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App for screening cognitive decline related to COVID-19 - A methodological statement

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Screening in public health

Systematic (usually brief) examination of groups of people at increased risk of disease or impairment or exposed to risk factors.

Why and how to do screening?

Since the outbreak of the COVID-19 pandemic an increasing number of post-COVID-19 patients has reported difficulties with

- attention
- concentration
- memory
- fatigue

i.e., cognitive symptoms also known in relation to psychosocial stress and the chronic fatigue syndrome.

Estimation of the prevalence and severity of these problems could be done by comparing a sample of post-COVID-19 patients (persons with COVID-19 antibodies) with a matched sample of persons, who has not had COVID-19 (with no COVID-19 antibodies) with cognitive tests. However, by August 2021 such a group is probably unavailable due to national mass vaccination programs.

The unavailability of a control group points to use of a test battery for which there exists *representative reference values* established from random samples of the general population.

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Decline

Reference values as criteria

Decline in cognitive performance means decrease from a level in the past. In practice no data exists on post-COVID-19 victims' cognitive performance before they caught the disease. To provide reliable indication of a decline in the current situation, cognitive testing must be done utilizing

- a standardized cognitive test battery
- valid reference values
- uniformity of the testing
- high degree of automation to minimize examiner influence
- comprehensive parameterization.



NOTE: Due to unavailability of case-specific pre-COVID-19 data one cannot expect to catch cases where performance has dropped from e.g., 55-percentile to 90-percentile.

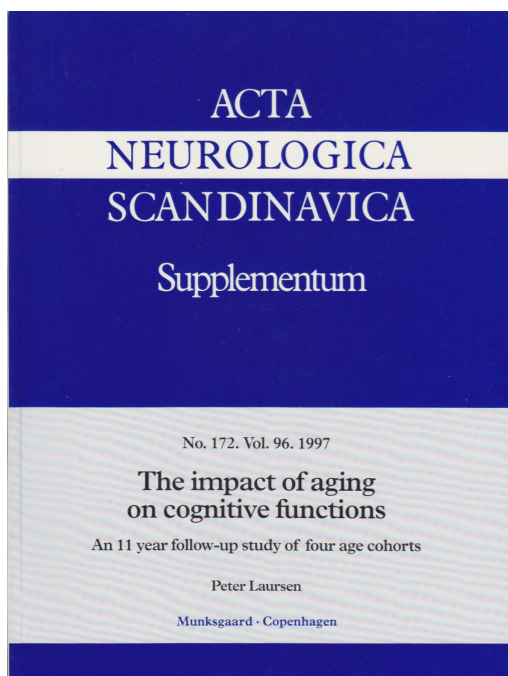
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Criteria

At prototype level the Cognitive Function Scanner was developed for screening a comprehensive set of cognitive functions among workers exposed for neurotoxic substances in their working environment, i.e. a situation with parallels to today's virus induced cognitive impairment.

To provide criteria for 'impaired' the test suite has been applied to two large-scale public health studies based on random samples of the general Danish population back in 1982-83 (N=1,026) and 1993-94 (N=711).

The outcomes of these public health studies were, among other things, comprehensive sets of reference values standardized on age, sex and education. Suspicion of 'impaired functioning' begins when a test score is on the poor side of the 'normal' 90- percentile.



