

# Development of a Neurocognitive Assessment Spanning all DSM-5 Domains, Designed for Low-Resolution Eye-Trackers

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## RESEARCH OBJECTIVE

The primary objective of this project is to develop a comprehensive battery of neurocognitive tests leveraging remote eye-tracking technology. These tests aim to assess every neurocognitive domain and subdomain defined in the DSM-5 (**table 1**), accommodating a wide age range from early childhood to late adulthood. The ultimate goal is to enable consistent monitoring of cognitive performance relative to age-specific norms.

**Table 1. Cognitive Domains and Subdomains as outlined in DSM-5**

*Adapted from the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, American Psychiatric Association.*

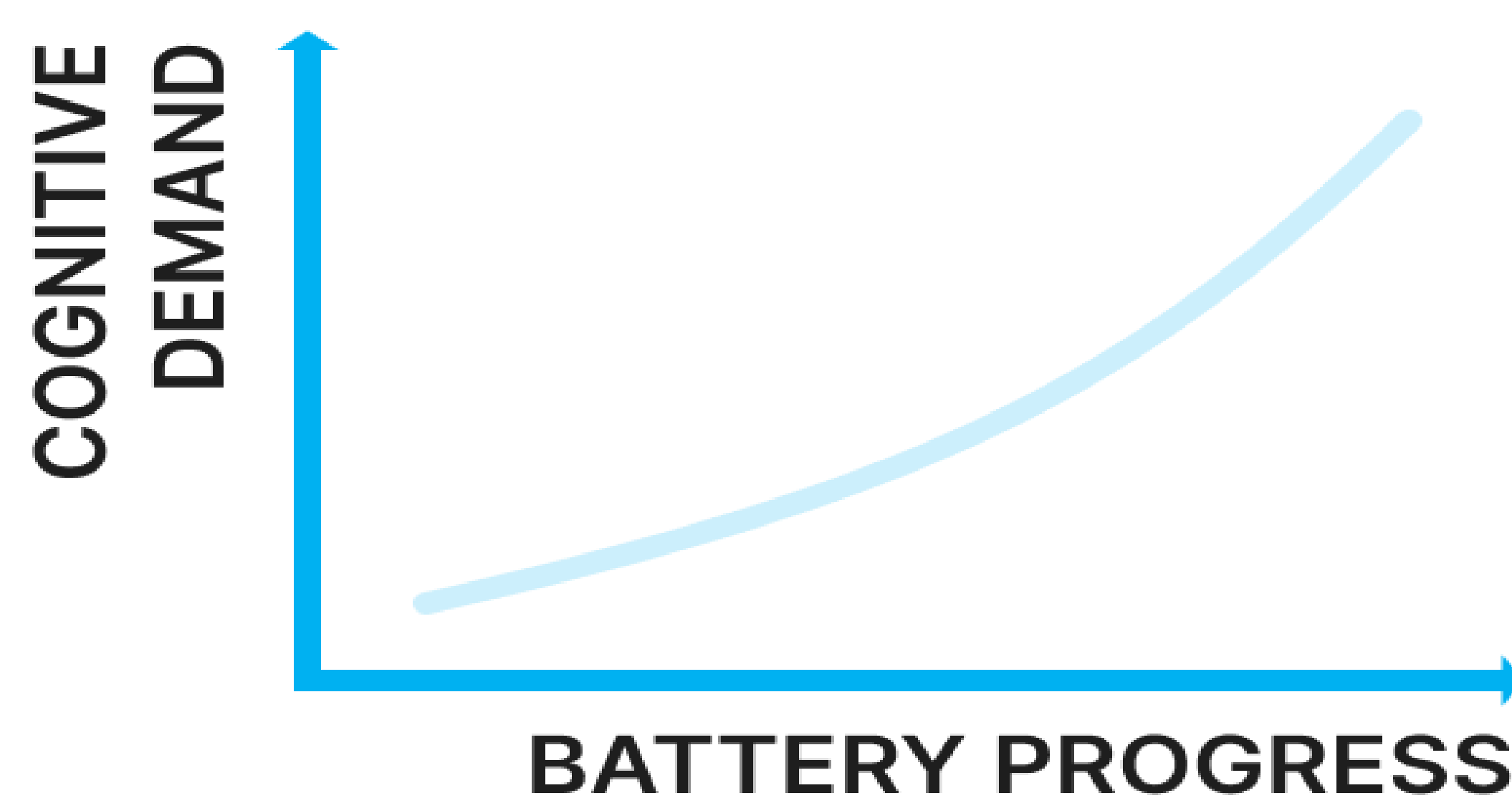
Cognitive Domain	Subdomain
<b>Complex Attention</b>	- Sustained attention
	- Divided attention
	- Divided attention
	- Divided attention
<b>Executive Function</b>	- Planning
	- Decision making
	- Working memory
	- Responding to feedback/error correction
	- Overriding habits
	- Mental flexibility
<b>Learning and Memory</b>	- Immediate memory
	- Recent memory (including free recall, cued recall, recognition)
	- Very long-term memory (semantic, autobiographical)
<b>Language</b>	- Expressive language (naming, fluency, grammar, syntax)
	- Receptive language (comprehension)
<b>Perceptual-Motor</b>	- Visual perception
	- Visuoconstructional
	- Perceptual-motor
	- Praxis
<b>Social Cognition</b>	- Gnosis
	- Recognition of emotions
	- Theory of mind

