Datasheet: Skinner_box.s2s

Summary

This Spike2 script is intended for recording a single channel of neural or other activity (sampling rate 10kHz) while a rat learns to press levers in a Skinner box. The script records the times when each of two levers in the box is pressed as events (on ports 0 and 1) and gives a TTL output pulse to trigger the Skinner box controller to release a food pellet when the required lever is pressed. The timing of rewards is recorded on event port 2. You can select the duration of a refractory period after a reward during which no further rewards are given even if the correct lever is pressed.

Three experimental paradigms are available:

1. Pressing either of two levers is rewarded (training).

2. Pressing the left lever is rewarded.

3. Reversal learning. Pressing the left lever is rewarded a set number of times and subsequently, only pressing the right lever is rewarded.

System requirements*:*

Hardware The script is compatible with a standard 1401 interface. However the maximum sampling rate of the standard 1401 (20kHz) is only sufficient for recording one waveform channel at high resolution (sampling rate > 10kHz). If you are using a more recent model of 1401, you can record multiple waveform channels at sampling rates of >10kHz. Simply add the extra channels to the basic sampling configuration provided.

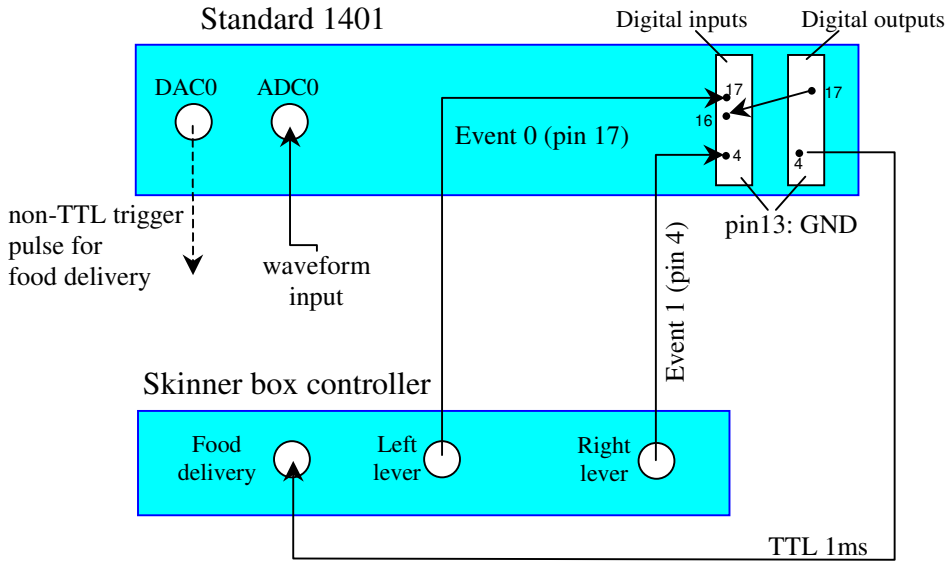
Software Spike 2 version 3.21 or higher.

Scripts etc. Skinner_box v1 *xx* script, sampling configuration and sequencer file (*xx* being a version number).

Hardware and Connections:

The external connections required to set up the system are shown below. Note that the digital inputs and digital outputs connectors are located on the front panel of the Standard 1401 and 1401*plus* interfaces but at the rear on more recent models. Micro1401 and Power 1401 users should check the box in the Spike2 *Preferences* control panel labelled '*Event ports 0 and 1 on rear digital input connector...*'. Consult your 1401 Owners handbook or the Spike2 help index for further information on the digital input and digital output connections.

External connections



You will need a customised cable to connect to the appropriate pins on the digital inputs and digital outputs connectors. The screen of the cable should be connected to Gnd (pin 13). The system is set up to respond on the positive–going edge of TTL pulses produced by the Skinner box controller when a lever is pressed. Digital outputs pin 4 (digital o/p bit 9) provides a 1ms duration TTL pulse to trigger food delivery. Pin 17 of the digital output connector (digital o/p bit 8) also produces a TTL pulse and is connected to Event port 2 (pin 16 of the digital inputs connector) to provide a reward monitor channel. An analog output to trigger delivery of a food pellet on non-TTL systems is also available on DAC0. The default amplitude and duration of this pulse (+4V, 3ms) can be adjusted by minor modifications to the output sequencer file, Skinner_box v1 *xx*.pls.

