Monkey CANTAB

Lafayette Instrument.
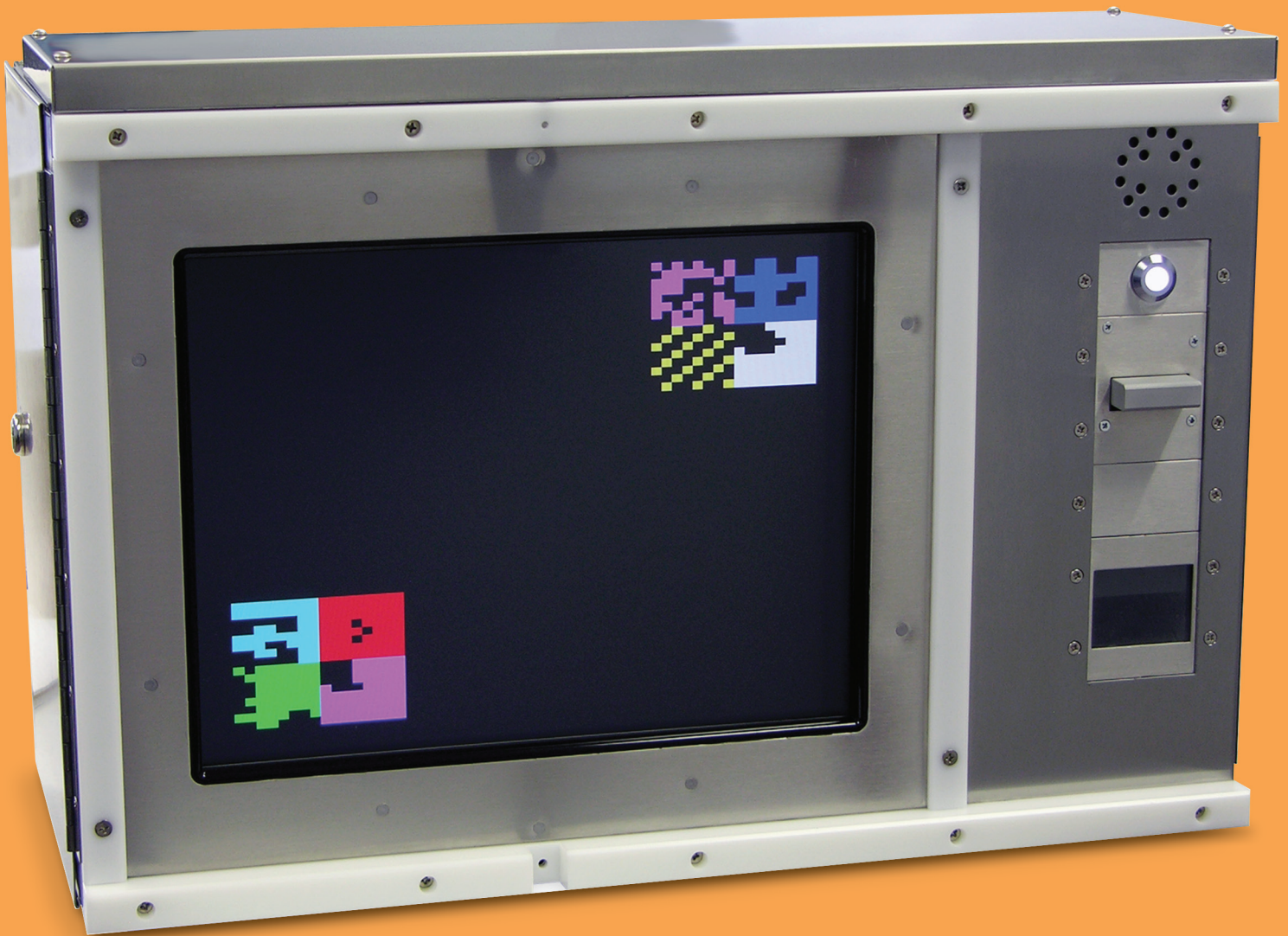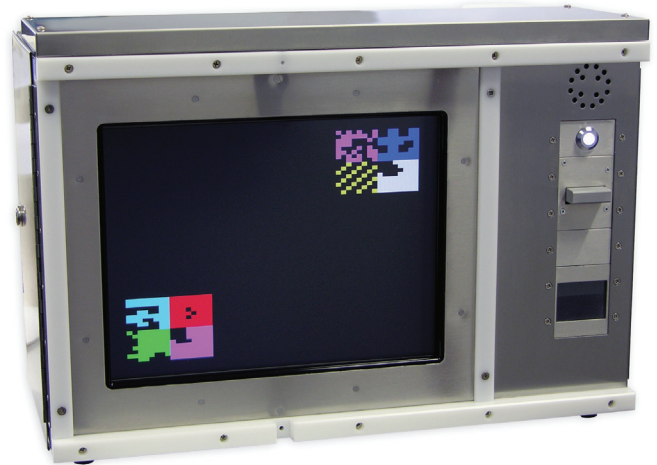
MONKEY CANTAB INTELLISTATION

