# TSE   Maze Systems

## Radial Maze / Elevated Plus-Maze

# Contents

# TSE   MAZE Systems

## Radial Maze / Elevated Plus-Maze

## 1.      Introduction

The TSE Maze system is a completely computerized modular system for studying animal activity, learning and memory performance or anxiety in a maze environment with small laboratory animals (rats, mice). It is suitable for use with different types of maze systems. The possibilities of analyzing a **Radial Maze** and an **Elevated Plus-Maze** are currently implemented.

In principle a MAZE system consists of 4 components:

1. a maze,
2. a control unit,
3. the MAZE software,
4. an IBM-compatible computer with up to 2 special interfaces.

### 1.1.      Radial Maze (8-arm maze)

The **Radial Maze** consists of the following components:

- A base plate, which can be fastened to a bench-like frame. The size of this base plate depends on the size of the maze.

- The maze has 8 equally sized arms. In the standard configuration the arm walls are made of opaque gray PVC and can be individually inserted in guide rails.

  The arms are currently available in 3 different sizes:

| Length (mm) | Width (mm) | Height (mm) | Animal |
|:---:|:---:|:---:|:---:|
| 550 | 150 | 225 | rat |
| 425 | 145 | 225 | rat |
| 300 | 50 | 150 | mouse |

- At the end of each arm there is a **food crib** in which the food pellets can be placed if the arms of the maze are to be baited.
- Infra-red sensors located at the pellet cups serve to monitor the removal of the pellet from the crib.
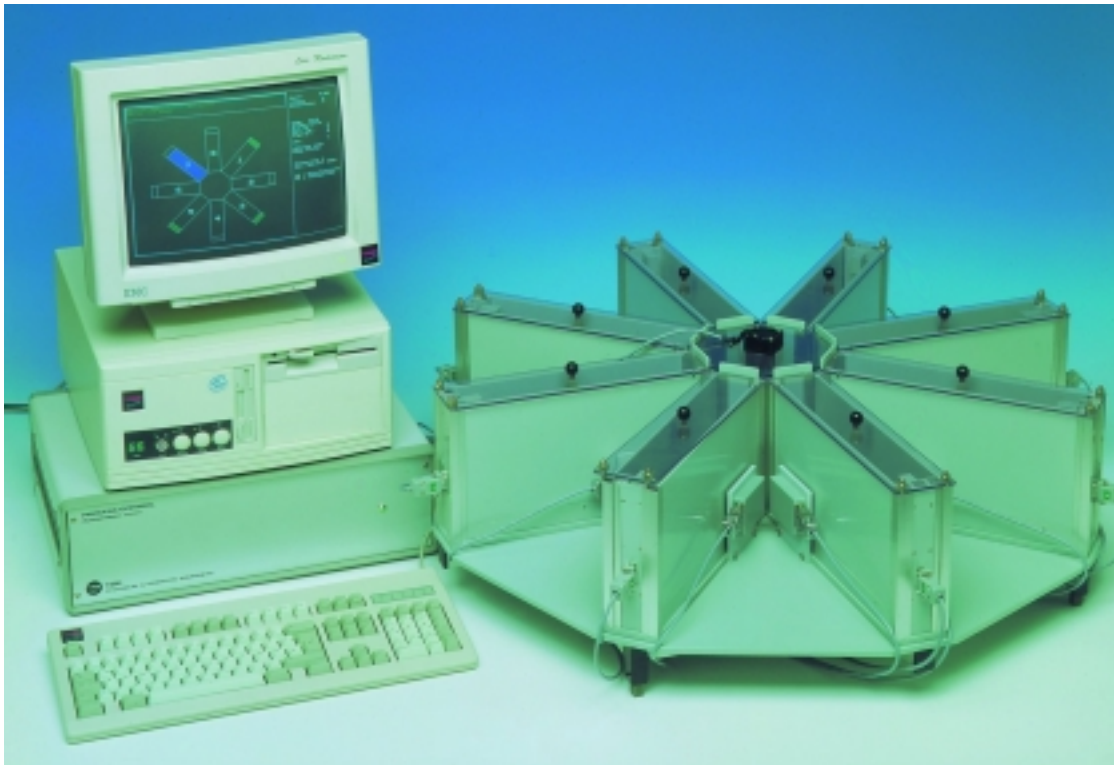
**Radial Maze (one of several configurations)**

- Infra-red sensors located at the arm entries serve to monitor the animal's transfers. It is always possible to recognize whether the animal is located "in the arm" or "in the center". The chamber side-walls are pierced at these points.
- Clear acrylic lids allow spatial orientation using extra-maze cues.

### *Optional:*

- Transparent arm walls to make it easier to detect extra-maze cues.
- Ventilator in the cover of the center of the maze. This ventilator produces a continuous gentle air flow towards the arms. This reduces the risk of the animal orienting itself by the scent of the food pellets during the trial if the food cribs are in use.
- Manually operated or motorized doors may be used to close individual arms.
- The food cribs can be connected to automatic pellet feeders if continuous refilling is required.
- A further light barrier in each arm located approx. 5 cm from the end of the arm to provide more detailed animal detection.
- A special version is available with stimulus grids in the arms and center allowing a foot shock to be applied.

## 1.2.   Elevated Plus-Maze

The elevated plus-maze test is one of the most widely used models to assess **anxiety** in small rodents.

This maze consists of 4 arms arranged in the shape of a cross. Two opposing arms have 2 side walls as well as an end wall ("closed arms"); the two other opposing arms have no walls ("open arms").
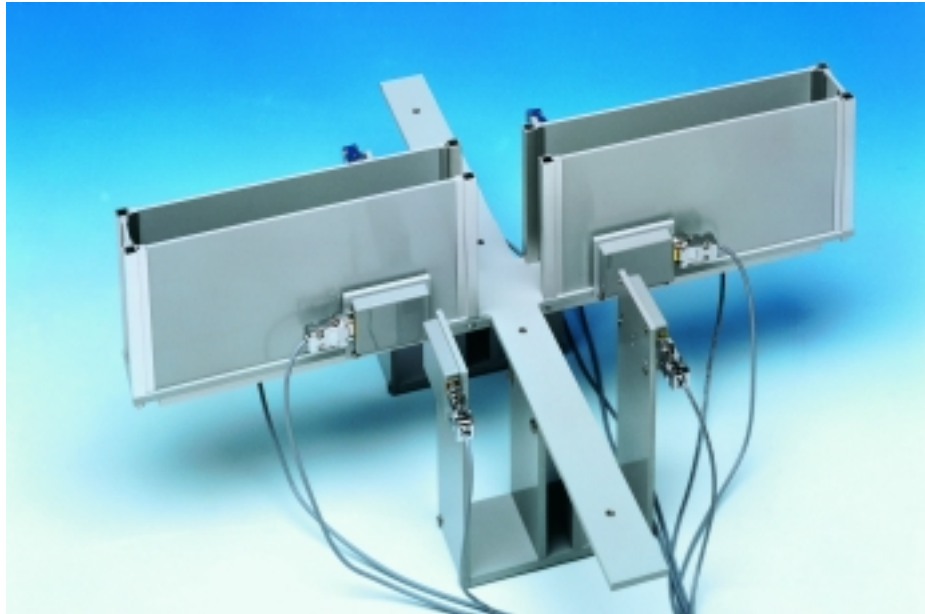


- Material: e.g. opaque gray PVC (variations are possible)
- The size depends on the operator's specification. An *example* for a mouse:

| Length (mm) | Width (mm) | Height (mm) | Animal |
|-------------|------------|-------------|--------|
| 300 | 50 | 150 | mouse |

- The walls of the two closed arms can be individually inserted into guide rails.
- The plus maze is fastened to a support frame which is usually made of aluminum, (standard height: 700mm).
- The maze is equipped with location sensors directly behind the arm entrances to monitor the animal's position throughout the experiment ("on arm" or "in center"). The chamber side-walls of the closed arms are pierced at these points.

## 1.3.    The control unit

The **control unit** contains

- the necessary power supplies, and
- the electronics for the location sensors and for controlling the automatic food pellet dispensers (optional) and the automatic doors (optional).

The control unit configuration depends on the type of maze used. Rat and mouse mazes can be operated with the same unit; all connecting cables can be easily interchanged.

## 1.4.    Software

The **software** is used to control the trial, record the movements of the animal and to store, analyze and document all measuring data. The software currently runs under the MS-DOS operating system. A Windows version is in preparation and will be finished soon.

Before the start of the trial all the animal and trial parameters must be entered. When the trial has started the movement of the animal can be followed continuously in a stylized maze shown on the screen. At the end of the trial the measuring data are stored together with the relevant information. The stored data can be subjected to a variety of evaluation algorithms. The data can be shown in graphical and tabular form and printed out if required. It is also possible to export the data in special export files in order to be able to subject it to further statistical analysis.

In the usual **Radial Maze task** food is available at the end of each arm (8 arms baited) or in selected arms only (e.g. only 4 of the 8 arms baited). The animal has to learn to visit each arm without going back to an already-visited and therefore empty arm. This is performed in training trials. Learning and memory impairments due to brain injury or drug treatment will influence the performance of the animal in subsequent test runs.

The complex behavioral analysis allows a total of 42 parameters to be calculated among them the number of visits to each arm, the lengths of stay in arms and center and the frequency of reference and working-memory errors. **Working memory** deficits increase entries to arms which have already been visited in the same trial. **Reference memory impairment** causes the animal to forget which arms usually have food across several spaced trials. In addition a walking angles evaluation is provided that is especially suited in the non-baited or continuously refilled maze configuration.

