

The K-Limbic System

Using K-Limbic: Five Choice Serial Reaction Time

Introduction

K-Limbic System provides the experimenter with the functions required for performing many operant tasks. We discuss here the K-Limbic implementation of the Five-Choice Serial Reaction Time task protocol, a well-known and documented operant task ⁽¹⁾.

The five-choice protocol provides graduated subject training tasks and study tasks using a combination of stimulus parameters.

Protocol

Figure 1 illustrates the protocol flowchart. The protocol presents a stimulus, then waits for a response in the corresponding response niche, if a response is recorded in the correct niche within the limited hold period the subject receives a pellet reward.

The protocol reacts to a number of conditions including:

- Premature responses
- Correct, incorrect & missed responses
- Perseverative responses

The user can control the stimulus and response characteristics using the sophisticated five choice parameters and subject database. Table 1 lists the variations available; the use of the parameters is discussed on the following pages.

(Please note the flowchart in figure 1 is an example flowchart, the flowchart details are user defined).

Five Choice Parameters

Stimulus

Duration of stimulus presentation
Range: 0mS - 60 seconds

Limited Hold

Duration of the Serial Choice stage
Range: 1 - 300 seconds

Iterations

Number of repeated trials
Range: 1 – 100

Banked

Determines fully random or banked trials
Range: Enabled/Disabled

Inter-Trial Interval

Duration of the Serial Distraction stage
Range: 1 - 300 seconds

Tone Burst

Duration of tone from the tone generator
Range: 10 - 1000mS

Tone Timing

Options: Off
t = 0
t = T/2
t = T

Tone Generator

Options: Use Sonalert
Use ANL926 (Audio Gen)

Table 1: Experimental Parameters

(1) Cole B.J., Robbins, T.W. 1989
Effects of 6-hydroxydopamine lesions of the nucleus accumbens septi on performance of a 5-choice serial reaction time task in rats: implications for theories of selective attention and arousal
Behavioural Brain Research, 33 (1989) 165-179

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Five Choice Table

The 'Five-Choice Table' is a parameter table in the subject database. The entries in the table generate user defined five-choice 'tasks'.

A basic 'five-choice table' (single stimulus type), caters for subject training, for multi-stimulus experiments use the five-choice table in 'series' mode. The parameters are the same regardless of whether the table is in "table" or "series" mode.

The table can contain as many entries as required. Each entry in the table is independent so all the parameters in table 1 can be varied in each entry.

Subject Training

During subject training, each entry in the table defines a stage in the training process. There is no practical limit to the permissible number of entries in the table. It is up to the individual experimenter to determine how many stages are necessary during training

During the session loading process, K-Limbic presents the subjects' 'five-choice table' to the operator, one entry in the table is selected and the experiment is generated using the parameters specified in the selected entry. K-Limbic ignores all other entries in the table.

During training it is expected that the parameters that will vary will be (i) stimulus duration and (ii) limited hold time, consider a six stage training process with the following stages:

The six stage training process below requires a 'five-choice table' with six entries. The first entry in the table specifies the 'entry point' stimulus for an untrained subject, (Stage 1); the next entry in the table specifies stage 2 and so on.

Stage 1:	Stimulus Duration:	30 S
	Limited Hold:	60 S
Stage 2:	Stimulus Duration:	15 S
	Limited Hold:	30 S
Stage 3:	Stimulus Duration:	5.0 S
	Limited Hold:	15 S
Stage 4:	Stimulus Duration:	2.0 S
	Limited Hold:	15 S
Stage 5:	Stimulus Duration:	1.0 S
	Limited Hold:	10 S
Stage 6:	Stimulus Duration:	0.5 S
	Limited Hold:	5 S

Note: This example is for illustration purposes only. We do not suggest that the process outlined above is suitable for subject training.

The remaining parameters will most likely remain constant throughout the training period, (although they may vary if required).

Number of Trials

The Iterations parameter determines the number of trials.