The Cognitive Testing System was developed for non-human primates and has been a part of the Lafayette Instrument touch screen product line since 2004.

The CANTAB Intellistation™ features a self-contained computer with dual core 1.65 GHz processor. The CANTAB Applications and WhiskerServer™ OS license are bundled separately per station to minimize startup costs. Each software bundle is factory installed to provide all test specific criteria, stimulus presentations, and animal response hardware needed for a complete system. To run as a stand-alone station, simply add a USB keyboard, mouse, and optional monitor (not included). Connection for any remote setup requires a standard RJ45 Ethernet Cable. Proprietary software is provided to support remote operation of a single unit or multi-station setup. Stations may be setup as a local network with a central master computer or may be connected to an existing network.

CANTAB Intellistation™ with Pellet Reward
Model 80950A

The Intellistation™ comes standard with pellet (rhesus) or liquid (marmoset) reward. Several dual reward options are also available as well as the Intellipanel™ test station with or without enclosure suitable for testing non-human primates, dogs, swine, and other species. Contact us directly for complete information.

CANTAB Test Stations

with **Pellet Reward**
Model 80950A

with **Liquid Reward**
Model 80951A

The Model 80951A Intellistation™ with Liquid-based reward is favored by users working with Marmoset monkeys. For Rhesus monkeys, we would recommend using a sturdier Model 80662B or Model 80663B Lick Tube.

If a system with both pellet and liquid reward is required, we recommend outfitting a Model 80950 Intellistation™ (with Pellet Reward) with a Lick Tube.

Features
- Touch screen panel encased in a durable stainless steel metal frame
- Splash-proof IR touch screen with LCD monitor
- IR touch array with tempered glass and protected safety film
- Fixed response lever
- Speaker to reproduce audio cues to the subject
- Calibrated 12.2ml flow rate peristaltic pump with receptacle
- Lick sensor allows liquid reward to be (optionally) delivered only when the animals's tongue is detected
- Fan maintains internal case temperature
- Hinged stainless steel side panels with latches to protect feeder and components from animal subjects
- Able to be installed in a test cubicle or used in a home chamber environment
- Dimensions: 22.5" W x 15.5" H x 12"
- Weight: approximately 50 lbs (22.5kg)

MONKEY CANTAB TESTING BATTERY

The Monkey CANTAB application portfolio is comprised of a test battery performed via a touch screen. Batteries are flexible and can be configured by the user. Multiple tests may be linked in the same subject session. Systems can be customized with pellet reward, liquid reward, or both.

New or Recently Released CANTAB Tasks

Conditional Visual Discrimination

- Each trial begins with a Marker 1 sound (optionally, following an initiation response).
- A stimulus appears on the screen, along with two response manipulanda (left and right). It is possible to obtain reward for any stimulus, but some stimuli require a Left response, and some stimuli require a Right response.
- The first response to a stimulus is registered, and the subject receives reward/punishment accordingly (or, if it fails to respond, an omission occurs and is punished).

A stimulus can appear briefly or for as long as the subject is allowed to respond.

The stimulus (like any in MonkeyCANTAB) can be a blank stimulus. This allows the task to be used as a two-choice vigilance task, as follows:

- Trials initiate spontaneously
- Two stimuli are used: one visible, one blank (invisible)
- The stimuli appear briefly, then the manipulanda appear
- The subject must respond (e.g.) left for the visible stimulus and right for the "non-stimulus"

Concurrent Discrimination

- Each trial begins with a Marker 1 sound (optionally, following an initiation response).
- Stimuli appear in various locations on the screen. Some stimuli are correct; some are incorrect.
- The first response to a stimulus is registered, and the subject receives reward/ punishment accordingly (or, if it fails to respond, an omission occurs and is punished).