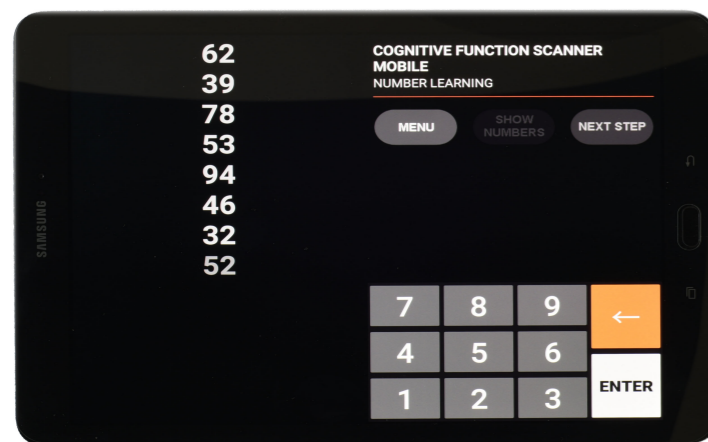
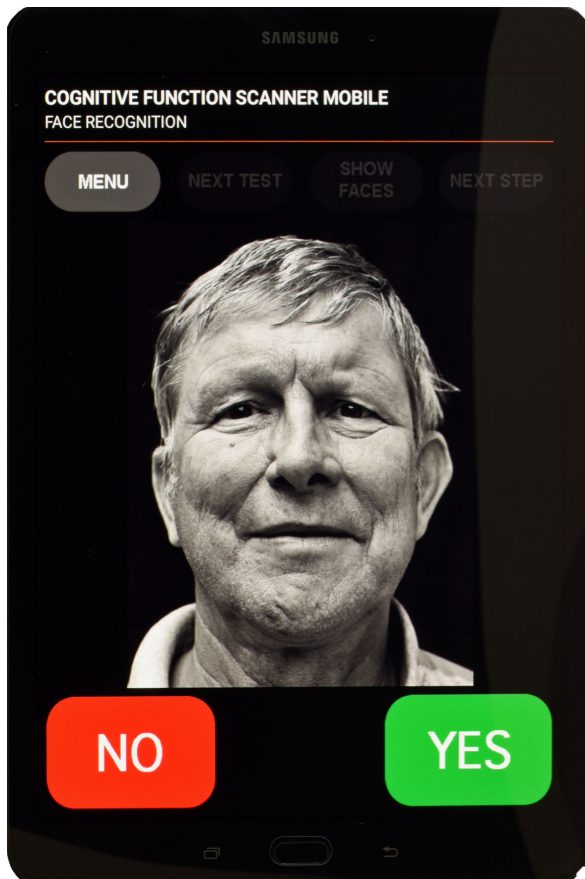
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Comprehensive parameterization prepared for statistical analysis by standard software

Experience from large-scale studies on the impact of aging on cognitive performance shows that performance time is as important indicator as is the content-associated parameters like unrecalled items in memory tests, inaccuracy in eye-hand coordination tests, etc.

All tests and test sections in the CFS battery include performance time recording measured as the sum of latencies at every test item.

All test score parameters are oneway polarized with best score at '0' and poorest score at '0 + X' to be proportional with length of latencies, i.e., long latencies and high error scores indicate poor performance.



Cognitive Function Scanner Mobile Test Suite generates

- Printable result charts ready for digital or manual archiving.
- Result files in ASCII-format that can be read by any computer system and analyzed statistically by standard program packages like SPSS, SAS, Stata, R, etc.