In the **Elevated Plus-Maze task** data analysis generates detailed result tables listing entries and time spent in the different plus maze areas.

# 2.    System installation & testing

## 2.1.    Interface installation

The MAZE test system uses up to two special **interface boards** which must be built into the computer. The exact number depends on the particular system configuration. The PC must therefore have a maximum of 2 free slots (**ISA-Bus**).

## 2.2.    Connecting the control unit to the PC

The control unit usually differs according to the **type of maze** which is connected.

- In the **Radial Maze** there are – depending on the number of interfaces – up to 2 sockets available which are used for connection of the computer.
- In the **Elevated Plus-Maze** there is normally only **one** output socket present, as in this case only location sensors are used.

## 2.3.    Connecting the maze to the control unit

The various functional elements of the maze are connected to the sockets of the control unit with the cables supplied. The same control unit may be used for large and small maze models.

- In the **Radial Maze** there is normally **one** cable per arm which is attached to the sensor housing at the entrance to the arm. You can choose any arm to be arm 1. Connect the cable (15-pole SUB-D plug) to control unit socket no. 1. Connect the remaining maze arms 2...8 to sockets number 2...8 **clockwise**.

   The maze should be placed in the lab so that the orientation of the arms corresponds to the display in the trial monitor.  Arm 1 should be located top right:
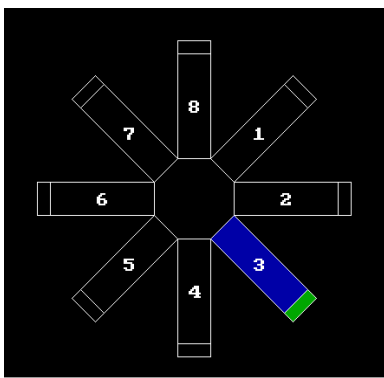
- In the **Elevated Plus-Maze** the connection is normally made via an adapter which is mounted below the maze. The connection from the adapter to the control unit is made with a single cable.

  For the Elevated Plus-Maze the software produces the following arrangement in the trial monitor:
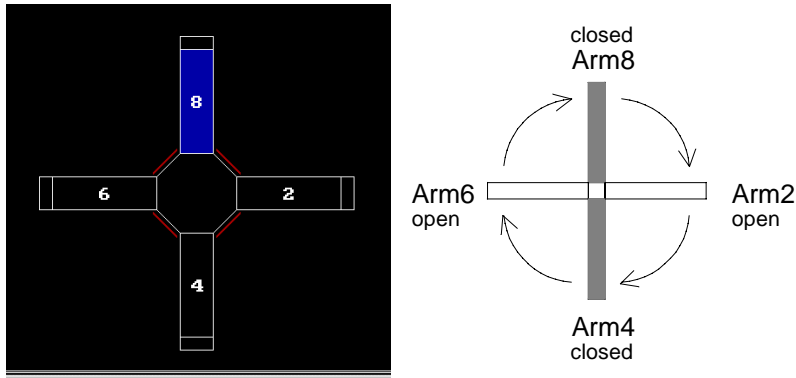
## 2.4.    Mounting the automatic feeders

If automatic pellet feeders are provided with the radial maze they usually are compatible with both large and small maze types. Feeders are mounted to the end of each arm and connected to the sensor housing box at the entrance of the arm. In some configurations the feeders have separate connections to the control unit.

## 2.5.    Carrying out system tests

The function test allows the location and food crib sensors to be checked as well as the automatic doors and feeders.

After selection of the menu item *System Test/Function Test* a window opens in which a diagram showing the maze from above can be seen. Which maze is shown depends on the settings in the *Program Parameters* window.

### 2.5.1.    Light-beam sensors / animal location

The location sensors at the entrances to the arms are – if they are not interrupted and are working properly – shown as **yellow lines**.
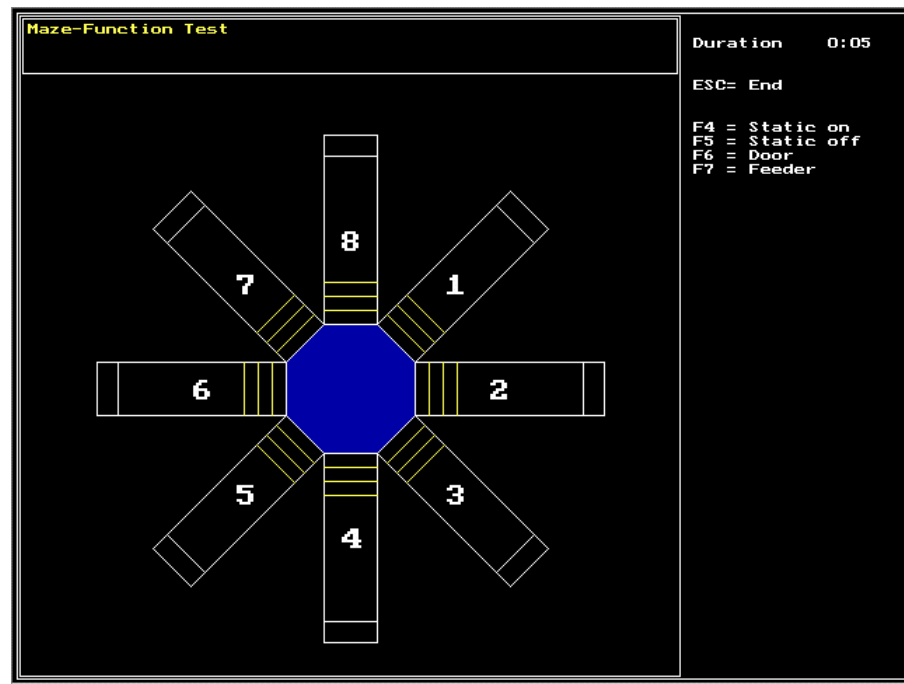
Each individual light barrier should now be covered with a suitable object; this should cause the corresponding yellow line to vanish from the screen.

The central sensor consists of 2 light barriers placed one above the other; these are *coupled* to each other. The light barrier line only disappears from the display when **both** these light barriers are covered **simultaneously**.

During the test the **dynamic recognition logic** for the location of the animal is also activated. If the animal moves through a sensor area then the sensors are interrupted in a particular **sequence**. This sequence is used for determining the animal's location (location=**blue area**).

If the maze has separate light barriers in the arms and if the option "Extra Sensors" has been activated in the *Program Parameters* window then additional light barriers will appear; their function can also be checked by interrupting them manually.

### 2.5.2.  Food crib sensors

The interruption of the food crib light barriers by occupation with food pellets is indicated by a green coloration at the end of the maze arm, just as in the actual trial.

### 2.5.3.  Doors

When **F6** is depressed the automatic **doors** (if present) can be opened and closed individually with the **F1** to **F8** function keys. **F9** activates **all** doors; they are

addressed in sequence. This process can take some time. This function can also be used to open closed doors at the end of the trial, e.g. for cleaning the maze. The doors can only be operated when the corresponding option has been activated in the *Program Parameters* window*.*

### 2.5.4.   Feeders

**F7** is used to activate a test of the automatic food pellet dispensers (if present). The **F1** to **F8** keys now cause the corresponding dispenser to release a food pellet. The feeders can only be operated when the corresponding option has been activated in the *Program Parameters* window and the correct control parameter "Duration Feeder" has been entered.

## 2.6.     Stimulus module

If the maze is equipped with a module for stimulation with a constant current then the functioning of the electrical stimulation grids can be tested.

The site at which the stimulation is to be applied is activated in the selection list (Arm1 to Arm8 or center). The actual current is shown in mA at the top right. The **+0.1mA** and **-0.1mA** buttons can be used to adjust the current in the selected channel.
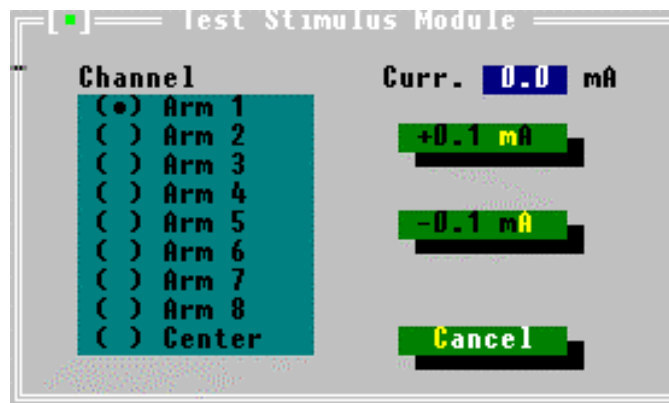
# 3.     Configuring the system parameters

For adapting the program to the existing hardware and to meet operator-specific trial procedure requirements it is possible to adjust a range of system parameters. The functions are found in the *Parameters* menu.