By default the task considers a separate set of correct and incorrect stimuli; however, you can also lock the correct stimulus list and the incorrect stimulus list together, creating a n-pair concurrent discrimination task (in which paired stimuli always appear together).
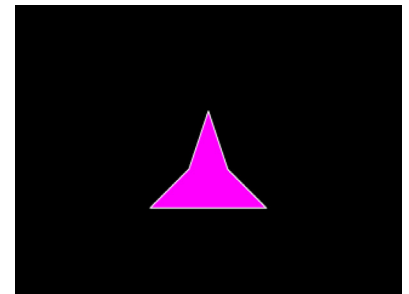
Continuous Performance Task

In brief, stimuli appear sequentially, and subjects must classify them as targets (and respond to them) or non-targets (and not respond to those).

Ancestry: Rosvold HE, Mirsky AF, Sarason I, Bransome EB, Beck LH (**1956**) A continuous performance test of brain damage. *J Consult Psychol* 20: 343-350.

The task is composed of a series of stages. Each stage defines a target and nontarget(s), and specifies their proportion (sometimes grouping trials into blocks that are approximately imperceptible to the subject). Stages can have a passing criterion, and if the stage is passed (e.g. success on a certain number of trials within a certain time limit) the task progresses to the next stage. Individual trials simply consist of presenting a stimulus (target or nontarget) and seeing what the subject does. Reinforcement options are configurable.
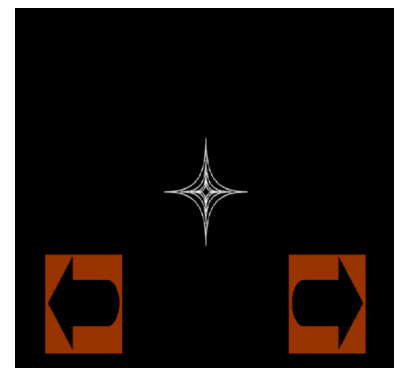
Impulsive Choice

Choice with delayed and/or probabilistic reinforcement (discrete-trial task).

Originally based on Evenden JL, Ryan CN (**1996**). The pharmacology of impulsive behaviour in rats: the effects of drugs on response choice with varying delays of reinforcement. *Psychopharmacology* 128: 161–170.

A number of types of task are possible with this program. The trial structure of a typical delayed reinforcement task, albeit using operant chambers rather than touch screens, is shown below (taken from Cardinal et al. 2001):
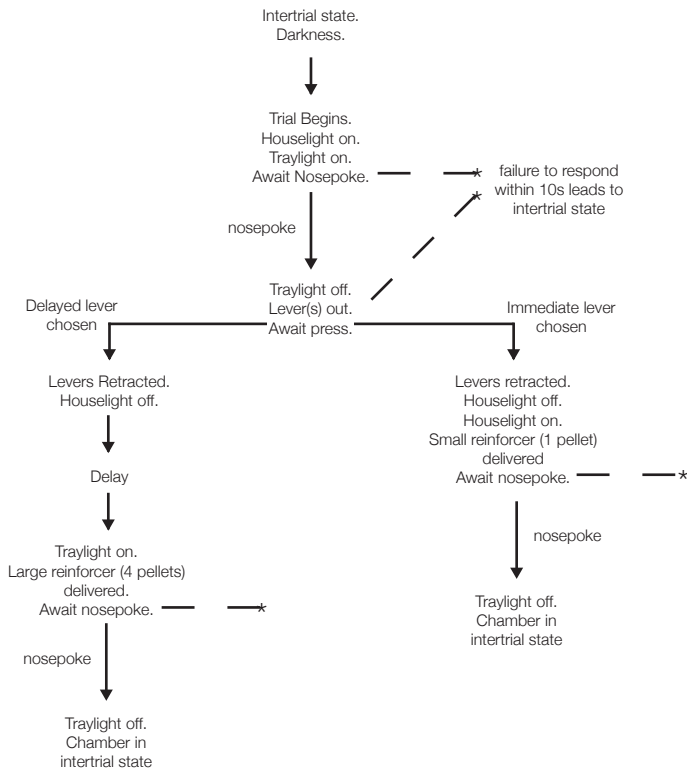
Figure 1: Delayed Reinforcement choice task. The format of a single trial is shown; trials began at 100-s intervals. A session lasted 100 min and consisted of five blocks, each comprising two trials in which only one lever was presented (one trial for each lever, in randomized order) followed by 10 choice trials. The delay to the large reinforcer was varied systematically across the session. Delays for each block where 0, 10, 20, 40, and 60 s, respectively.

