WESNES COGNITION

CogTrack
Precision Cognitive Testing Online

CogTrack Overview

CogTrack

CogTrack is being developed to enable the status of cognitive function to be assessed by anyone, at any time in any place. The first phase, completed in 2015, involved the creation of an internet platform of cognitive function tests which over the last 35 years have proven to be the most sensitive and repeatedly used in worldwide clinical trials. Moving these automated tests to an online platform has enabled various on-going major long-term studies to utilize CogTrack to measure cognitive function outside of the traditional constraints of laboratory or clinical settings. The consequence has been to dramatically increase the scale, practicality and economic efficiency of such trials. Already in one 10-year study which began in late 2015 more than 14,000 older individuals have performed CogTrack on up to six occasions. The current phase of development is to enable the CogTrack tests to be performed on handheld and touchscreen devices and offer immediate feedback.

CogTrack Background

The CogTrack System is the progression of a method of sensitively measuring changes in cognitive function developed by Keith Wesnes in the 1970s. This method involved automating a range of tests of major aspects of mental ability, and in the 1980s became the Cognitive Drug Research (CDR) System. For over 30 years CDR has been the most widely system of its type in worldwide clinical research. At the start of this millennium Keith Wesnes pioneered the method of administering CDR System tests via the internet, enabling large populations to be tested remotely, while also providing a method for individuals to take an interest in and remotely self-monitor their own cognitive function. A range of highly successful studies were conducted involving approaching 200,000 individuals worldwide. This work confirmed the utility of internet testing and the engagement and interest of individuals to participate in such studies. The cognitive tests in CogTrack have been based on the most sensitive and widely used tests in the CDR System.

The CogTrack System

Wesnes Cognition is interested in supporting and progressing research into factors which influence cognitive function. Whilst the CogTrack software is not available for licensed purchase, it can be accessed by clients and collaborators whose studies have been authorized for use by Wesnes Cognition. Once a study has been authorized, the task selection and testing schedule is setup and the collaborating group is provided with the study specific web link and participant access codes.

The data from the cognitive tests will be delivered to the collaborator at agreed intervals via a secure server, where the file can be downloaded and opened using a separately supplied password. The file will contain an excel spreadsheet of the results from each test for each individual in a pre-agreed format. Other formats including SAS® are available.

All access to the CogTrack Online Cognitive Assessment System is secured with HTTPS. No personally identifiable information is recorded for participants, and cookies are not used to remember or track participants.

Costing proposals are delivered in response to a study protocol or research proposal from collaborators who wish to use CogTrack in their research. These include individual study proposals and long term academic collaborations.

Practical considerations for using the CogTrack system

Internet Connections:

Concerns about poor quality internet connections are alleviated by the fact that the system works on a task by task basis. All the required resources for each task are downloaded within the browser prior to the start of each task, ensuring that the control of stimuli presentation as well as the capture of the accuracy and speed of all responses are managed locally within the browser. Importantly, it is not until the end of each task that the data is returned to the server. This methodology ensures that 'in task' performance is not impacted by connection issues.

Internet Browsers:

The CogTrack system has been tested on the most popular browsers; Chrome, Internet Explorer and Safari and thus it is recommended for use in these. The CogTrack system however will record and store the internet browser used during each session.

Required Equipment:

The CogTrack system requires an internet connection as it is a web based platform and thus is not restricted by hardware. Study sites and Participants testing at home can therefore use the hardware of their choice (e.g. Laptops, Desktops, Macs, iMacs), providing they are connected to the internet and the keyboard has well-functioning left and right arrow keys (e.g. not sticking) which will be calibrated at the start of the program. We advise study sites and participants testing at home to test on the same equipment at each session where possible, however we do collect the data from the testing participant as to which equipment is being used on each session. The development of touchscreen enabled administration of the CogTrack System is currently underway, and it is expected that touchscreen reliant devices will be able to use the System by the end of 2016.

Participant IDs:

Participant IDs can be predefined, and alphanumeric combinations are not restricted.

Current projects which are using the CogTrack System

PROTECT Study (Platform for Research Online to investigate Genetics and Cognition in Ageing)

http://www.protectstudy.org.uk/

This is an exciting and important 10 year UK research study, which aims to understand what happens to our brains as we age. The study is open to volunteers aged 50 and over. The study is designed to gather data and support innovative research into the factors which influence cognitive function during the ageing process. It is becoming widely recognized that certain factors such as genetics, lifestyle choices, exercise both physical and mental all influence the risk of pathological age-related cognitive decline, including the development of dementia.