The number of trials, N, is the product of the iterations parameter and the number of sensors:

$$N = \text{Iterations} \times \text{Sensors}$$

For example, if an entry has an iterations value of 20 K-Limbic will create...

$$N = 20 \times 5 = 100 \text{ trials}$$

With banking enabled, these trials are organised in 20 banks of five trials, (each bank containing one stimulus presentation in each niche). With banking disabled, the trial order is fully randomised.

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Inter-Trial Interval

The inter-trial interval parameter determines the delay used for the inter-trial interval stage in the protocol. In this training example the ITI value remains constant for all trials. The ITI parameter allows subject specific variation of the ITI. It may be any integer value between one second and 300 seconds.

Table 2 illustrates the example five-choice table above, (see later).

Multi-Stimulus Task

A multi-stimulus task uses a combination of stimulus parameters to vary the task trial by trial. To create the trial-by-trial variation we use the five-choice table as a 'series'.

Variable ITI, (four levels of ITI).

Consider the example task of comparing performance at a number of ITI values, all other parameters remaining the same. In this example, we will provide four values of ITI. We use one entry in the parameter table to define each value of ITI. Table 3 shows the example five-choice entries.

Number Of Trials

The five-choice series of table 3 produces a five-choice series auto control consisting of:

$$\begin{aligned} N_{\text{TRIALS}} &= \text{Iterations} \times \text{SENSORS} \times N_{\text{ENTRIES}} \\ &= 5 \times 5 \times 4 = 100 \text{ Trials} \end{aligned}$$

With banking enabled, these trials are organised in banked form, i.e. five banks of 20 trials. Each bank contains one presentation of each 'task' in each niche, (randomly organised).

With banking disabled, the trial order is fully randomised.

The combination technique for a Five-Choice Series remains the same regardless of the contents of the parameter table.

Each entry in the parameter table defines one 'task'. The number of entries in the table determines the number of different 'tasks' used during the session. K-Limbic creates a bank of trials presenting each task in each niche in random order. In the examples above the parameter table contained four entries; therefore, each bank consisted of 20 trials.

The Iterations parameter in the first table entry determines how many banks are created. In the examples above, this was five therefore K-Limbic creates five banks of trials.

Note: the ordering of trials within each bank is unique.

If banking is enabled then the trials are progressed in bank order, i.e. all trials in bank one, followed by all trials in bank two and so on. If banking is disabled then the trial order is fully randomised.

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Multi-Parameter Variations

The discussion above illustrates the use of the five-choice table to create an auto control in which only one parameter setting varies.

The parameter settings in each 'task' are independent of all other 'tasks' and therefore as many different parameter settings may vary as required. Five-choice parameter tables can combine multi-parameter variations; i.e. varying ITI and tone presentations, or stimulus duration and inter-trial interval.

Example Five-Choice Table

Table 2 details the parameter entries to create the six-entry, five-choice table of the subject training example.

	Stimulus Duration	Limited Hold	Iterations	Banked	Sensors	ITI	Tone Burst	Tone Timing
1	60.0	60.0	20	Yes	5	5	50mS	Off
2	15.0	30.0	20	Yes	5	5	50mS	Off
3	5.0	15.0	20	Yes	5	5	50mS	Off
4	2.0	15.0	20	Yes	5	5	50mS	Off
5	1.0	10.0	20	Yes	5	5	50mS	Off
6	0.5	5.0	20	Yes	5	5	50mS	Off

Table 2: Example Five-Choice Table (for subject training)

Each entry creates an auto control containing 100 trials.
 Each entry specifies an inter-trial interval of five seconds.
 Each entry specifies Tone presentation is off in all trials.
 The limited hold and stimulus duration decrease progressively.

The operator selects the appropriate table entry when loading the protocol.

Example Five-Choice Series

Table 3 details the parameter entries to create the four-entry, five-choice series of the variable ITI example.