Figure 2: Likewise, the trial structure of a typical probability-based task is shown below (taken from Cardinal & Howes 2005):
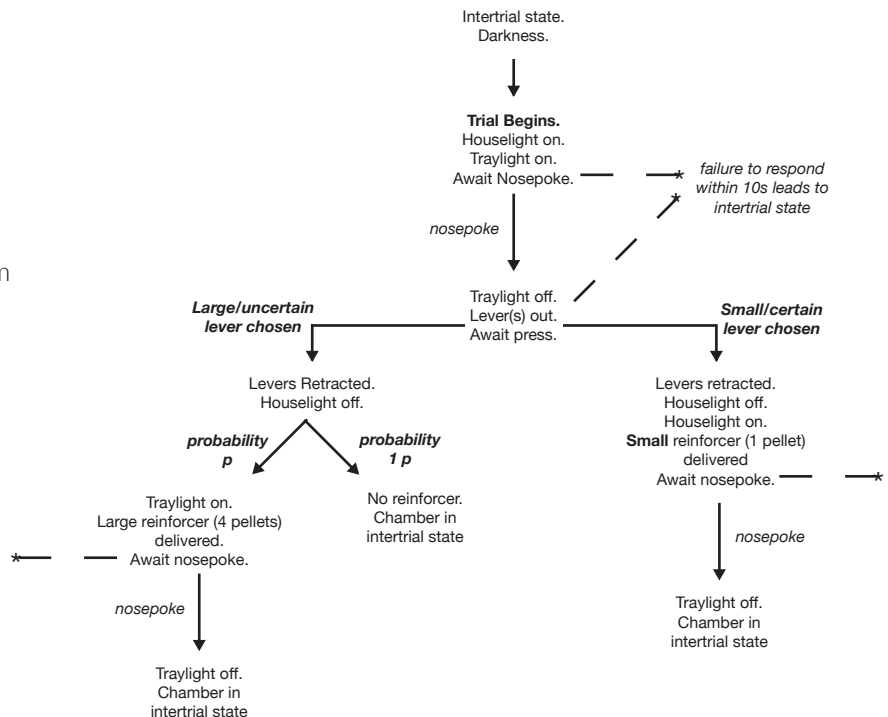
Rapid Visual Information Processing

- Each trial begins with a Marker 1 sound.
- The subject may initiate a trial (and subsequently respond) by pressing (and then releasing) a lever, or by touching (and later releasing) a stimulus on the screen, or by pressing a lever to initiate the trial and then touching the target to respond.
- Following initiation, the target area appears on the screen.
- After a configurable delay, stimuli start to appear in the target area. The subject must watch for the target stimulus. Before it appears, there is usually a series of distractor stimuli that must be ignored.
- Success occurs when the subject responds to the target stimulus. Failure occurs when the subject fails to initiate the trial, fails to respond to the target, or responds early to one of the distractors.
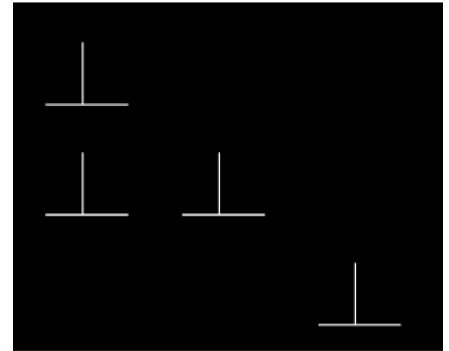
List-based Delayed Matching/Non-Matching to Sample

This task is a variant of the normal D(N)MTS task. Suppose you want to test many long delays (e.g. 5 minutes, 10 minutes, and 15 minutes). In the conventional task, in which SAMPLE and CHOICE phases are paired, this would be slow, but the task could potentially be run in a more time-efficient manner, also requiring the subject to memorize several samples at once.

Other Popular CANTAB Tasks

Reinforcement Familiarization

The aim of this program is to teach the monkeys that the onset of a tone signals the availability of reinforcement. This is the standard signal for the availability of reinforcement across all the cognitive tests.

Features

- Optional association of reinforcement with correct tone
- Reinforcement delivery option contingent upon an independent response (e.g. licking)

Training Program

The aim of this program is to train the monkey to touch a solid box that is presented anywhere on the computer touch screen.