## 3.1.    System language

After installation the maze program starts up in **German** as standard. A change to the **English** software version can be made in the menu item *System Language*.
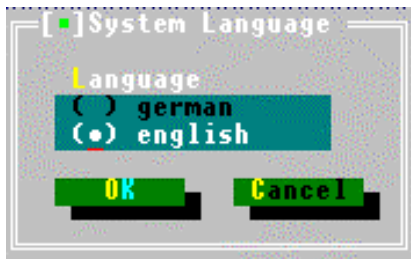


## 3.2.    Program parameters



---
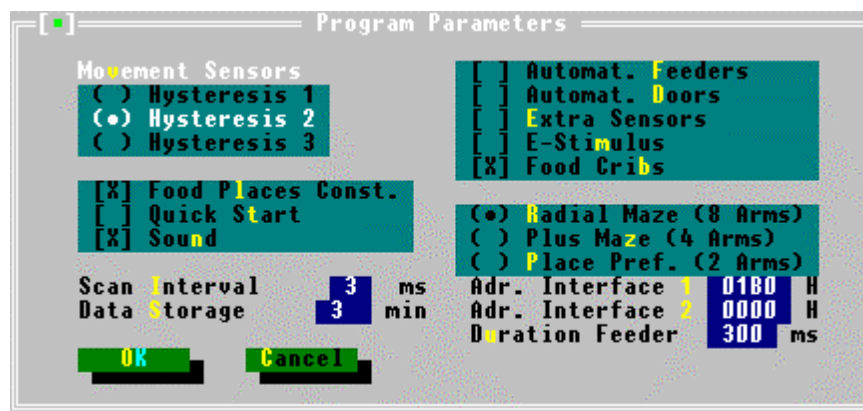
### 3.2.1.  Movement sensors

The parameter **Movement sensors** influences the type of data acquisition. The operator can adapt the so-called **hysteresis** of the movement sensors in order to determine from which position the system is to recognize an animal as being "in the arm" or "in the center".

The following table describes the relationships:

| Decision | Hysteresis 1 | | | Hysteresis 2 | | | Hysteresis 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | S1 | S2 | S3 | S1 | S2 | S3 |
| "in the center" | x | | | x | | | x | | |
| "in the arm" | x | x | | x | x | x | | x | x |

S1      sensor towards center
S2      middle sensor
S3      sensor towards arm

The **cross** symbolizes light beam interruption.

- Hysteresis 1 is the most sensitive arm location detection method. In it even sticking the head into the arm is recognized as being "in the arm"; i.e. barriers S1 and S2 are interrupted. This setting is also ideal for very small animals.

- Hysteresis 2: In this case a transfer "in the arm" is recognized when all the sensors are interrupted. The animal is then in the front part of the arm.
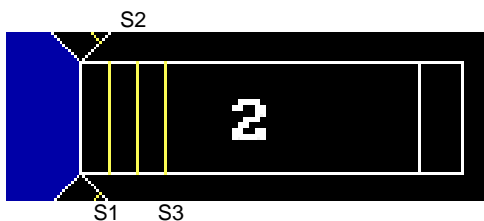
- The most clear-cut hysteresis is Hysteresis 3, i.e. the least effects are noticed here. The animal is only detected as being "in the arm" when it is so far in the arm that only its rear interrupts the two inner sensors S2 and S3. The animal is recognized as being "in the center" when it has passed these two inner sensors and **only** the last light barrier at the end of the arm is still interrupted.

The decision as to where the animal is located in the maze is only made when the animal has **left** the light barrier area in the direction of the arm or the center. A short switch between the sites of recognition *during location detection* is possible for all types of hysteresis and is *normal* (the most intermediate switches are produced with H1, the least with H3).

**These effects are eliminated during data correction, if activated (see 5.3).**

### 3.2.2.  Data storage interval

During the trial all measuring data is stored on the hard disk at selected intervals (2-20 minutes). If the system breaks down (e.g. owing to a power cut) then all the trial data up to the last intermediate storage are available for analysis. We recommend an interval of 3 minutes.

### 3.2.3.  Scan interval

This scanning interval determines the intervals at which the light barriers are to be scanned and analyzed in order to determine the position of the animal. The scanning interval should be **as short as possible** (target: 1 ms).

### 3.2.4.  Interface addresses

The selection of the hardware addresses for the two MAZE interfaces makes it possible to avoid an address conflict if other plug-in boards have been built into the computer.

Basic interface:        Standard address **1B0H**

### 3.2.5.  Maze type



The information about whether the following trial is to be an experiment in a **Radial Maze** or in the **Elevated Plus-Maze** determines the way in which the maze will be shown, among other things.



**Radial Maze**                              **Elevated Plus Maze**
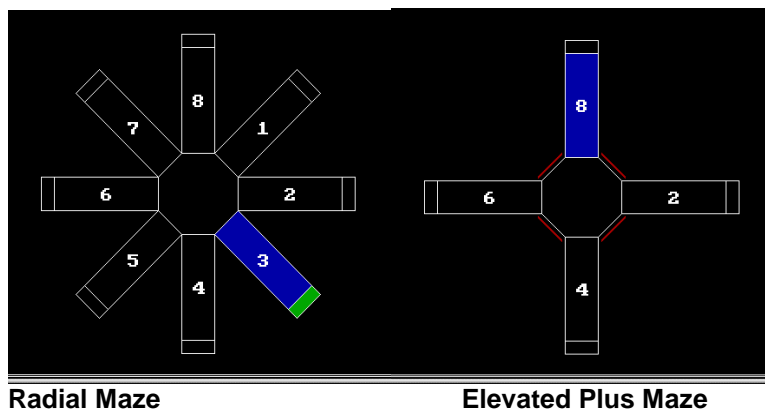
*The Place Preference option does not function at the current time.*

### 3.2.6.  Maze components



- If an experiment is carried out in the **Elevated Plus-Maze** then **all** the options must be deactivated as this type of maze is normally only fitted with location sensors (basic configuration).
- The **Radial Maze** is supplied with **components** which differ according to the operator's requirements. The relevant options must be activated before the start of a trial by marking them with a cross. Only if the corresponding options have been activated is it possible to control the components during the trial or in a function test.

### 3.2.7.  Duration Feeder

If automatic pellet feeders are integrated in the system this entry defines the duration of the control signal (in ms) that is output by the PC in order to activate the feeder. This value is set by the service and should **not** be changed by the user.

### 3.2.8.  Trial run parameters



1. The parameter *Food places constant* (only in Radial Maze) prevents operating errors when a trial design is being selected in which the food places for all the runs with an animal – even over a period of several days – are **not** to be altered. The system prevents faulty operation and produces an error message.

2. If the parameter *Quick Start* is activated then at the end of a run the system will inquire whether the next run with the same animal is to be carried out **immediately**. If the operator answers "YES" then the following run will be started with the same trial parameters.

   If **Food stochastic** is activated in the test preparation window (precondition: *Food places constant* inactivated) and/or a **9** has been entered as the **Start position** (i.e., stochastic determination of the start arm) then the system will carry out the corresponding adaptations.

3.  If the *Sound* parameter is activated then the operator will be informed of the end of the trial or of an error condition by an acoustic signal. However, this noise is also heard by the animal and could therefore have an interfering effect on the run; in such cases the parameter should be deactivated.

## 3.3.    Printer parameters

For **graphics** printing the system must be adapted to the existing printer. Several types of printer are suggested; a compatible printer should be selected from these.
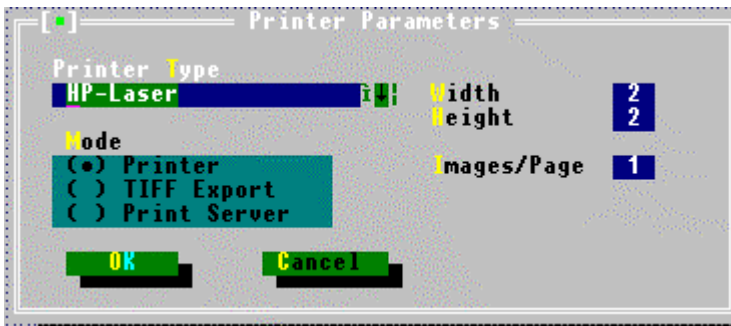


- The operator can determine the size of the printed image within certain limits.
- *Images/Page* is used to determine the number of images after which the printer should provide a page feed. 1 should be selected for a large image and 3 for a small  image.
- The option *Printer* is activated when the graph is to be produced by the printer directly.
- The **Printer server** as well as the export of the graphs in a file in **Tiff** format have not yet been implemented in the MAZE system.

## 3.4.    Export parameters

The export file format is set here. 3 export formats are supported: ASCII, SDF and CSV.
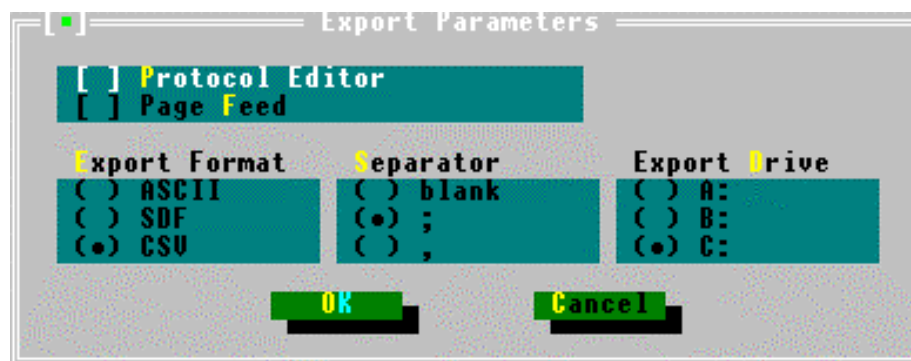
In the ASCII (**\*.TXT**) format strings or text passages are **not** enclosed in quotation marks (" "). In the dBase-compatible formats **SDF** and **CSV** all strings (e.g. column separators) are enclosed by quotation marks.