	Stimulus Duration	Limited Hold	Iterations	Banked	Sensors	ITI	Tone Burst	Tone Timing
1	0.5	5.0	5	Yes	5	5	50mS	Off
2	0.5	5.0	n.a.	n.a.	5	10	50mS	Off
3	0.5	5.0	n.a.	n.a.	5	20	50mS	Off
4	0.5	5.0	n.a.	n.a.	5	40	50mS	Off

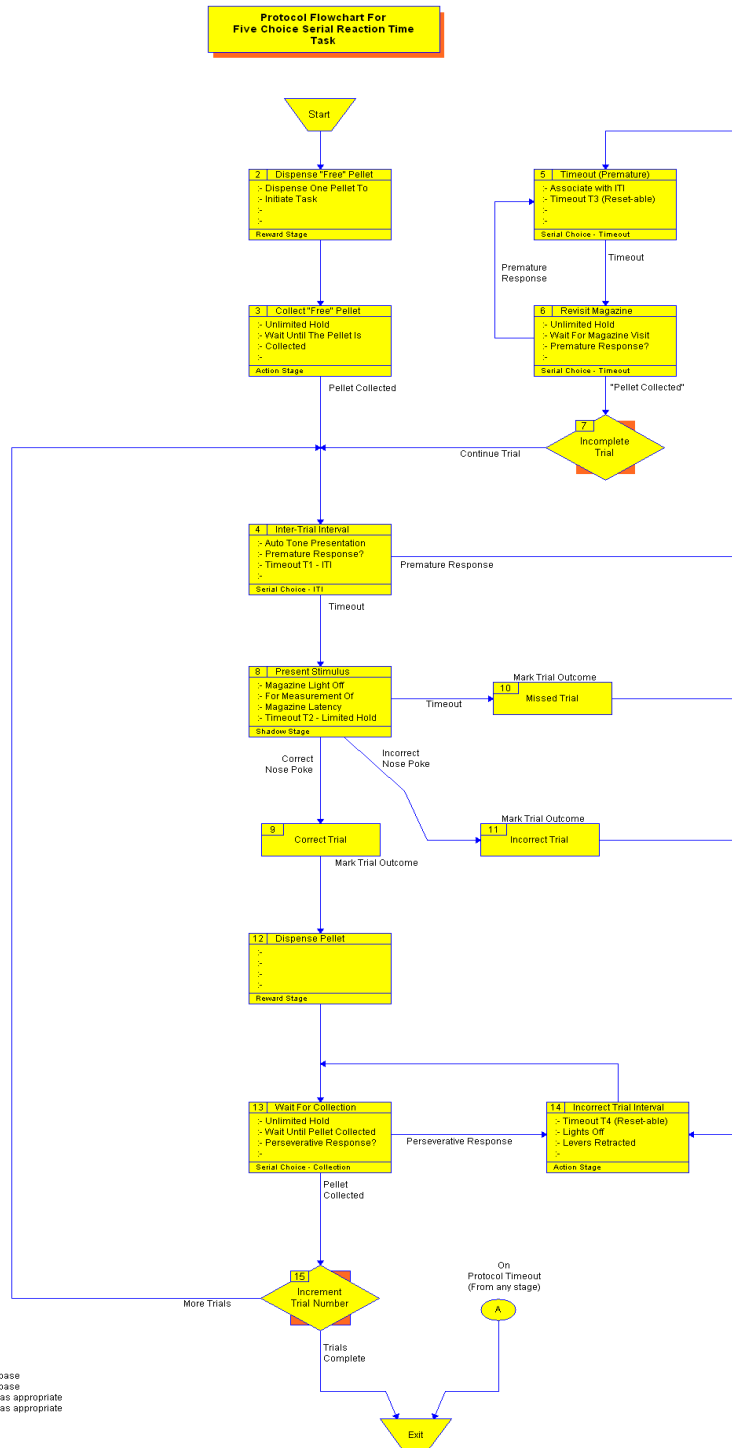
Table 3: Example Five-Choice Series (variable stimulus intensity)

The series creates an auto control containing 100 trials.
 The series creates four values of ITI.
 Each entry specifies Tone presentation is off in all trials.
 The limited hold and stimulus duration remain constant for all trials.

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Figure 1: 5CSRTT Flowchart



Notes: -
 Timeout T1 - set using database
 Timeout T2 - set using database
 Timeout T3 - set in protocol as appropriate
 Timeout T4 - set in protocol as appropriate