Features

- Up to seven box sizes
- Boxes may be one of seven colors
- A touch outside the box restarts the trial
- Reinforcement delivery option contingent upon an independent response (e.g. licking)
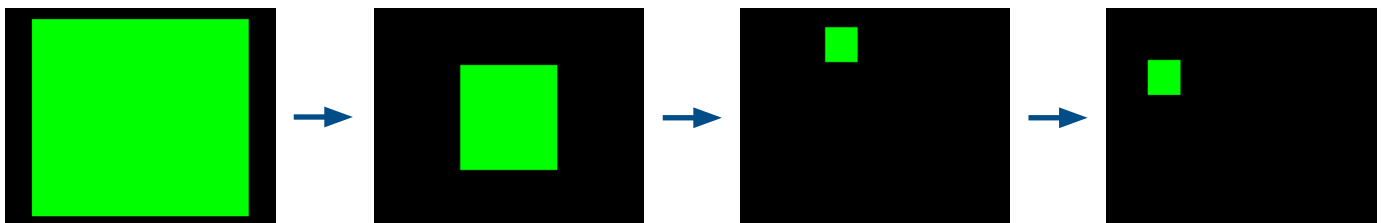
Delayed Matching / Non-Matching to Sample

This platform tests the short-term memory using a non-repeating sequence of arbitrary symbols. It is analogous to the use of junk objects in the Wisconsin General Testing Apparatus. The symbols used are the same as the stimulus used for the human CANTAB Delayed Match to Sample Test.

Phase 1   Phase 2   Correct Response
(if matching)

Incorrect Response
(if non-matching)
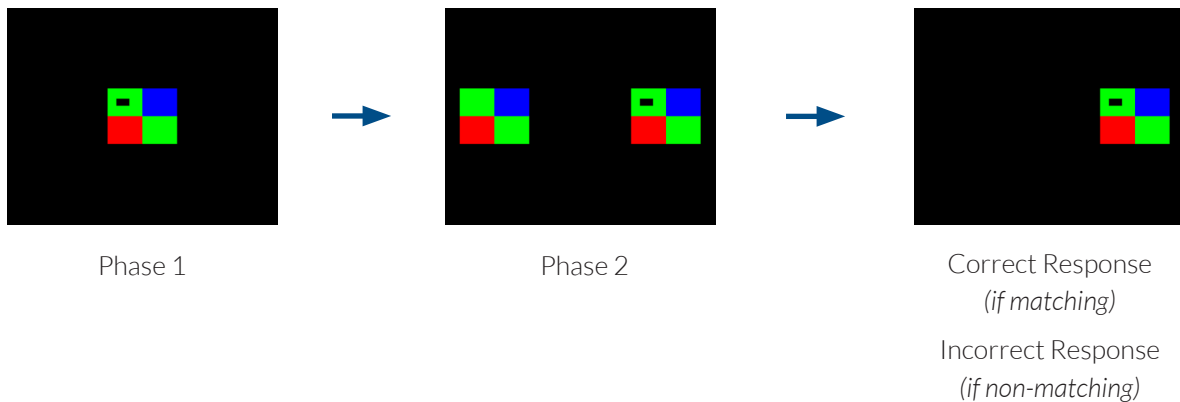
Choice Serial Reaction Time

This task is analogous to Lenonard's Five-Choice Serial Reaction Time task, which is based on the Continuous Performance Test of Rosvold and Mirsky. The subject is presented with a tone (optional) and a set of empty target stimuli (typically five open circles) to signify the start of a trail. The subject makes a response by pressing a key or a screen stimulus.

After a delay, a target stimulus is presented for a specified duration in one of five places (e.g. a filled circle appears within one of the five open circles). If the subject touches the filled circle or the place where it was presented, it is reinforced: incorrect responses are punished. Accuracy of the response and the reaction time are recorded.