### *Short description of the CSV format*

| -110 | 8 | | | | | | | |
|------|------|--------|---------|----------|---------|--------|-------|----------|
| -120 | AnimNo. | Exp.No. | TrialNo. | Date | without | before | after | Duration |
| -130 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 |
| -900 | 20 | 1 | 1 | 23.02.98 | 5 | 2 | 1 | 204 |
| -900 | 20 | 1 | 1 | 23.02.98 | 6 | 0 | 2 | 103 |
| -900 | 20 | 1 | 1 | 23.02.98 | 7 | 0 | 1 | 140 |
| -900 | 20 | 1 | 1 | 24.02.98 | 4 | 0 | 2 | 124 |
| -900 | 20 | 1 | 1 | 24.02.98 | 2 | 0 | 0 | 103 |
| -900 | 20 | 1 | 1 | 24.02.98 | 5 | 0 | 1 | 113 |
| -900 | 20 | 1 | 1 | 25.02.98 | 6 | 0 | 3 | 135 |

This file format is supported by all professional statistics packages. The file structure follows the following definition:

| 1st line: | identifier -110 and number of data in one line |
|-----------|------------------------------------------------|
| 2nd line: | identifier -120 and information about the short names of the data which will later also be used by the statistics program |
| 3rd line: | identifier -130 and definition of the data format with the following arrangement:<br>1= text<br>2= numerical value with decimal point<br>3= whole numbers without decimal point |
| from 4th line | data with introductory identifier -900, each record orthogonal in one line |

### 3.4.1.   Column Separator

The selection of a column separator is possible. For selection of a **space** a list is generated which contains strictly formatted columns. With **comma** or **semicolon** as separator the record is compressed as much as possible to save memory space (elimination of all blanks). A semicolon is generally recommended.

### 3.4.2.   Export drive

The export disk drive is set here (A, B or C). If drive C: is chosen, the export file is stored in the **current** data directory.

# 4. Experimental procedure

Work with the MAZE system is carried out according to the following pattern:

- **Trial preparation**
- **Carrying out the trial**
- **Data analysis**

## 4.1. Trial preparation

Right at the start a check should be made as to whether the software has been set correctly for the **type of maze** used (Radial Maze or Elevated Plus-Maze), the existing equipment and the planned trial concept. This is done by activating the menu item *Parameters/Program Parameters*. The settings here are

$\Rightarrow$ type of maze (3.2.5),
$\Rightarrow$ maze components (3.2.6) and
$\Rightarrow$ the trial run parameters (3.2.8).

The other program parameters are determined during the initial installation and are normally not altered subsequently.

## 4.2. Data record selection



When the menu item *Experiment/Start* has been activated the "Data record selection for follow-up trial" window opens. Here a decision must be made as to whether a **First trial** with a new animal (new animal number) is to be carried out or a **Follow-up trial** with an animal which has already been tested (identical animal number).
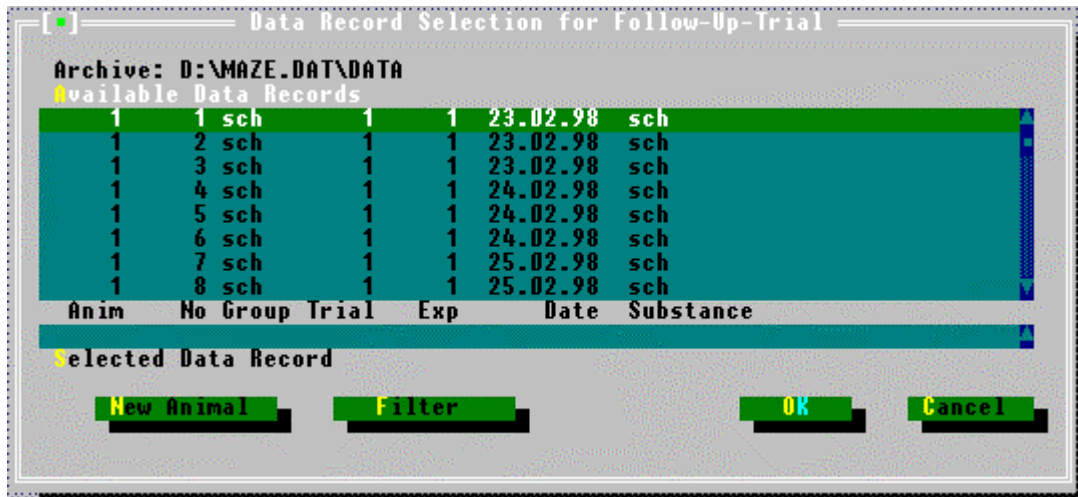
The active results drive is indicated in the **Archive** message line.

⇒ The **First trial** is the first trial of the animal *in the active results drive*.

⇒ A **Follow-up trial** is each further trial with this animal and the same trial concept, the day on which it is carried out does **not** matter.

Example for a learning test in a radial maze (4 of 8 arms baited, constant food places for all runs on one day; places are changed on the next day):

| Animal 2 | Run 1...3 | 23.3.99 | 20 minutes time interval between runs |
|---|---|---|---|
|  | Run 4...6 | 24.3.99 | 20 minutes time interval between runs |
|  | Run 7...9 | 25.3.99 | 20 minutes time interval between runs |

Run 1 ist the first trial, the other 8 runs are follow-up-trials.

### 4.2.1. First trial

If a first trial is to be carried out then the *New Animal* button (**Alt-N)** must be operated. The "Experiment parameters" window opens in which all the parameters used to describe the animal and the trial and which determinate the trial procedure are defined. These parameters are assigned to one of three groups:

1. Animal Data
2. Trial Data
3. Trial Parameters

#### 4.2.1.1. *Animal data*

These parameters are those which describe the animal:

| AnimNo | numerical | 1...64000 | obligatory |
|---|---|---|---|
| Group | alphanumerical | 5 characters | optional |
| Strain | alphanumerical | 5 characters | optional |
| Age (days) | numerical | 5 characters | optional |
| Weight (g) | numerical | 5 characters | optional |

In the first trial the **Animal number** is laid down. The system demands this entry. The input of all other animal data is optional; fields which are not required are not occupied.

This animal number **cannot** be altered in a follow-up trial with the same animal. A further first trial with the same animal number in the active results drive will be prevented by the program.

The alphanumerical field **Group** allows – just like the animal number – the later selection of the records and should therefore also be used with care (e.g. control group, drug group).

### 4.2.1.2.   Trial data

The following parameters characterize the trial:



| TrialNo | numerical | 1...64000 | obligatory |
|---|---|---|---|
| ExpNo | numerical | 1...64000 | obligatory |
| Code | alphanumerical | 9 characters | optional |
| Temp | numerical | 5 characters | optional |
| Operator | alphanumerical | 20 characters | optional |
| Remarks | alphanumerical | 40 characters | optional |
| Substance | alphanumerical | 40 characters | optional |
| Dosage | alphanumerical | 40 characters | optional |

The *Experiment number*, the *Trial number* and the *Substance* can be used for filtering the records and must therefore be chosen with particular care.

**Example of Radial Maze entries – locomotion test**

**Example of Radial Maze entries – learning behavior test**

**Example of Elevated Plus-Maze entries**

*Remarks:*   The **Experiment number** should be the superordinate description of an experiment. It is recommended that this number is also used in the name of the archive directory. In **one** results drive all animals should have the same experiment number.
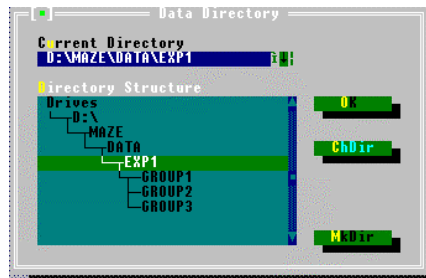


For example, it is possible to enter the running number of the particular trial day as the **Trial number**, i.e. Trial day 1=TrialNo.**1**. In this case when carrying out subsequent individual analyses in the Radial Maze it is possible to make a selection according to trial days irrespective of the calendar days). This trial number then has no relationship to the terms "First trial" and "Follow-up trial" used in these instructions.

### 4.2.1.3.    Trial parameters

Trial parameters are:

- Feeding characteristics
- Start position
- Doors
- Termination condition
- Max. rest time

## a.   Feeding characteristics (Radial Maze only)

Feeding is only intended for use in the **Radial Maze**; in the Elevated Plus-Maze the following parameters are irrelevant (the "Food crib" field in the *Program Parameters* window should always be inactivated!).  Feeding is determined by:

- Feeding places,
- Feeding stochastics and
- Refilling.

### 1. Feeding places ("Baited Arm")

In this list field the operator determines **in which arms** food pellets are to be provided.

Typical design: the same 4 out of 8 arms are baited during the runs that take place at the same day. On the next test day another combination of 4 arms is selected.

---

By operating the *1x Stochastic* button *now* the feeding places set by the operator are immediately changed stochastically by the system. Setting the crosses then only determines the **number** of the feeding places but not their positioning. In this way the operator can immediately obtain a stochastic selection of the arms to be baited.

If the parameter "Food places constant" is activated then the selection of the baited arms for the first trial is also binding for the follow-up trials, i.e. the feeding places cannot be subsequently altered! This option offers the operator increased protection against accidental faulty entries.

Feeding pellets are placed in the feeding cribs **before** the animal is placed in the Radial Maze (either manually or – if the system is equipped with automatic pellet dispensers – automatically).

