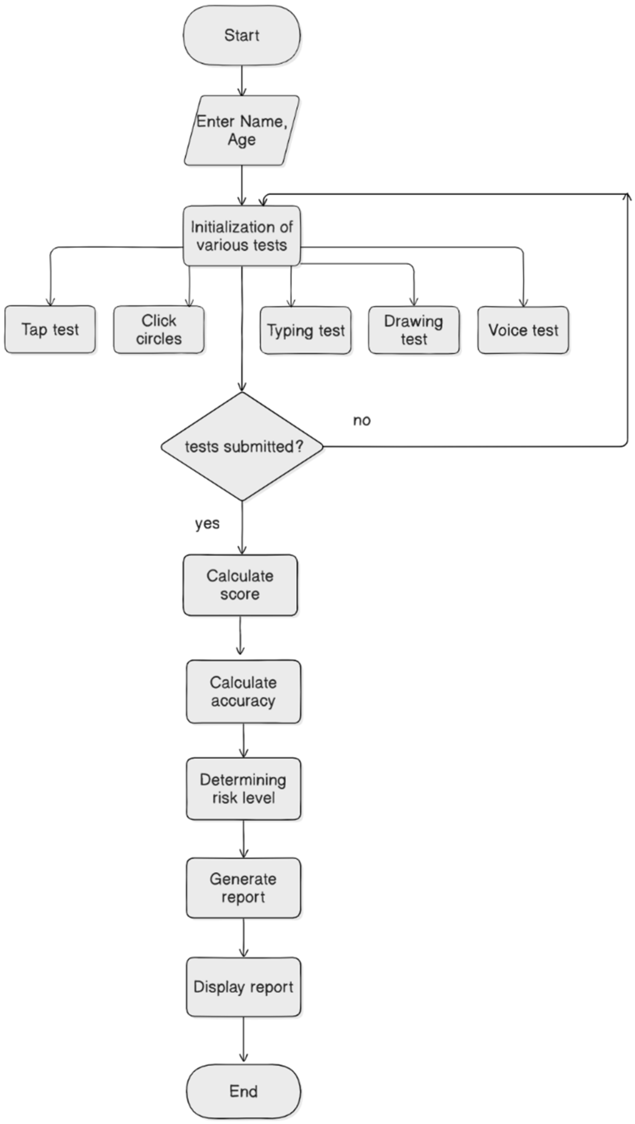

FIG 5. PARKINSONS DETECTION TEST

IV. EXPERIMENT DESIGN AND IMPLEMENTATION

For this study, we developed and applied a digital test system designed to measure both thinking ability and motor skills. The goal was to capture small changes in reaction speed, accuracy, and flexibility, since these early signs of brain-related problems are often missed during regular checkups.

Participants were recruited from both hospitals and the general community to make sure we had a mixed group of healthy individuals and patients with neurological conditions. Each testing session was supervised by a researcher or doctor who explained the tasks carefully. Before the real test began, participants were given practice trials so they would be comfortable with the tasks.

The test included several activities: simple and choice

reaction time tests with both sound and images, an animal sound test where users had to match a noise to the correct picture, a spiral drawing test to check hand control, and typing or fast-clicking tests to measure fine motor skills and effort.
Clear differences were seen between the two groups. Healthy people usually answered quickly, around 250–350 milliseconds, while patients with brain conditions were slower, often 400–600 milliseconds or longer. Patients also showed more variation in their answers and had difficulty with long or changing tasks. As the session went on, many became tired and made more mistakes. The spiral drawing and typing tasks showed motor issues most clearly. Patients' drawings were shaky and uneven, while healthy participants made smoother lines. In tasks where rules suddenly changed, healthy participants adapted without much trouble, but patients found it harder to adjust. Feedback from doctors was very positive. The detailed reports—with graphs, response times, and error patterns—helped them see small problems that normal tests might overlook. They found the tool useful for better understanding patient difficulties and for planning care.

Description	Operator	Duration (s)
Mentally prepare (by heuristic rule 0)	M	1.35
Move cursor to *departure*	P	1.10
Click mouse button	K	0.20
Mentally prepare (by heuristic rule 0)	M	1.35
Move cursor to *origin*	P	1.10
Click mouse button	K	0.20
Move hands to keyboard	H	0.40
Press *p*key	K	0.20
Press *a*key	K	0.20
Press *r*key	K	0.20
Press *down arrow* key	K	0.20
Press *enter* key	K	0.20
Press *enter* key	K	0.20
Total time predicted		6.90

TABLE 1. REFERENCE OF KLM MODEL

An Additional Part Of Our Design Was Based On The Keystroke-Level Model (KLM), Which Breaks Down User Actions into Small Steps. for example, in the emotional stroop test, participants think about the color (m), move their pointer (p), and click (k). in the tap test, they press keys repeatedly after preparing mentally and positioning their hand (m + p + k). the pointing test required multiple rounds of identifying and clicking targets (m + p + k for each circle). in the typing test, participants prepared mentally (m) and typed each letter (k × n). in the drawing test, they had to plan (M), click and drag (p + h + d + h). each of these steps reflected attention, decision-making, and motor effort. by using klm, we could better estimate efficiency, workload, and the challenges participants faced. Overall, this experiment shows how digital tools can help track both thinking and movement skills. the system not only makes testing more objective and reliable but also gives doctors and researchers valuable insights that support early detection and treatment.