Features

- Minimum key-holding time can be independent or locked to delay
- The delay may be set from a specified list, either in the identified order or chosen randomly from the list (it also may be chosen randomly by the computer)
- A list of stimuli durations can be stimulated, from which either a truly random selection is made or a pseudo-random selection is made so that each delay is presented in random order
- Stimulus duration may also be reduced following x correct consecutive trials for training purposes
- Frequency of stimuli between positions may be varied
- One-choice test allows basic reaction timing, and a three-choice test is also available
- Optional Distracter signal
- Both TRAINING and TESTING modes of operation are provided

Empty Targets   Flash Stimulus   Empty Targets   Correct Response
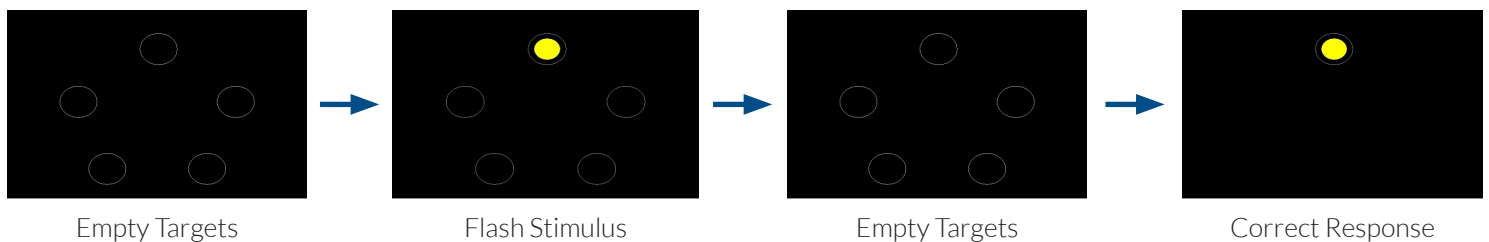
Paired Associates Learning

This conditional memory and learning task, located in the trial-unique patterns, must be learned and remembered. Human variations of the test are sensitive to changes in the early on-set of Alzheimer's disease.

Features

- Novel patterns on every trial
- Each trial repeated until correct (changes order of presentation)
- Pre-training stage for task familiarization
- Two alternative training procedures
- Six levels of difficulty: two training and four testing
- Each session can have multiple (progressive) stages

| Stimulus Presentation	Response Phase	Correct Response
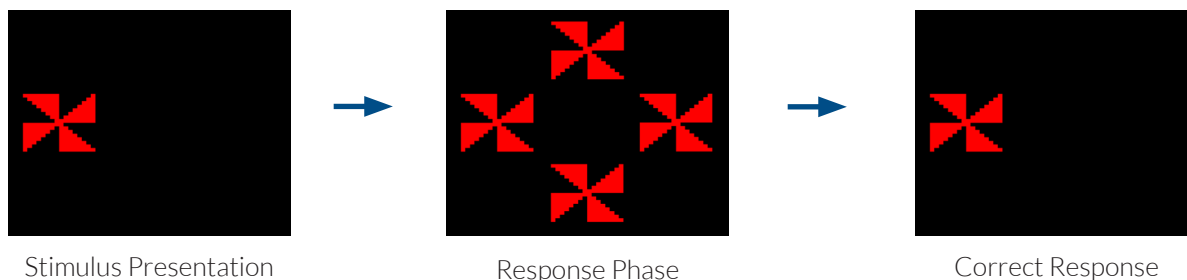
Intra / Extra Dimensional Set-Shift and Visual Discrimination (ID/ED)

This set of visual discrimination and reversal tests can be used to study a range of cognitive processes which include:

- Simple associative learning: learning that a response to a particular stimulus is associated with reinforcement
- Selective attention: learning to attend selectively to a particular dimensional property of the stimulus
- Attentional set-shifting: learning to shift attention from one dimensional property of another stimulus

The two types of test that make up this program use either simple (one-dimensional) or compound (two-dimensional) stimuli. Each dimension used is color-filled shapes or white lines. Simple stimuli are composed of just one of these prepositions, whereas, compound with stimuli are composed of both. The stimulus is the same as those used for the human test.

| Stimulus	Correct Response	Stimulus	Correct Response
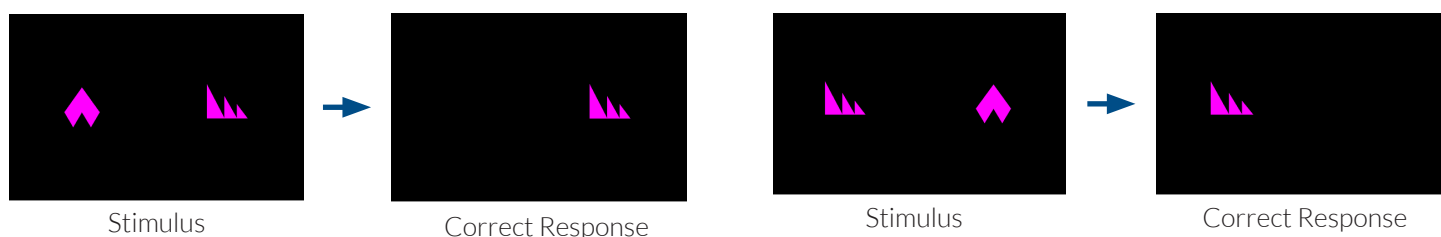
Simple Schedules of Reinforcement

This program provides conventional operant schedules of responding to a single fixed square at the center of the screen or on the response lever.