### 2. Feeding stochastics

If the baited arms defined in the first trial are to be altered in a subsequent follow-up trial then this can either be carried out

- **manually** before the start by setting different crosses or
- by pressing the *1x Stochastics* button again

A third way of changing the feeding places is given by the parameter *Feeding stochastics*. If it is activated in the first trial then the system will determine the feeding places stochastically from run to run. This parameter can also be switched off again if necessary.

*Note:* *Setting the parameter **Food places constant** (see **Program Parameters**) is important in this context.*

*If during an experiment the feeding places are to be changed from run to run then the parameter **Food places constant** must be **deactivated**.*

### 3. Refilling

This field is only important when the Radial Maze is equipped with automatic pellet dispensers. If this field is activated then after the animal has removed a pellet and returned to the center a food pellet will be dispensed again. A precondition is that the "Automatic Feeders" option is activated (*Program Parameters*).

### b.   Start position

The start position determines where the animal is to be placed in the maze. Possible entries for **Radial Maze** are:

**1** to **8**     Arms 1 to 8
**9**         The start position is determined stochastically by the system before the start of a new run. Only arms which do **not** contain food pellets and which

are open are allowed as the start arm. If no arm satisfies this condition then the center will always be selected as the start position.

**0**          Center

If the start is made in an arm then this start position is **not** counted as a visit to the arm!

Typical design: In the baited maze the start is performed from a non-baited arm. If all arms are baited, the animal is usually placed in the center.

In the **Elevated Plus-Maze** a start from the center ("**0**") is provided as standard.

## c.   Doors

### Radial Maze

The options *Arm 1 to 8* determine which of the 8 arms of the Radial Maze are to be closed by doors. Automatic doors are automatically closed by operating the start button before the animal is inserted. A precondition is that the "Automatic Doors" field is activated (*Program Parameters*). Manual doors must by closed "by hand".

### Elevated Plus-Maze

If the option **Plus-Maze** is activated in the *Program Parameters* then doors 1, 3, 5 and 7 will be "closed automatically". These numbers represent the arms which do not exist in the 4-arm Plus-Maze. Here only arms 2, 4, 6 and 8 "exist"; these must remain open. The operator should not alter this standard setting.

## d.   Termination condition

A trial can be terminated in different ways:

- when a particular trial duration has been reached *(Max. Duration),*
- when a defined number of arm visits has been made (*Max. Entries*),
- only in the baited Radial Maze: when the food pellets have been removed from all food cribs (*End food*).



**If several crosses are set then the first criterion which is fulfilled will terminate the test.**

- If the trial is to be terminated after a certain period has elapsed then this time must be entered in the *Duration* field. The trial duration is preset at 99 minutes; this is also the maximum trial duration.

- If the trial is to be terminated after a particular number of arm visits then this number must be entered in the *Entries* field. The maximum possible number of arm visits is set at 266*.*

## e.   Maximum rest time

The maximum rest time is the time in seconds in which a message is to appear on the screen if the animal has shown no signs of activity (i.e. the animal has not interrupted location sensors in this period). If the animal shows signs of activity, i.e. by changing from arm to center or by removing a food pellet then this time will be reset.

| **When all parameters have been entered the trial can start.** |
| --- |

### 4.2.2.   Follow-up trials

If the program parameter *Quick Start* has been activated then a query will be made at the **end** of a run as to whether the next follow-up trial with the same animal is to be carried out **immediately**. If the answer is "Yes" then the next run will be started with the same parameters.

Alternatively the next run with the animal (follow-up trial) can be carried out **later**. After selection of the menu item *Experiment/Start* an existing record of the relevant animal can be selected so that the data of the following test can be "appended" to it.

## 4.3.   Carrying out the trial

### 4.3.1.   Trial Monitor

After the entry of all parameters the *Start* button in the "Experiment parameters" is pressed. The so-called **trial monitor** appears on the screen and shows a stylized plan view of the maze. Whether a Radial Maze or a Plus-Maze is shown depends on the system configuration.

In the instructions field (top left) the operator receives instructions and messages about the trial procedure.

A trial consists of several phases:

- Closing the doors (only Radial Maze)
- Placing the pellets in the food cribs (only Radial Maze)
- Inserting the animal in the marked area
- Start

1. First the **doors** defined in the trial preparation are closed. If automatic doors are present and if this option has been activated in the *Program Parameters* window then these will be controlled by the system. Otherwise the doors must be closed manually: pressing the **Enter** key confirms the closing. Closed arms are symbolized by a red bar at the entry to the arm.
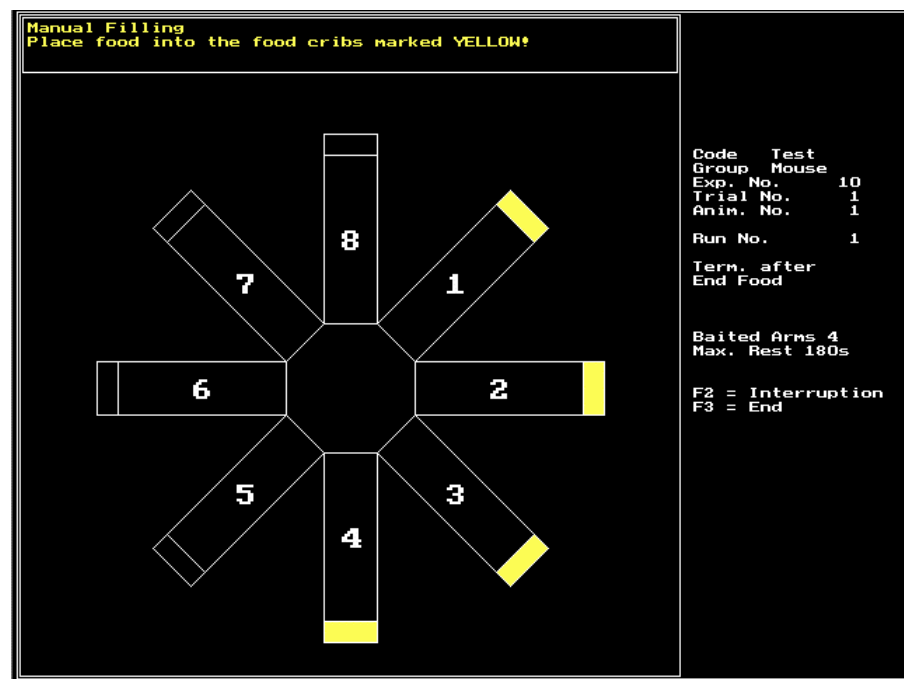


**Radial Maze with food cribs (manual filling)**

2. Now – if defined – **food pellets** are placed in the food cribs. If automatic feeders are present and if this option has been activated in the *Program Parameters* window then food pellets will be filled into the food cribs automatically. Otherwise the food pellets must be placed in the food cribs **manually**. The food cribs to be filled are shown in yellow. When the food cribs are occupied their color changes to green.

3. The trial monitor now shows the start position of the animal in the maze (blue coloration of one of the arms or the center).
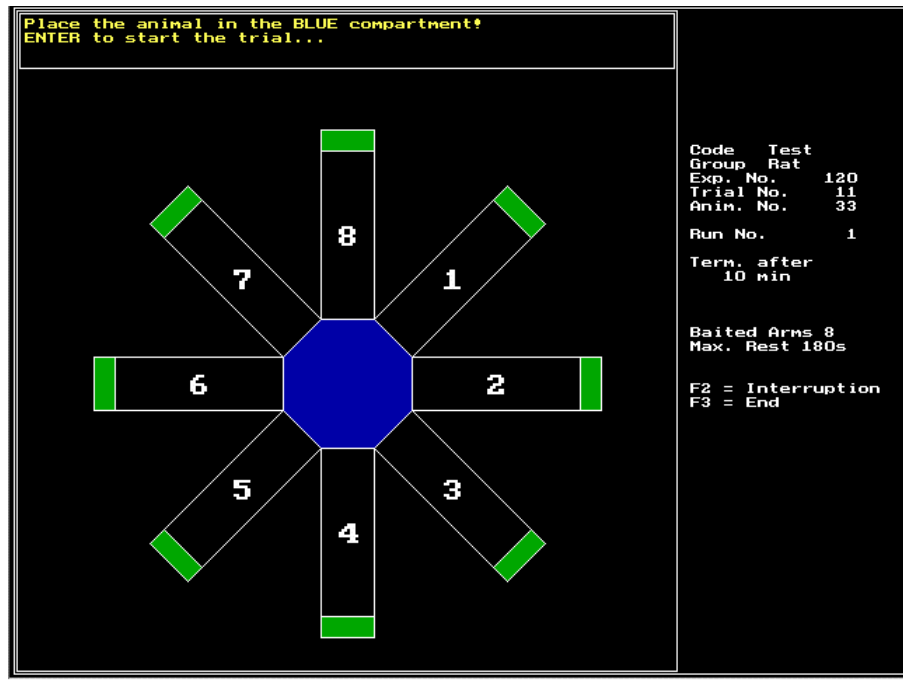
**Radial Maze with 8 baited arms**

When the animal is inserted the Enter key must be pressed immediately – the trial starts (Message: "Trial is running").

After the animal has been inserted into the Radial Maze the arms and center are – if necessary – closed by their covers.

### 4.3.2.   The running trial

During the run the trial monitor shows:

- the status of the doors
- whether there are pellets in the food cribs and
- the location of the animal.

The animal´s location in the maze is indicated by an alteration in the color.