## METHODS

The methodology involves a structured sequence of tests that escalate in cognitive demand without the necessity for extensive new instructions (**Fig. 1**). This sequence is interspersed with hand-eye coordination tests doubling as calibration checks for eye-tracking (**Fig. 2**). The stimuli distribution in the tests is specifically designed to suit the spatial resolution limits of 60Hz eye-trackers, which are commonly found in smartphones (**Fig. 3**).

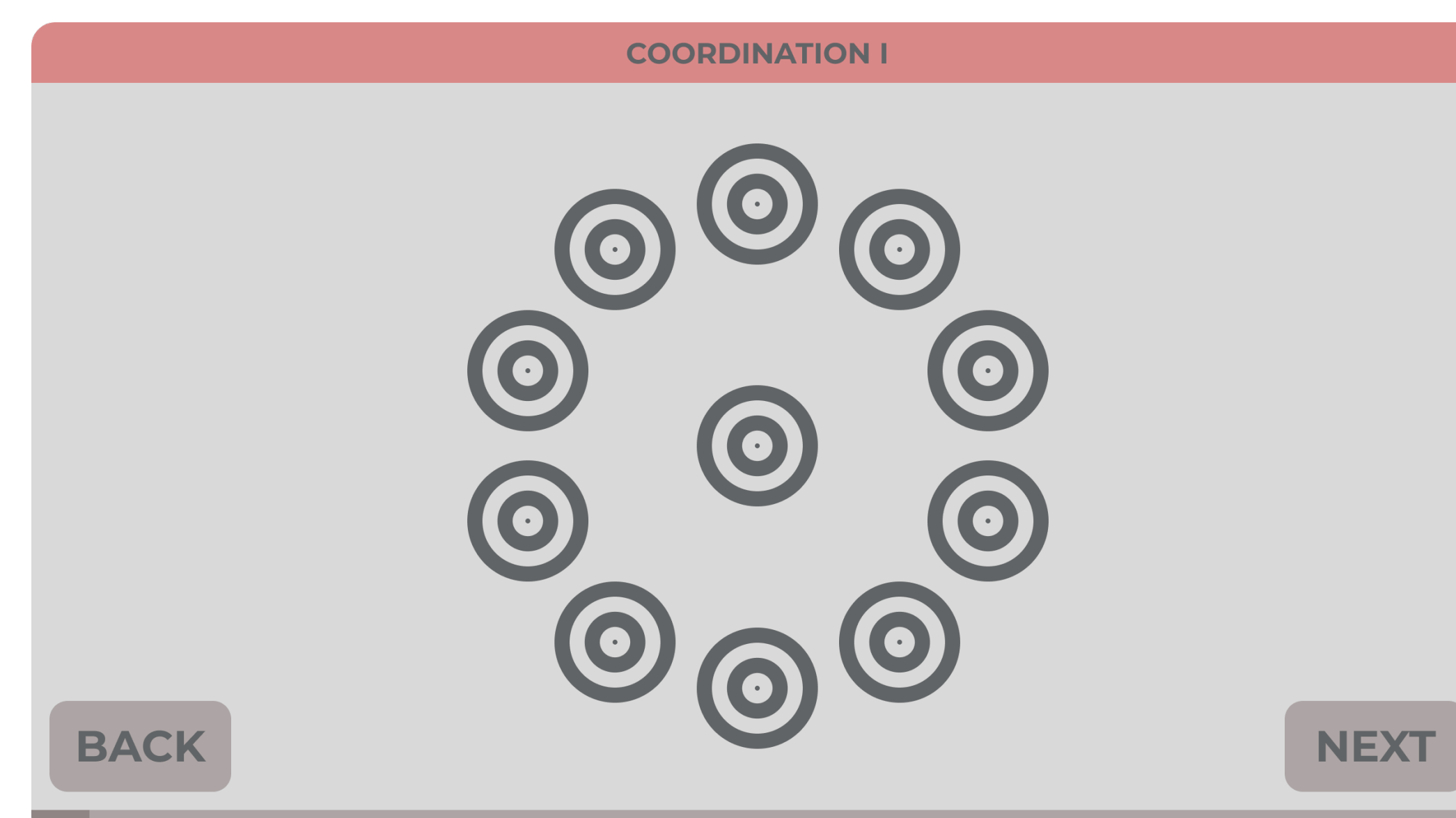
**Fig. 1. Tests escalate in cognitive demand**

*As the battery progresses, each test demands more cognitive resources than the previous one. Additionally, each test serves as a tutorial for the following test, reducing the need for complex instructions.*



**Fig. 2. Hand-eye coordination tests double as calibration checks for eye-tracking**

*The combination of visuoconstructional tests with eye-tracking calibration reduces the length of the battery.*



## RESULTS

We have successfully launched the first (**table 2**) of three planned sessions, now accessible at [ubc.neurocognition.ai](http://ubc.neurocognition.ai).