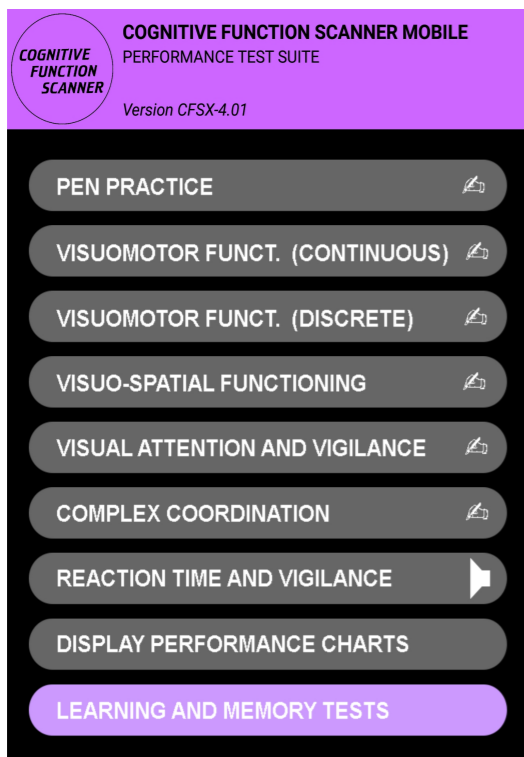
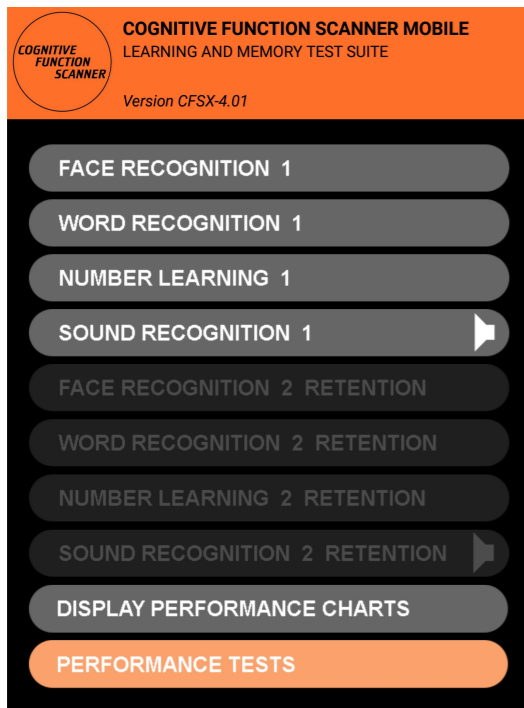
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CFS-tests targeting post-COVID-19 cognitive functioning

As the cognitive post-COVID-19 symptoms relate to difficulties with attention and concentration, memory, and fatigue, i.e., to diffuse impairment, our suggestion to a cognitive screening program includes:

- Tests of working memory, learning and retention (face recognition, word recognition, and a demanding number learning* featuring a selective reminding procedure)
- Tests of visual and auditory attention, perception, and vigilance (cancellation test and reaction time test)
- A test of complex coordination (combination of attention, motor functioning, and memory).

* Memory for numbers is less well described as for example memory for words. As numbers are independent of language and culture and per se meaningless we view a number learning test as especially appropriate in relation to examination of persons with limited proficiency in, e.g., one of the Nordic languages.



Result charts and reference values

COGNITIVE FUNCTION SCANNER MOBILE		Client No. 20180604-7				
License No. 1803061		Male, age 51				
Psychometric comparison table (ref. values congregated via PC-version)		Skilled or similar				
2018.06.04_13:35		Dominant hand: R				
		Client better than 50 percentil.	Reference group 50 percentil.	Client between 50-90 percentil.	Reference group 90 percentil.	Client poorer than 90 percentil.
Face Recognition, 1st trial, unrecognised			0	1	2	
- - , - - , incorrectly recognised		0	2		7	
- - , - - , time sec.			60.8	66.0	87.1	
- - , retention, unrecognised		1	2		3	
- - , - - , incorrectly recognised		0	6		9	
- - , - - , time sec.			61.7	64.3	103.5	
Word Recognition, 1st trial, unrecognised			1	2	3	
- - , - - , incorrectly recognised		2	2		6	
- - , - - , time sec.			49.0	63.0	77.3	
- - , retention, unrecognised		0	2		5	
- - , - - , incorrectly recognised		3	6		12	
- - , - - , time sec.			57.7	65.5	103.2	
Number Learning, 1st trial, number of unrecalled		4	4		5	
- - , total number of unrecalled		6	18		37	
- - , - - - retrieval errors		1	12		30	
- - , - - - invented			0	2	10	
- - , - - - perseverations		2	13		32	
- - , learning phase, time sec.		107.6	320.5		492.1	
- - , retention, number of unrecalled		2	2		4	
- - , - - , time sec.		31.4	51.5		80.8	
Sound Recognition		No reference values				

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Practicalities of screening

Experience shows that screening differs from traditional neuropsychological examination by demanding:

- time-efficiency
- no time for on-site supplementary examinations
- sparse time for on-site individual counseling.

Duration of a CFS examination covering the domains related to the reported symptoms is approx. 35-45 minutes depending on subject's performance.

People participating in a public health screening program usually want feedback about their health status in return for their time and effort. To meet such demands the applied method should facilitate immediate feedback.