One exciting aspect of this study is that it is entirely conducted from the comfort of the participant's homes through the use of the internet. Individuals who choose to participate in this study will provide a range of personal information and complete online assessments of important aspects of their cognitive abilities. The annual repetition of these assessments will provide invaluable information on cognitive decline with ageing and the role of lifestyle choices in these changes. The participants will also provide a sample of their DNA through a simple at-home postal kit.

A further innovative feature of PROTECT is that the participants will be able take part in innovative studies to that aim to answer crucial questions such as**:**

- How do key measures, such as memory, language and reasoning change over time as we age?
- How do our lifestyle choices, including our exercise habits and diet affect our risk of dementia?
- The role played by genetics in cognitive ageing
- What are the early signs of dementia and how can they be distinguished from normal ageing?
- What approaches can be delivered online to influence the ageing process and the development of dementia?

Protect Launched in November 2015. Over the first 5 months of the study CogTrack data were gathered online from over 14,000 participants aged 50 to 94 years who have performed the tests up to six times.

This study is sponsored by the Biomedical Research Centre for Mental Health and Dementia Unit at South London and Maudsley NHS Foundation Trust The Institute of Psychiatry, King's College London.

Remote assessment of Parkinsonism supporting ongoing development of interventions in Gaucher's disease (RAPSODI GD)

RAPSODI is a pioneering new study that uses the internet to find new ways to enable Parkinson's disease to be diagnosed earlier. A gene called glucocerebrosidase (GBA) which causes the condition Gaucher disease has been found to be associated with a slightly higher risk of developing Parkinson's much later in life, possibly after the age of 80. RAPSODI aims to use existing tests that have been successfully developed and are currently used in a sister study called PREDICT PD, that can identify clues that appear many years before the appearance of the movement problems associated with Parkinson's.

Recent research suggests that problems including loss of smell, sleep and memory problems, constipation and anxiety may occur many years before the movement related problems of Parkinson's appear. These problems are not specific to Parkinson's, however by looking for combinations of them amongst large groups of people who we know carry the GBA, we believe that in due course we will be able to detect those in the very earliest stages of developing it. By using the internet, we can include large numbers of people, who can take part from home, enabling us to process lots of information quickly, cheaply and efficiently. Over the past 4 years PREDICT PD has been using the internet to look for these patterns which may predict Parkinson's amongst the general population. The information gained in the RAPSODI study will complement that obtained in PREDICT PD and together the two studies will allow an unparalleled insight into the way Parkinson's develops at an early stage. The ultimate aim of this research is to develop new drug treatments that protect neurons many years before any damage or loss occurs helping everyone at risk of developing Parkinson's.

The Busselton Healthy Aging Study (http://bpmri.org.au/)

This is a large multidisciplinary project investigating the causes of and risk factors for a wide range of conditions of public health importance in an ageing population.

Between 2010 and 2015 over 5100 Baby boomers (adults born 1946 and 1964) completed measures on vision and hearing disorders, respiratory and cardiovascular disease, muscle strength and physical function, obesity, diabetes, sleep disorders, bone health, spinal pain, and mental health and cognition. The study is providing important information about the risk factors underlying disease and debilitation common to ageing and the impact of multi-morbidity on physical and cognitive function. The CDR System was used in the first Phase. The study has now entered the first follow up Phase which encompasses a second round of testing and CogTrack is being used to assess cognitive function.

Prospective Longitudinal All-comer Inclusion study on Eating Disorders (PROLED)

The Biomarkers and Clinical Research in Eating Disorders (BCRED) research group is led by Associate Professor Magnus Sjogren, Psychiatrist and Chief Physician, Copenhagen University and Mental Health Center Ballerup, Capital Region of Denmark. Dr Sjogren has more than 120 scientific publications, and an h-index of 34. BCRED hosts the PROLED study (Prospective Longitudinal All-comer Inclusion study on Eating Disorders) and has collaborations with Professor Keith Wesnes, Northumbria University, Professor Thomas Werge and his research group, the Institute of Biological Psychiatry at St Hans Centre, Roskilde, Professor Cynthia Bulik, University of North Carolina and Karolinska Institute, and Associate Professor Rene Støving, University of Southern Denmark. The biological samples collected in the PROLED are stored at the Danish National Biobank (SSI). The PROLED study invites all patients with eating disorders who are investigated and treated at the Mental Health Center Ballerup, Denmark, to be enrolled in the study. The main scientific interests are biomarkers, psychopathology, disease course, and biology of the disease of Eating disorders as well as associated disorders. The mission is to study the biological and clinical aspects of eating disorders via collecting clinical data from interviews and tests, cognition tests, medical record data, and withdraw blood and other biological samples, during the course of the disease, and via genomics, and other technologies, identify biomarkers, study and characterize the psychopathology, the disease course, prognosis and biology of eating disorders. The ambition is to improve the clinical and biological understanding of these disorders and find leads for molecular targets for novel treatments.