The location sensors of the Maze system permit different modes of recognizing whether an animal is "in the arm" or "in the center". Please refer to the "Movement sensors" field under the menu item *Parameters/Program Parameters*.
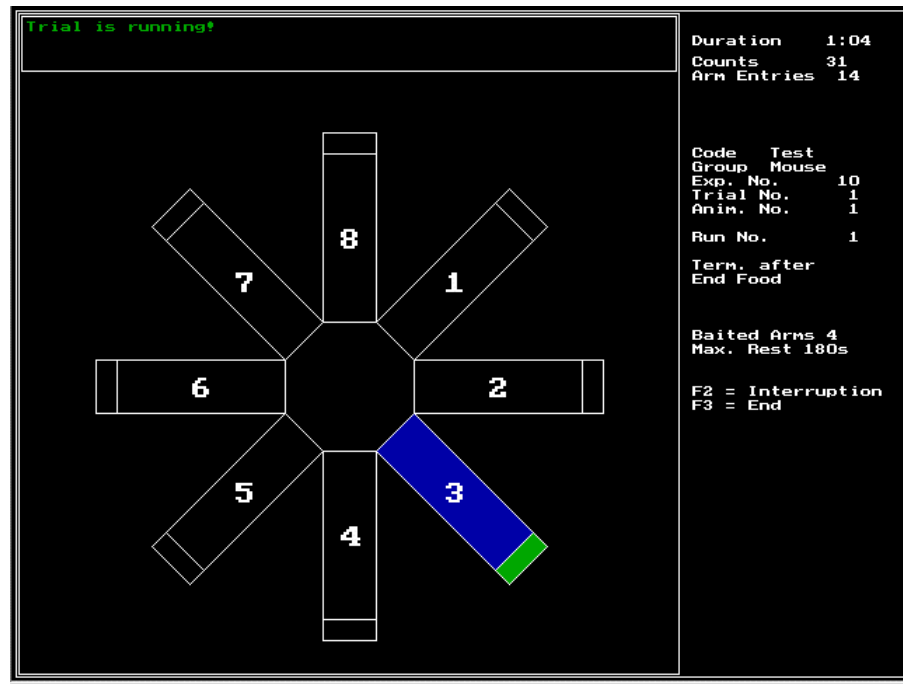
**Radial Maze**
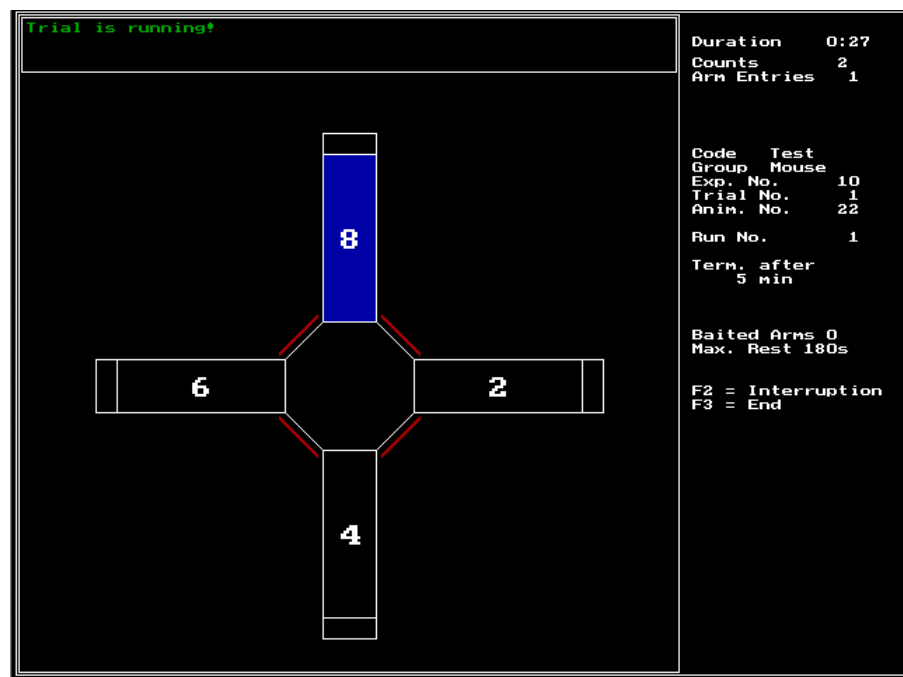


**Elevated Plus-Maze**

The monitor also shows the elapsed **trial duration** (top right) and the actual number of **arm entries**. **Counts** records the actions of the animal in the maze.

If **refilling** is switched on then when a food pellet has been removed it will be replaced as soon as the animal has returned to the center. This method is only possible with automatic feeders.

During the trial all the animal, trial and run data will be stored at defined intervals .

### 4.3.3.   Trial end

The trial ends automatically when the set termination criterion has been fulfilled. It is also possible to

- interrupt the trial with the **F2** key or
- abort it manually with the **F3** key.

If the program is interrupted with F2 the timer is stopped.

By definition the trial can only be continued when the animal has been positioned in the maze **center** again.

If the *Quick Start* field (**Program Parameters**) has been activated then when a run has ended the system will ask whether the next run is to be carried out immediately with the same animal.

If the *Sound* field has been activated (**Program Parameters**) then the end of the trial will be indicated by an acoustic signal. This signal for the end of the trial will be repeated every minute until the message has been confirmed with **Enter**.

# 5.     Evaluation
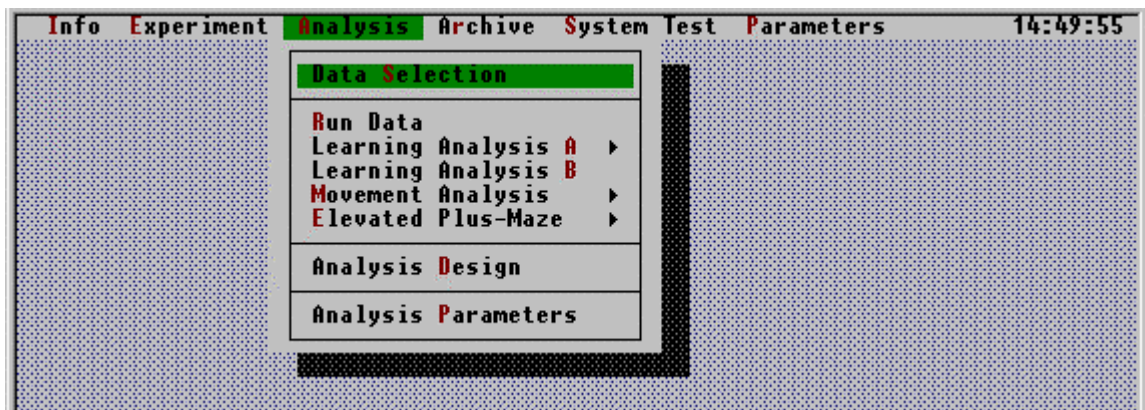


In the evaluation various results are calculated from selected trial data. Calculation and presentation of the results are influenced by the *Analysis Parameters*.

*Run Data* are available for all types of experiments.

In the **Radial Maze** a differentiation is made between

◆ the individual analyses *Learning Analysis A,*
◆ *Learning Analysis B* and
◆ *Movement Analysis*
◆ as well as the so-called *Analysis Design*.

In the individual analyses each data record is considered by itself. In this way the operator obtains an overview of all results parameters of an animal. The various individual analyses have been developed in cooperation with different operators. The *Analysis Design* produces tables in which results parameters selected by the operator are documented throughout several trial days. It is possible to export these data tables for subsequent statistical investigations.

The animal behavior evaluation in the **Elevated Plus-Maze** takes place under its own menu item

◆ *Elevated-Plus Maze.*

 The results are shown in tabular form (*Tables*) and can be exported (*Export*).

> **Which of the analysis functions is accessible depends on the system configuration!**

## 5.1.    Data selection

In the *first* step the data to be analyzed are selected. Each data record corresponds to a single run of an animal.

The menu item *Analysis/Data Selection* allows to select the records of interest from this directory for displaying the run data and for the individual analysis (Radial Maze: Learning analysis A+B, Movement analysis; Elevated Plus-Maze). It is always only possible to evaluate the data records in *one* results drive.

**Note:**  In the **Analysis design** a selection made in the Data Selection window is of no importance. Here all data records in the active data directory and **all** sub-directories in this drive are available for analysis. A selection can here be made using the Filter function in the Analysis Design window.
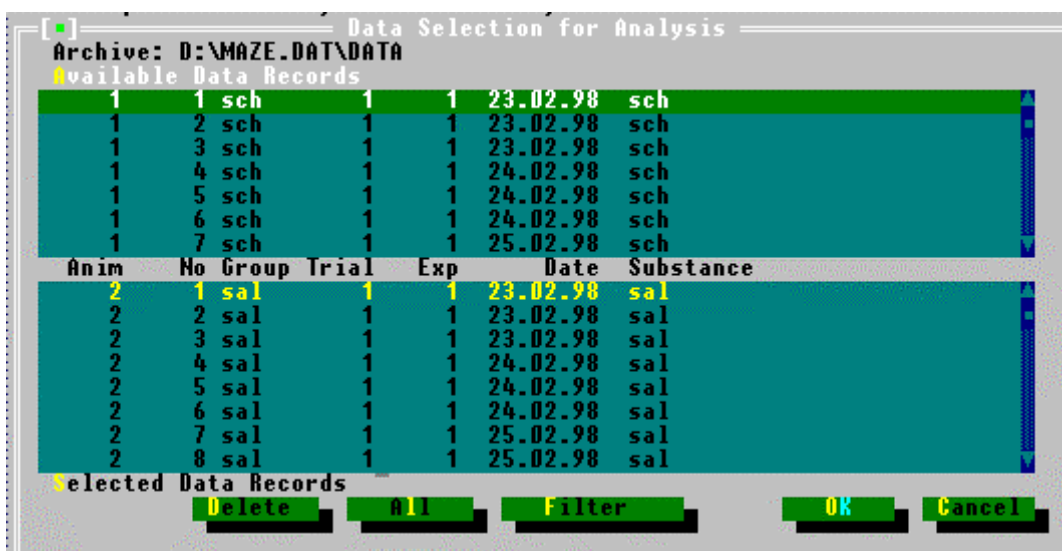


The upper area shows all the data records available in the **active results drive**. Each data record is characterized by the animal number, the number of the data record in sequence in the file, animal group, trial number, experiment number, date recorded and substance. The displayed data records can be preselected with the help of a filter.

