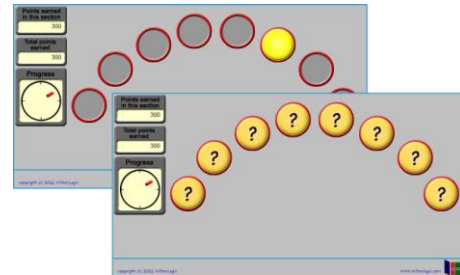




## Module 6: Working Memory

### Discrete Trial Spatial N-Back (DTSNB)

The Discrete Trial Spatial N-back has been adapted for use with human participants from a procedure first used in rodents by Ko & Evenden (2009). The test participant is shown eight target locations arranged in an arc across the screen. During the sequence phase of each trial these targets are “lit up” by the computer, one at a time, in a randomized order. This is followed by the recall phase. During the sequence phase, participants have to click on each lit target in turn, and then on a second centralized button to light up the next target. The number of lit locations in the sequence varies from 5 to 8, so that the participant does not know when the recall phase will take place. The last three lit targets in each trial are always assigned to three different locations, whereas the rest of the targets making up the trial are assigned randomly. In the recall phase, all eight targets are lit up at the same time, and labeled with a question mark. At this point, in the 1-back version of the test, the participant is required to click on the location of the last target which is lit up in the sequence phase. In the 2-back test, the participant is required to click on the penultimate target in the sequence, and in the 3-back, on the third to last target. The locations of the correct target are allocated at random, so that the same location could be correct on multiple trials. The procedure is entirely self-paced, and the participants can take as long as they like to make each response to a target, and to make the choice in the recall phase.



There are 10 trials in the 1-back test and 12 each in the 2-back and 3-back tests. Each phase of the procedure is preceded by instructions as to the test contingencies, and two practice trials, which are not included in the data analysis. Transition between the phases is supported by a change in the background color and the color of the target surrounds. The key measure in this test is choice accuracy, percent correct choices at each of the three levels. In house experience suggests that 3-back is the level which best differentiates amongst healthy individuals, whereas 2-back may be the optimal level for distinguishing psychiatric patients.

### Symbol N-back (SYNB)

The Symbol N-back is based loosely on the published procedure of Callicott and colleagues (1998), It differs from the discrete trial test in that it is a go/no go test, rather than forced choice test. Symbols were used in this test rather than the more traditional numbers to discourage rehearsal of the sequence.



One of six symbols are shown in the middle of the screen for 1s with a 1s inter-target-interval. Underneath the target array is a single response button. In the 1-back version of the test, a correct response consists of clicking on the response button if the same symbols occurs twice in a row ( a “hit”). To be considered a hit, the response has to be made before the next symbol appears. Responses made at any other time are recorded as “false alarms”. Only one response can be made following each target, and has no effect on the presentation time or order. In the 2-back test a hit is recorded if the participant clicked on the response button when the current symbol is the same as the second to last symbol, i.e. with one intervening symbol, and in the 3-back, when the current symbol is the same as the symbol separated by two intervening targets. There are six different presentation sequences for each level of the test, and these are designed so that potential hits occurred at 5-8 target intervals, similar to the discrete trial N-back. To minimize task interference, the presentation sequences in the 2- and 3-back levels were designed so that there are no examples of 1-back at any point in the sequence.

There are 12 trials at each level of the tests. Each change in condition is signaled by instructions on the new contingency, two practice trials, and a change in background color and the color of the target surround. Percent hits and percent false alarms are recorded, and from these SI and RI are calculated. In these tests SI represents the sensitivity to the difference between targets and false targets, and may be considered as a measure of working memory. RI represents the tendency to respond regardless of whether the target is correct or incorrect.

A numerical version of this test is also available.

### **Pattern Memory Test (PMT)**

The Immediate Memory and Delayed Memory tests are based were first described by Dougherty, Marsh & Mathias (2005) and involve detecting repeated sets of digits in an ever-changing series. The Pattern Memory Test is similar to the Immediate Memory Test, but uses shapes rather than digits, and is designed to eliminate the possibility of sub-vocal rehearsal of the numbers. On



each trial five small pictures are picked from a menu of ten to create a linear visual pattern. On some occasions, the same 5-picture pattern is presented twice in a row. This is a target, and the participant is required to click on a button before the next number is presented in order to record a correct detection or “hit”. On other occasions a pattern differing by only one randomly-selected picture from the previous number is presented. This was a false-target, and a button click is considered a “false alarm”. A button click response has no effect on the rate or order of the digit presentation. After the tutorial explaining the test, the participants are allowed 30s to practice, and then data are collected for a further 8 min, 40 s (520 numbers). Target or false targets are presented with a minimum of 3 and maximum of 6 intervening numbers. The percentage of hits and false alarms are also calculated, and from these the non-parametric signal detection indices, SI and RI (Frey & Colliver, 1973) are calculated. SI is a measure of task accuracy (working memory), whereas RI is a measure of disinhibition (impulsivity).