**Table 2. Session I (14 tests)**

*This first session has been developed as a proof of concept for building the backend architecture of the webapp. It operates natively on internet browsers without the need to download any software. After the initial eye-tracking calibration, a working memory test is administered. Then, following a second calibration, an immediate memory test is administered. Next, a sequence of time-based tests is presented. Finally, a recent memory test recalls the stimuli from the initial immediate memory test.*

Test	Description
<b>Coordination I</b>	Calibration with circularly arranged stimuli
<b>Working Memory - Numeric</b>	Reverse digit span task
<b>Coordination II</b>	Calibration with stimuli in a rectangle
<b>Immediate Memory Non-Verbal</b>	Involves targets and distractors
<b>Motor Speed</b>	Prepares for speed-dependent tests
<b>Perceptomotor Speed</b>	Baseline reaction time test
<b>Visual Processing I</b>	Simple reaction time test
<b>Coordination - Columns</b>	Calibration with columnar stimuli
<b>Visual Processing II</b>	Complex reaction time with four responses
<b>Cognitive Control</b>	Test with directional responses
<b>Cognitive Flexibility</b>	Task switching
<b>Coordination II</b>	Repeat calibration
<b>Selective Attention</b>	Visual exploration
<b>Recent Memory - Non-Verbal</b>	Recall task