Features

- FR, FI, VR, VI, or Progressive Ratio
- Selectable box size and color
- Optional change of color on response
- Optional breakpoint

Spatial Working Memory

This platform provides a test of functioning memory analogous to that tested in rodents in an 8-arm maze. Boxes appear on the screen with an obvious pattern, and the subject must select each box in turn without revisiting a box already touched.
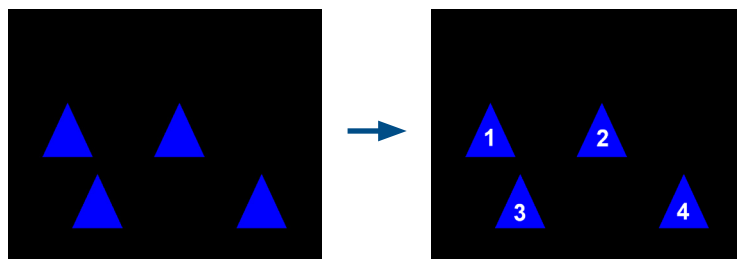
Options are available for training a subject and for varying the difficulty of tasks:

- 16 possible positions: 4 in each quadrant of the screen
- Each trial may have 1-16 boxes
- Box positions may be random or specified for each trial
- Number of boxes in randomized trials can be increased in blocks
- A pool of boxes may be specified to act as a source for randomization
- Boxes may disappear or change color for any amount of time when touched
- Screen may be blank for any amount of time when touched
- Option to increase task difficulty by reinforcing every correct response as opposed to only rewarding the terminal response in a trial
- A number of possible colors and shapes for stimulus
- Both initial and secondary colors can be specified for each trial

# MONKEY CANTAB WITH WHISKER® EMBEDDED SOFTWARE
for all **Intellistations**
Model 80990

This package includes the CANTAB test applications and the basic Whisker® Multimedia Suite necessary to run those applications.

These translational tasks are based on well-established human tests. Alteration from human tests have been kept to the absolute minimum, consistent with the ability in non-human subjects that learn the tasks. The sensitivity of the tests and the direct comparison with human results makes this Monkey CANTAB best for:

- Characterization of the functional organization of the brain
- The development of new and improved animal models with brain disorders
- Early identification of progressive disorders, whether endogenous or as a result of environment
- Easy progression from pre-clinical to clinical studies

Many of the tasks are also available for rats and mice using the Bussey-Saksida Touch Screen Chambers.
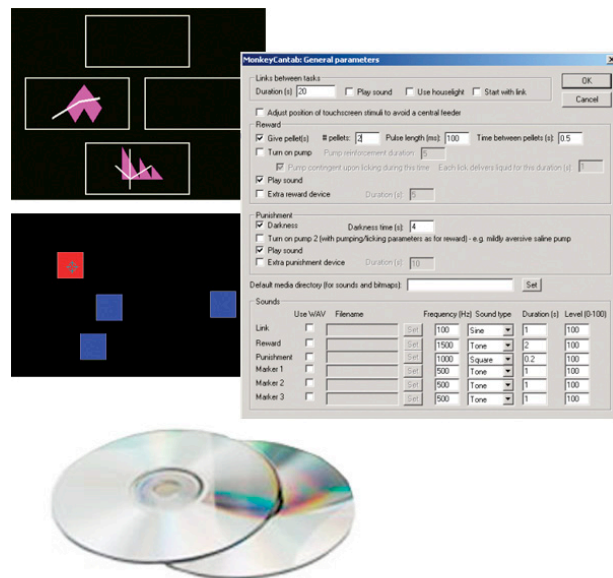
CANTAB WHISKER® MULTIMEDIA

Whisker® Multimedia is a software suite designed to control devices for behavioral research.

Standard Apparatus Devices include:
- Digital Input devices (e.g. Levers, Infrared detectors)
- Digital Output devices (e.g. lights, motors, pellet dispenser, and liquid pumps)

Unlike most operant control systems, Whisker® Multimedia also supports advanced graphical output on multiple monitors, touch screen input, keyboard and computer mouse input, as well as audio output. Whisker® Multimedia is the underlying platform that runs some of the most popular behavioral task suites today!