Newcastle University

http://research.ncl.ac.uk/medplant/index.php

CogTrack is being used in a series of research studies involving the cognitive benefits of various natural products such as blackcurrants, energy drinks, and studies combining CogTrack testing with sophisticated assessments of the patterns of electrical activity in the brain.

Northumbria University

https://www.northumbria.ac.uk/

CogTrack is currently being used in a number of studies, including a major long-term investigation into the cognitive effects of smoking cessation and the role of e-cigarettes in this process.

Available Cognitive Tests

The tests currently available to assess three major domains of cognitive function are listed below followed by more detailed descriptions:

Attention, Concentration, Vigilance

Simple Reaction Time - 2 minutes

Digit Vigilance – 3 minutes

Choice Reaction Time - 2 minutes

Working Memory & Executive Control

Numeric Working Memory – 1.5 minutes

Spatial Working Memory – 1.5 minutes

Episodic/Declarative Memory

Word Presentation – 0.5 minutes

Immediate Word Recall – 1 minute

Delayed Word Recall – 1 minute

Word Recognition – 1.5 minutes

Picture Presentation – 1 minute

Picture Recognition – 2.5 minutes

Attention, Concentration, Vigilance

Simple Reaction Time

This task assesses alertness and the ability to focus concentration by measuring the speed with which a simple motor response can be made to an imminent and expected stimulus, which may occur at any moment. During the task, the word YES is presented in the centre of the screen at brief but unpredictable intervals. The participant is instructed to place the right forefinger lightly on the RIGHT arrow keyboard key and to press the key as quickly as possible to the occurrence of the stimulus. It is emphasized that the finger should not be removed from the key between stimuli and that the speed of response is crucially important. It is also made clear that only the word YES will appear and it will always appear in the middle of the screen. Each stimulus remains on the screen until the RIGHT arrow keyboard key is pressed. 50 stimuli are used with randomly varying intervals between 1 and 3.5 seconds. The task takes approximately 2 minutes to complete.

Digit Vigilance

This task measures sustained and intensive attention; also known as vigilance. The participant is instructed to monitor a rapidly appearing series of digits presented one at a time in the centre of the screen. At the start of the task a 'target' digit is selected randomly and presented on the right hand side of the screen where it remains throughout the 3 minute task. The digits are presented in an unpredictable order at the rate of 150 per minute, and there are 15 targets every minute. The participant is instructed to press the RIGHT arrow keyboard key as quickly as possible every time a target digit appears in the series of digits, even if the digit is no longer displayed. As in simple reaction time, this is the only type of response made during the task, and the participant is again required to keep the forefinger lightly on the key throughout the test. The task records the number of correct detections (hits), the speed of these correct detections, and all responses made in error (false alarms). By having a high target rate, the task effectively monitors the quality of focus second by second over the 3 minute task duration. The advantage of having the target digit constantly displayed is that it removes any involvement of working memory from the task, allowing the quality of performance of the task to be a pure measure of attentional ability.

Choice Reaction Time

This task measures alertness, the ability to focus concentration as well as information processing. Besides being a measure of attention and focus, this task also measures the processing time required to identify the stimulus and select the appropriate response. The task, similar to Simple Reaction Time with the exception that each stimulus can be either the word YES or the word NO. The participant is asked to place the left forefinger on the LEFT arrow keyboard key and the right forefinger on the RIGHT arrow keyboard key. They are instructed that stimuli will be presented in the centre of the screen in an unpredictable order. The participant is instructed to press the appropriate key as quickly and accurately as possible. It is emphasized that the fingers should remain on the buttons throughout the task. 50 stimuli are used with randomly varying intervals between 1 and 3.5 seconds. The task records speed and accuracy of all responses and takes approximately 2 minutes to complete.