**Fig. 3. Tests are designed to suit the spatial resolution limits of 60 Hz eye-trackers.**

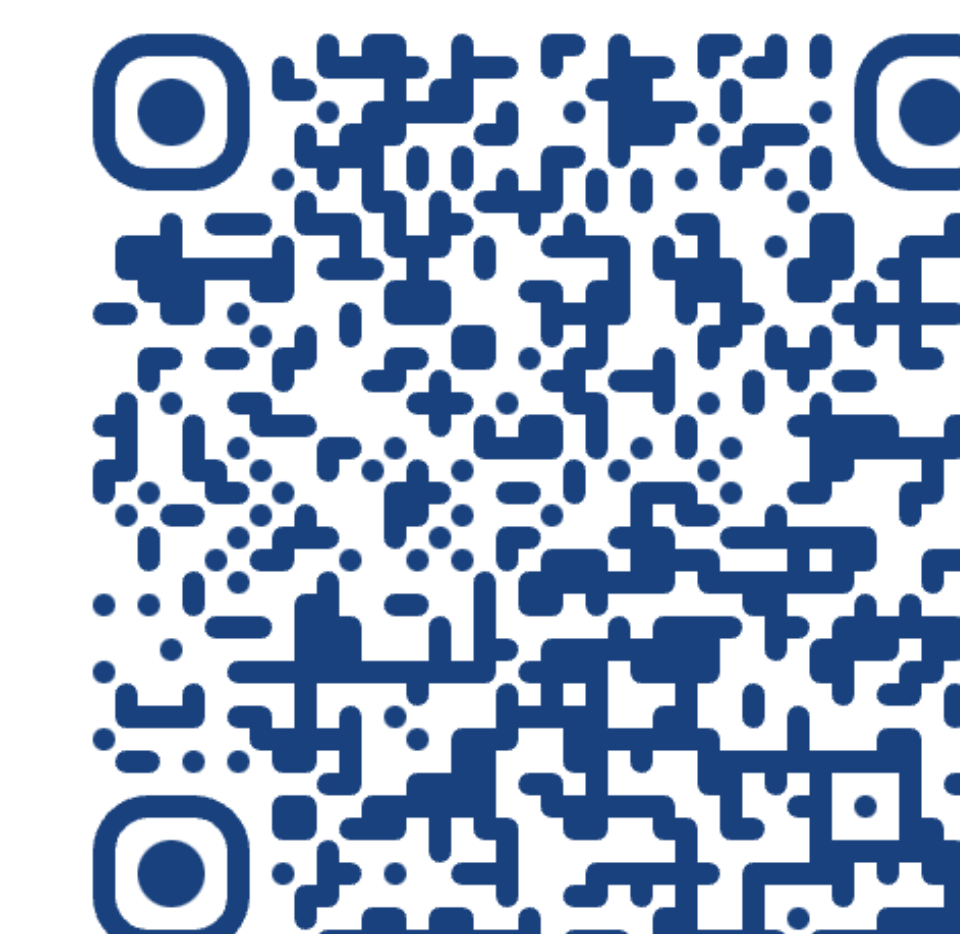
*Here is an example of the Selection Attention test, which is based on a visual search paradigm. A test trial is overlaid with a thermal map representing eye fixations (where red indicates more fixations on a given area) and eye saccades (where arrows indicate a sequence of eye movements).*



## CONCLUSION

The full battery, upon completion of three sessions, will cover all DSM-5 neurocognitive domains and subdomains, significantly advancing digital neurocognitive assessments using remote eye-tracking technology. This method promises greater accessibility and precision in cognitive evaluation across diverse age groups.

*This QR code redirects to [ubc.neurocognition.ai](http://ubc.neurocognition.ai).*



*Please use a computer with a keyboard to attempt a demo version of the first session of the battery. The process is anonymous, and no results are provided at this stage.*