V. RESULT AND DISCUSSION

We tested the system with many people, including healthy participants as well as patients who were under medical care. From these trials, some clear patterns could be seen in how fast people responded and how well they completed different tasks.

1. Reaction Time
Most healthy participants reacted quickly, usually within 250–350 milliseconds for both sound and visual tests. Patients with brain-related conditions, like Parkinson's, were noticeably slower, often taking 400–600 milliseconds or more. They also found quick clicking and drawing tasks harder to perform smoothly.

2. Sound and Image Together
When sound and image were combined in the same test, some patients had difficulty. For example, in the Animal Sound Test, they sometimes clicked the wrong animal or took much longer to choose. This showed that combining two senses at once was more challenging for them.

3. Drawing and Typing Tasks
The spiral drawing test helped us notice hand tremors. While healthy people drew smoother lines, patients' drawings were usually shaky and uneven. Typing and clicking tasks (like the KLM test) also took patients more effort and time, showing that even simple actions felt more demanding for them.

4. Task Load and Switching
Healthy people quickly adapted to repeated simple tasks and often got faster as the test went on. Patients, however, became tired more quickly. In the later part of the tests, they took longer to respond and made more mistakes, especially when the rules suddenly changed.

5. Usefulness for Doctors
Doctors found the reports helpful because they showed small details that normal checkups might miss. The response times, graphs, and performance patterns gave them a clearer picture of the patients' abilities and challenges, making the results useful for medical understanding.

Trial	Your Time (ms)	KLM Standard (ms)	Difference
1	1480.4	3100	1619.6
2	1459.9	3100	1640.1
3	6231.1	3100	-3131.1
4	1722.4	3100	1377.6
5	2107.9	3100	992.1
6	2489.1	3100	610.9
7	2901.3	3100	198.7
8	1685.5	3100	1414.5
9	2133.2	3100	966.8
10	1909.5	3100	1190.5

Performance Summary

Your Average Reaction Time: 2412.0ms

KLM Model Average: 3100ms

Performance Difference: 688ms

Wrong Clicks Impact: Incorrect clicks do not count towards average time but indicate attention lapses

TABLE 2. SAMPLE RESULT

In the future, the potential of digital assessment technologies is way beyond the purview of our current work. As technology evolves, we envision that one day these tools will be invisibly integrated into home and clinical environments alike, and continuous, unobtrusive monitoring of cognitive and motor function. Imagine a world where smart home devices and wearable sensors are working together with assessment software to provide a detailed picture of a patient's health throughout the day.

All of this emphasizes the necessity for future investigation into how to make digital tests adaptable for use in a wide range of populations, including those older people who feel less at ease with technology and individuals with more severe disabilities. Simplification of interfaces, voice-guided instructions, and multilingual support will be required in enabling these innovations for all. The next wave is bringing artificial intelligence and machine learning together. By examining extremely large databases of computerized tests, we can determine novel patterns and predictors of disease progression or response to therapy, which will lead to earlier and more precise diagnoses. Virtual reality and gamification of measurement can continue to further enhance participation and ecological validity, such that the process of evaluation is not only informative but also fun.

Ultimately, the goal is to create a healthcare ecosystem in which digital tools for measurement enable patients, support clinicians, and advance the frontiers of neuroscience and rehabilitation. Through the adoption of these technologies, we can bring about a future where all individuals have the opportunity to maintain their cognitive and motor well-being with dignity, agency, and hope.

VI. FUTURE SCOPE

The possibilities of digital assessment technology extend far beyond the boundaries of current research with the rapid pace of technological advancements; it is possible to envision a future where assessment system is seamlessly integrated into both clinical and everyday home environments. In such future assessment would feel like distinct or scheduled task but instead become continuous, unobtrusive processes woven into daily life. But as we move forward, we must Rembert that technology should serve everyone – young or tech savvy, older adults who may not be who may not be comfortable with technology, or serious disabilities must be able to benefit too. This means creating interface that are simple, adding voice instructions for guidance, and making tool available in different languages. Only then can these systems reach those who need them the most.

Another exciting direction is the use of ai and ml. By analyzing large set of data from digital test ai could help the doctors notice small changes that might predict illness or showing how someone is responding to the treatment. This could lead to earlier diagnosis or personalized care. Also, tools like virtual reality and gamified tests could make the whole process more engaging. The larger goal is to crate healthcare environment where technology empowers humans to better understand themselves, help clinicians make more informed decisions, and push the boundaries of what we know about the brain. done right, these inventions could give people the ability to maintain their health with dignity confidence and hope.

XII. Conclusion

Web –based reactions tests are already showing how technology can give people simple, convenient ways to check in their brain health. They bring science into everyday life in a way that feels approachable and even enjoyable. But to truly serve everyone, these tools need to be inclusive, easy to use and meaningful across different communities and cultures. In our project, we tried to keep this spirit in mind. We built our own web-based reaction test using b=core technologies like html, CSS and JavaScript. But we kept the design simple and fast so that anyone – whether doctor a patient could use it without difficulty.

The app responds instantly to clicking, filtering out mistake, like accidental presses, and is built in part so it can grow with future needs. At its heart the project is more than just a technical exercise. It represents a small step towards a bigger vison: using digital tools to help people care for their minds and bodies in ways that feels natural supportive. If we continue to innovate while keeping empathy and accessibility at the centers, we can move towards a future where technology doesn't just measure health – it helps sustain it, enabling people to live with more confidence, independence and wellbeing

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