The second area is located in the lower screen half. This shows the data records which have been **selected for analysis**.

## 5.2.    Data selection with filter

The filter function allows a preselection of the data records in the active results drive. If the filterable data are suitably integrated in the trial plan then the operator possesses a powerful instrument for the management of even large amounts of data.

The filter is used several times in the MAZE system:

- for the selection of data records for the follow-up trial,
- for the selection of data records for individual analysis,
- in the Analysis design.

After pressing the *Filter* button a window opens in which the concrete filter conditions can be entered.
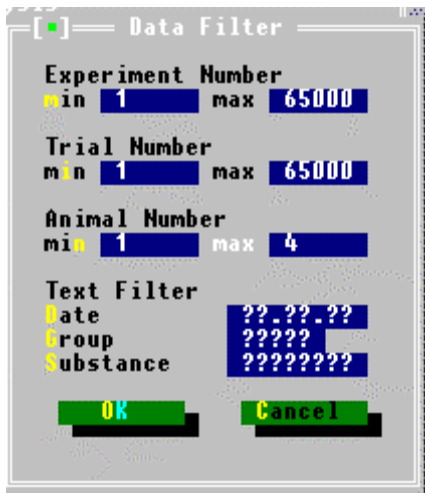


After filtering only those data records which meet the filter criterion will be shown in the upper window of "Data selection". The selection possibilities should be taken into account during the planning of the trial. The *All* button can be used to transfer all the data records shown in the upper window to the lower window.

## 5.3.    Analysis parameters

The analysis parameters can be used to alter both the initial data processing during the evaluation and the presentation of the data in tables and graphs.
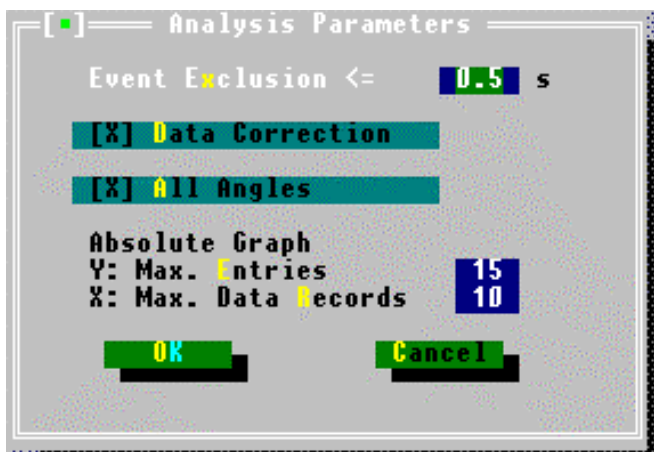
## 1. Event exclusion/Data correction

The *Event exclusion* parameter lays down how long an action by the animal must last in order for it to be included in the analysis. A setting of 1 second or lower is recommended. The *Event exclusion* will only be used if **Data correction** is activated **[X]**. All stays in the arm or center which are **shorter** or **equal** to the set time (entered in seconds) will be excluded from the analysis. Or expressed differently: only stays in an arm or in the center with a duration which is longer than the set time will be taken into account.

The duration of these excluded event intervals will in each case be added to the previous interval.

However, a further precondition is that the time interval to be eliminated lies between 2 identical stay locations.

1st example:

## Sequence    5s Arm1 – 1s Center – 8s Arm1

With this sequence and an exclusion parameter of 1 second the sequence will be summarized as a stay in Arm 1 of 5+1+8=14 seconds. Movements of the animal in the region of the light barriers at the entrance to the arm which extend beyond the set hysteresis are compensated by the visit to the center not being counted.

2nd example:

## Sequence    5s Arm1 – 0s Center – 8s Arm5

This sequence is **not** altered by data correction. In this case the animal has moved at a high speed from Arm 1 to Arm 5; this movement is only possible if the animal passes through the center. The stay in the center is less than 1 second, so that a time of zero is given for the stay in the center. The visit to the center is nevertheless counted.


## 2. Angle presentation

The operator can choose between 2 different angle presentations for **Angles/Angle Bias** and **Angle frequency(%)** in locomotion analysis experiments:

1. All angles

| 0° | 45° | 90° | 135° | 180° | 225° | 270° | 315° |
|----|-----|-----|------|------|------|------|------|

2. Summarized angles

The angles 45°/315°, 90°/270° and 135°/225° are treated together:

| 0° | ±45° | ±90° | ±135° | 180° |
|----|------|------|-------|------|

Which of the two presentations is chosen depends on whether the parameter ***All angles*** has been activated by setting a cross (=All angles) or not (=angles treated together).


### 3. Standardizing the graphical analysis

This parameter only plays a role in the graphical presentation of the recorded measuring data (***Analysis/Learning Analysis A/Graph***). The operator enters the maximum values for the abscissa and the ordinate for the absolute curve presentation.


## 5.4.    Run data


The run data list contains each action which the animal makes and provides information about the course of the run. It is called up via the menu item ***Analysis/Run Data***. The head of each list contains the information which characterizes the data record.

```
MAZE - Run Data
Dr. Diaz-Heijtz, Astrid Lindgrens Children Hospital, Sweden

Operator  =
Time      = 23.02.98  16:52
Comment   =
Trial No  =     1 Exp. No  =     1 Code    =
Anim. No  =     1 Run No   =     1 Strain  =     Group = sch
Age       =    0d Weight   =    0.0g
Substance = sch
Dose      = 1ml/kg
Duration  =    4:14 min:s
Baited Arms    =  4  No. 1/4/6/7/
Open Arms      =  8  No. 1/2/3/4/5/6/7/8/
Start Position =  5
Refilling      = No
Termination    = Food

min:s           | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
 0:00.0    5.2s
 0:05.2    3.2s  . o .   .   . o .   . o . A .   .
 0:08.4    3.7s  . o .   .   . o .   . o . A .   . Food removed
 0:12.1    1.9s
 0:14.0    4.6s  . o .   .   . o .   . o .   . A .
 0:18.6    0.8s
 0:19.4    0.9s  . o .   .   . o .   . o .   . A .
 0:20.3    1.3s
 0:21.6    6.0s  . o . A .   . o .   . o .   .   .
 0:27.6    5.1s
 0:32.7    5.0s  . o .   .   . A .   . o .   .   .
 0:37.7    4.8s  . o .   .   . A .   . o .   .   . Food removed
 0:42.5    1.5s
 0:44.0   12.6s  . o .   .   .   . A . o .   .   .
 0:56.6    5.7s
 1:02.3    7.8s  . o .   .   .   .   . o . A .   .
```
**Radial maze example – learning behavior test (only the beginning of the table is shown)**

The list consists of the following columns:

◆      Time of an action calculated from the start of the trial in minutes:seconds
◆      Elapsed time until next action in seconds
◆      Food crib occupancy ("o" means "Food present"),
◆      Animal present in one of the 8 arms ("A")
◆      Information about food removal

The resolution of the system is 1/10 s!

The following are regarded as being an **action** (*counts* on the monitor):

• the animal moving from the maze center to an arm or vice versa,
• the animal removing food from the food crib or manipulating it so that the light barriers are interrupted.

If the maze is equipped with extra light barriers then the interruption of these sensors will also be entered in this list. An **empty** line in the list means that the animal is currently located in the **center** of the maze.

## 5.5.    Radial Maze evaluation

The following analyses are available:

◆ *Learning Analysis A*
◆ *Learning Analysis B*
◆ *Movement Analysis*
◆ *Analysis Design*

### 5.5.1.   Learning analysis A



The analysis algorithms in this analysis group are used for investigating into the effects of drugs or brain injury on learning and memory performance.

• The animal is to learn to find **constant food places**.
• Refilling does **not** take place in this case.

Within this analysis group there is the possibility of showing the measuring data as a *results list*, as a *results table* and as a *run graph*. *Export* of the results parameters is also possible.