You can test the script and sequencer before connecting up the Skinner box by using a function generator as a source of TTL pulses to simulate lever presses, and connecting DAC0 to ADC0 in order to monitor the analog output pulse that coincides with the food delivery trigger.

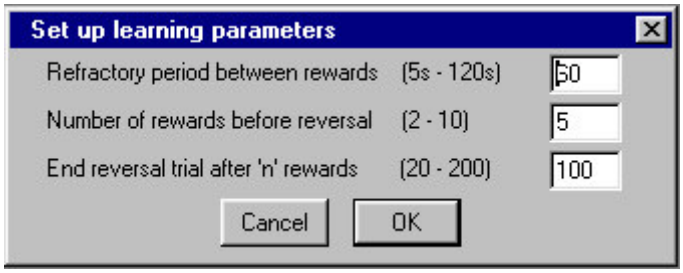
Installing the script.

The Skinner box script package consists of 4 files with the filename Skinner_box v1 *xx*. The file types are .s2s (script), .s2c (sampling configuration) .pls (output sequencer) and .pdf (this datasheet). Store these files in a folder named Skinner_box files inside the Spike3 folder on the C: drive. This folder is also the default location for storing data files generated by running the script. If you store this folder elsewhere (e.g. in the Spike4 or Spike5 folder) then you will need to edit the fpath$ variable at the beginning of the script so that the script will find the relevant files. For example: fpath$:="C:\\Spike4\\ Skinner_box files\\"; .

You will need to edit the sampling configuration Skinner_box v1 *xx*.s2c in order to set up the calibration of the waveform channel appropriate to your set up. Use the *Load Configuration* command on the *File* menu, browse to the file and open it. Select the waveform channel from the list, then press *Edit*. You can enter the signal calibration on the control panel that appears. Close the sampling configuration control panel by clicking OK then save the modified configuration with the same name using the *Save Configuration As* command on the file menu.

Running the script

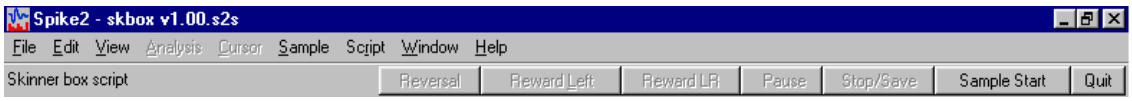
The simplest way to run the script is to use the *Load and Run* option of the *Run script* command on the Spike2 Script drop-down menu. Browse to Skinner_box v1 *xx*.s2s in the Skinner_box files folder and click on Open. You should now see a dialog for selecting various learning parameters:



Entry 1 sets the time that must elapse after a reward is given before the system will respond again to the correct lever being pressed. The default value is 60s.

Entries 2 and 3 are only relevant to the final phase of testing (Reversal), when the rat has already learned to press the left lever. They specify the number of times that pressing the left lever will be rewarded before the system switches to rewarding presses of the right lever (default: 5) and the number of right lever presses before the trial ends (default: 100). Cancelling the dialog closes the script. Press OK to continue with the chosen parameters.