WHISKER® MULTIMEDIA PRO
Model 80696pro

Programmer's license for Whisker that allows Whisker to be programmed in a variety of languages. Tools are available for C++ and Visual Basic.

ADDITIONAL CANTAB INTELLISTATION OPTIONS
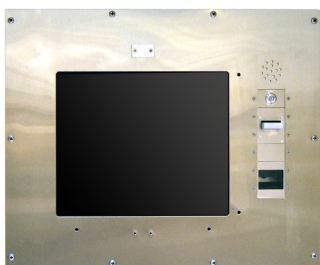
Large CANTAB Wall Mount Intellistation™ Touch Screen Response Panel
Model 80960A

A flat display and touch screen with signal light and speakers. This style of unit was first designed for use with dogs and has also been used with swine.

Omni-Directional Rod
Model 80710

The Omni-Directional Rod is designed to be mounted from the ceiling of the test kennel and will register a response when displaced in any direction by the head or body of the animal. Designed for a 5 foot (1.52 meter) high ceiling with adjustable floor clearance of 30.5 - 10 inches (77.47 - 25.4 cm), this has been used as an orienting response for the CANTAB tests to initiate the start of each trial.

Dog Feeder
Model 80750

This 28 V DC Feeder was originally designed for IAMS® brand dry food for small, medium, and large breeds. It dispenses small quantities of food when given an appropriate control pulse, and has been used with other types of dry food and other species including small swine. Contact us for more information about how this device may be suitable for your application.
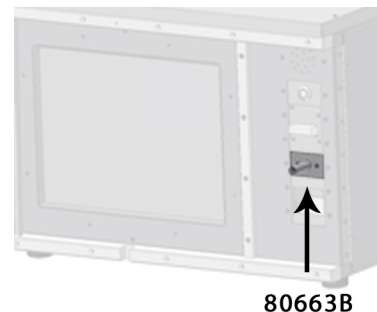
Rhesus Lick Tube
Model 80662B

Add this stainless steel sipper to a Model 80950A Monkey CANTAB Intellistation™ with Pellet Reward. This is generally used with Rhesus and larger monkeys. A peristaltic pump is also required. The unit is designed to mount in the center or on the left side of the touch screen. Older units may require replacement bumper strips to accommodate this unit.

Side Mount Lick Tube
Model 80663B

Add this stainless steel sipper to the Model 80950A Monkey CANTAB Intellistation™ with Pellet Reward. This is generally used with Rhesus and larger monkeys. A peristaltic pump is also required. The unit is designed to mount on the right hand side above the pellet tray, although the lever, light, sipper, and tray are all modular and can be moved as needed.

80663B

Marmoset Lick Tube
Model 80661

Order this stainless steel sipper as a replacement for the sipper on the Model 80951A Monkey CANTAB Intellistation™ with Liquid Reward. This is generally used with Marmoset monkeys. The peristaltic pump is included with the Model 80951A Intellistation™. In most applications where both pellet and liquid reward are require, start with the Model 80950A Intellistation™ - Pellet and add a sipper and pump; however, if the Marmoset lick tube is essential, we recommend starting with the Model 80951A Intellistation™ with Liquid Reward and adding a pellet dispenser and reward tray.

Contact Lafayette Instrument for more information about CANTAB accessories.

RECENT BIBLIOGRAPHY

A select list of recent research using the CANTAB system. CANTAB has been a mainstay in published research for over 30 years.

2019

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Schmitt, V. (**2018**). Implementing new portable touchscreen-setups to enhance cognitive research and enrich zoo-housed animals. *BioRxiv*, 316042.

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Golub, M. S., Hackett, E. P., Hogrefe, C. E., Leranth, C., Elsworth, J. D., & Roth, R. H. (**2017**). Cognitive performance of juvenile monkeys after chronic fluoxetine treatment. *Developmental cognitive neuroscience*, 26, 52-61.

Weed, M. R., Polino, J., Signor, L., Bookbinder, M., Keavy, D., Benitex, Y., ... & Olson, R. (**2017**). Nicotinic alpha 7 receptor agonists EVP-6124 and BMS-933043, attenuate scopolamine-induced deficits in visuo-spatial paired associates learning. *PLoS one*, 12(12), e0187609.

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