Working Memory & Executive Control

Spatial Working Memory

This task measures the ability to keep spatial information in working memory and to retrieve it. The participant is presented with a 3x3 array of light bulbs for 10 seconds. Four are lit, and the participant must remember the spatial location/pattern of these bulbs. A series of 'probe' stimuli (3 x 3 arrays) in which only one bulb is lit, is shown on screen one at a time, each lit bulb position of the original target pattern is probed four times (16) and each non-target position is probed four times (20) giving 36 probes in total. The order of presentation is randomized. During this part of the task the participant is instructed to place the left forefinger on the left arrow keyboard key, and the right forefinger on the right arrow keyboard key. The participant is instructed to press the RIGHT arrow keyboard key whenever an original lit bulb is presented, or the LEFT arrow keyboard key if the probe is not one of the original items. The probes remain on the screen until the key is pressed, and the participants are instructed to make their decisions as quickly and accurately as possible. The accuracy of responses is recorded, as is the speed of all appropriate responses. The task lasts approximately 1.5 minutes.

Numeric Working Memory

This task measures a participant's ability to hold numeric information in working memory and rapidly retrieve it. A 'target' series of 5 digits (0 to 9) is presented one at a time. Each digit is displayed for 1150 ms with an interval of 50 ms between each presentation. A series of 30 probe digits follow (digits from 0-9), and the participant is instructed to press the RIGHT arrow keyboard key if the digit was one of the targets originally presented, or they LEFT arrow keyboard key if it was not. Probe stimuli remain on screen until a response is made. Half of the probe stimuli require a RIGHT arrow key response and half a LEFT arrow key response. During this part of the task the participant is instructed to place the left forefinger on the LEFT arrow keyboard key, and the right forefinger on the RIGHT arrow keyboard key, and to make the responses as quickly and accurately as possible. The task last for approximately 1.5 minutes.

Episodic/Declarative Memory

Verbal Recall & Recognition

This task measures episodic memory for verbal information. Fifteen words are initially presented on screen, one at a time; each word is displayed for 1500 ms with an interval of 500 ms between each presentation (one word every 2 sec). Immediate word recall follows this task directly after the final word has been presented; recall is achieved by participants typing as many words as they can recall (in any order) within 60 seconds. Participants then complete the CogTrack tests of attention and working memory, followed by delayed word recall and delayed word recognition. In delayed word recall, the participant again types as many words as they can remember seeing earlier (in any order) within 60 seconds. Word Recognition then follows, in which the original words together

with an number of equivalent distractor words are presented one at a time, in a random order. During this part of the task the participant is instructed to place the left forefinger on the LEFT arrow keyboard key, and the right forefinger on the RIGHT arrow keyboard key. The participant is instructed to press the RIGHT arrow keyboard key whenever an original word is presented, or the LEFT arrow keyboard key if it is not one of the original words. It is emphasized that the responses must be made as quickly and accurately as possible. Each word remains on the screen until a response is made and the speed and accuracy of every response is recorded. A different but equivalent list of words presented on each testing occasion. These tasks take approximately 4 minutes in total.

Pattern Separation

This task measures the ability to store and retrieve visual information, being a measure of cued episodic secondary memory retrieval. A series of 20 pictures of everyday scenes and objects is presented on the screen at the rate of 1 every 3 seconds. The participant is instructed to pay close attention to the detail of each picture, as they will later be shown these pictures together with very similar ones (named lures). There are no responses for this part of the task. Then, after other intervening tests have been performed, usually around 15 minutes later, the 20 original pictures are presented mixed with the 20 lure pictures. During this part of the task the participant is instructed to place the left forefinger on the left arrow keyboard key, and the right forefinger on the right arrow keyboard key. Each picture has a closely similar paired picture, and the participant is instructed to press the RIGHT arrow keyboard key whenever an original picture is presented, or the LEFT arrow keyboard key if it is a different one. Again the stimuli remain on the screen until the key is pressed, and the participant is instructed to make the decisions as quickly and accurately as possible. The accuracy and speed of every response is recorded. The two parts of the task together take approximately 3 minutes and 30 seconds. Different picture pairs are used at each participant visit. This accuracy and speed of response to the lure stimuli in this task have been shown to be selectively sensitive to activity in the dentate gyrus of the hippocampus, the area responsible for neurogenesis.