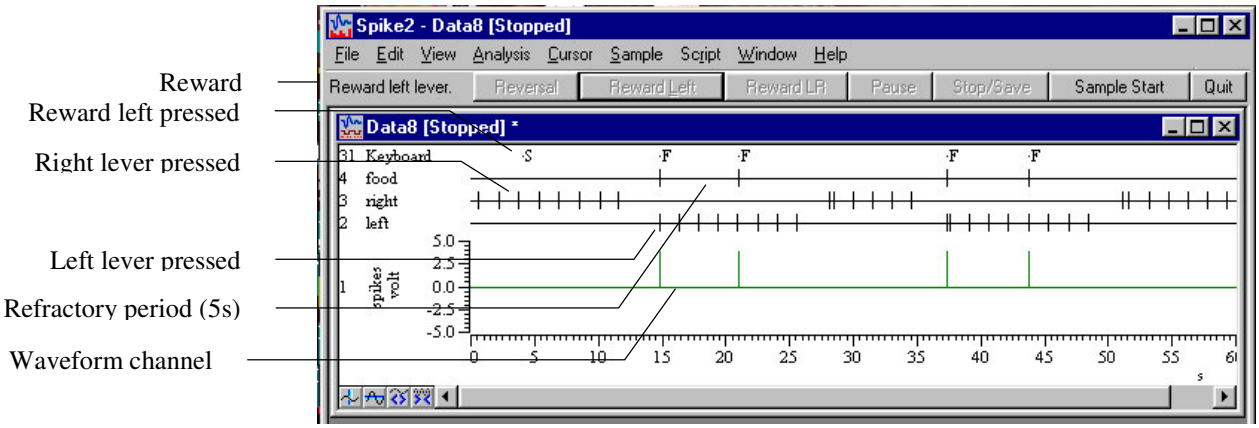
A toolbar with 7 buttons then appears. Toolbar buttons are only enabled when pressing them would be appropriate. Initially, only the Quit and Sample Start buttons are available. Press SampleStart to begin. A data file opens in the upper 2/3 of the screen and sampling begins on 5 channels. Channel 1 is the waveform input connected to ADC0 sampled at 10kHz.



This sampling rate should give a resolution adequate for extracellularly recorded nerve impulses. Traces 2 – 4 are Event+ channels recording the times of left and right lever presses and reward delivery displayed as vertical lines. The keyboard marker channel is also shown. Characters entered at the keyboard are recorded here along with various characters entered by the script as detailed below. (*Tip: If the keyboard marker channel doesn't respond to your entries, click on the data file with the mouse and try again.*)

Initially, the system records the waveform and lever presses but does not administer rewards. This period may be useful for setting up the recording of physiological data. When you are ready to train the rat, press Reward LR. A letter S on the keyboard marker indicates the start of the trial, and, from now on, rewards will be given in response to pressing either left or right levers, subject to the minimum delay between rewards specified at the outset. A summary of the number of presses of each lever and the number of food pellets administered is displayed on the toolbar at the top-left of the window. A letter F appears on the keyboard marker whenever a food reward is given. In fact, this character is the trigger for the output sequencer to deliver a TTL pulse from digital output pin 4 (digital output bit 0) and an analog output on DAC0. Pressing upper case F at the keyboard will also trigger delivery of a food pellet.

Example data file



Clicking Pause (recorded as P on the keyboard marker) pauses delivery of food pellets and stops writing data to disk. Data logging and delivery of rewards is re-started when the Resume button is pressed (R on keyboard marker). A code of 00. or 01. on the keyboard marker indicates when writing to disk stops and starts.

When this phase of training is complete, press Stop/Save. Sampling stops and a Windows dialog appears for you to name the data file, save it to disk and close it. If you cancel this dialog, the file retains its default name and remains on the desktop. It can be saved under another name later. After saving the current data file (or not, as the case may be), you can press SampleStart again to record more data. Usually, the next stage would be to train the rat to press the left lever by pressing the Reward Left button. As before, this trial continues until Stop/Save is pressed.

The final stage is Reversal learning. Simply, start sampling and press the Reversal button to begin the trial. The switch to rewarding the right lever occurs after the number of rewarded left presses specified in the start up dialog. The trial is paused after the requested number of right lever presses, and a warning message is shown on the screen. After acknowledging the message, you can save the file with Stop/Save.

The Quit button is always available Pressing it stops any ongoing sampling, and closes the script. However, the current data file remains on the desktop and can be saved, if required, using the *FileSaveAs* command on the File drop-down menu.