### 5.5.1.1.    Results list

The results list is called up via the menu item ***Analysis/Learning Analysis A/List***. The list is headed by all the information which characterize the trial. Then follows:

- Food removal (sequence with arm number + time)

as well as the 3 results parameters:

- Entries in arms without food (per arm + total number of entries)
- Entries in arms *before* food removal (per arm + total number of entries)
- Entries in arms *after* food removal (per arm + total number of entries)

If several data records are selected then the analyses will be carried out in sequence and separated by a cross-line.

```
Food Removal
Arm 7   after   0:08.4
Arm 4   after   0:37.7
Arm 6   after   2:14.6
Arm 1   after   4:03.3

Entries in arms w/o food
Arm 2   Number =    3
Arm 3   Number =    2
Arm 5   Number =    2
Arm 8   Number =    3
_____
                   10

Entries in arms before food removal
_____
                    0

Entries in arms after food removal
Arm 4   Number =    1
Arm 7   Number =    1
_____
                    2
```


### 5.5.1.2.    Results table

The results table (***Analysis/Learning Analysis A/Table***) briefly summarizes the 3 results parameters of the selected data records.

```
MAZE - Learning Analysis A
Dr. Diaz-Heijtz, Astrid Lindgrens Children Hospital, Sweden

    Anim      Exp    Trial       Date      w/o bef. aft.    Durat.
      1        1       1      23.02.98     10    0    2    4:14.0
      1        1       1      23.02.98      3    0    1    2:33.0
      1        1       1      23.02.98      3    0    0    3:46.0
      1        1       1      24.02.98      3    0    1    2:06.0
      1        1       1      24.02.98      8    0    2    5:24.0
      1        1       1      24.02.98      3    0    0    2:24.0
      1        1       1      25.02.98      2    1    0    6:15.0
      1        1       1      25.02.98      1    0    0    6:54.0
      1        1       1      25.02.98      1    0    0    2:30.0
```

This provides an overview of the behavior of the laboratory animal in the course of the experiment or allows different animals to be compared.

### 5.5.1.3.    Run graph

The run graph shows the behavior of the animal in a graphical form. In the coordinate system the selected **runs** (=data records) appear as the abscissa (X-axis; it is a running number of the selected runs that does *not* correspond to the absolute run number!) and the number of *Entries* as the ordinate (Y-axis).
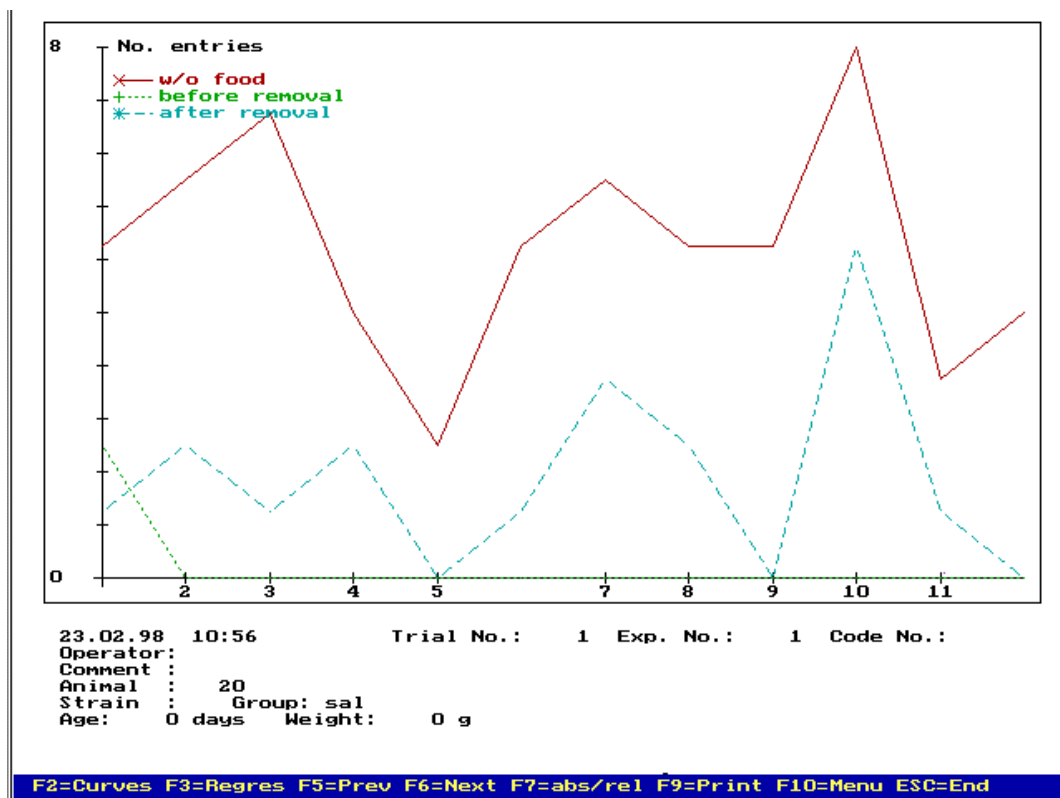


**Relative presentation**

The results parameters

- Total number of *Entries* in arms without food,

- Total number of *Entries* in arms *before* food removal and
- Total number of *Entries* in arms *after* food removal

are shown in different colors. The single measuring points of the first and the follow-up trials are connected up by straight lines. The additional information belonging to the curves is also shown.

A series of function keys can be used to change the presentation of the curve:

**1. Menu bar:**

**F2**  *Curves*
Shows the individual curves or all 3 curves. Each time the key is pressed a jump is made to the next individual curve.

**F3**  *Regres*
A regression curve of the shown curves (linear regression) is calculated and additionally inserted in the coordinate system. Pressing **F3** again switches the function off again.

**F7**  *abs/rel*
Switches between relative and absolute (standardized) curve presentation. In absolute presentation the operator enters the maximum values for the abscissa and the ordinate. This means that it is possible to easily compare curves of different animals. Settings are made in the menu item **Analysis Parameters**. In relative presentation (=standard setting when run graph is called up) the coordinate system is optimally adapted to the curves.

**F9**  *Print*
The run graph is printed out on a printer. In the menu item **Parameters/Printer Parameters**) the type of printer used must be specified before the printout is made.

**2nd Menu bar:**

**F2**  *Grid*
A grid is inserted into the coordinate system. Pressing **F2** again conceals the grid.

**F3**  *Spline*
Calculates a spline function as a connecting line between the individual measuring points (smoothing). Pressing **F3** again switches off the spline presentation.

**F4**  *Points*
Shows the individual measuring points without connecting lines. Repeatedly pressing **F4** switches between the mutual and individual presentation of the 3 results parameters.

### 5.5.1.4.   Data export

The results table can be stored in the form of an export file for further complex analyses with commercially available spreadsheet programs such as EXCEL. The operator can currently choose between 3 export formats (menu item **Parameters/Export Parameters**). The required export drive must also be set in this window.

This file, which contains all the data records chosen under data selection, is generated under the menu item *Analysis/Learning Analysis A/Export*.

## 5.5.2.  Learning analysis B

In this second analysis group the learning behavior of the animal in the Radial Maze is also analyzed. Further reaching analysis parameters are calculated here.

- In this second group of analysis functions there is also *no* refilling of the food cribs in the arms when the pellet has been removed by the animal.

The results are presented in a table. No graphical evaluation is carried out.

```
MAZE - Learning Analysis B: Summary
Dr. Diaz-Heijtz, Astrid Lindgrens Children Hospital, Sweden

Exp. No.      =     1
Open Arms     =     8
Baited Arms   =     4
Termination   =  Food

Anim    Gr     Date  Trial  No    TTi    CTi    ATi AEn  TEr  RM  WM WMc WMi
   1   sch 23.02.98     1    1   4:14   1:08   3:06  16   12   3   9   2   7
   1   sch 23.02.98     1    2   2:33   0:19   2:14   8    4   1   3   1   2
   1   sch 23.02.98     1    3   3:46   0:41   3:06   7    3   3   0   0   0
   1   sch 24.02.98     1    4   2:06   0:23   1:43   8    4   2   2   1   1
   1   sch 24.02.98     1    5   5:24   0:51   4:33  14   10   3   7   2   5
   1   sch 24.02.98     1    6   2:24   0:13   2:11   7    3   2   1   0   1
   1   sch 25.02.98     1    7   6:15   3:18   2:57   7    3   1   2   1   1
   1   sch 25.02.98     1    8   2:13   0:18   1:55   6    2   2   0   0   0
   1   sch 25.02.98     1    9   6:54   0:14   6:40   4    1   1   0   0   0
   1   sch 25.02.98     1   10   2:30   0:17   2:13   5    1   1   0   0   0
   1   sch 26.02.98     1   11   2:39   0:16   2:23   7    3   2   1   0   1
   1   sch 26.02.98     1   12   2:22   0:15   2:07   6    2   1   1   0   1
```

The table head gives the experiment number and the number of open arms or baited arms. The following **results parameters** are calculated:

| | |
|---|---|
| **TTi** | Total Trial Time |
| **CTi** | Center Time |
| **ATi** | Arm Time |
| **AEn** | Total Arm Entries |
| **TEr** | Total Errors (RM+WM) |
| **RM** | Reference Memory - Error |
| **WM** | Working Memory - Error (WMc+WMi) |
| **WMc** | Working Memory correct - Error |
| **WMi** | Working Memory incorrect - Error |

*Note:*      *If the start is not made from the center then the start arm will **not** be counted as an arm visit!*

The errors are defined as follows:

### Reference-Memory-Error (RM)
Number of **first** entries to **unbaited** arms (also during the first run!). RM can accept a maximum value of 8 minus the number of arms containing food if the center is selected as the start position. If the start position is in an arm then the maximum value is 7 minus the number of arms containing food.

### Working-Memory-correct-Error (WMc)
**Repeat** entry to a **baited** arm after the pellet has been removed in this trial.

### Working-Memory-incorrect-Error (WMi)
**Repeat** entry to an **unbaited** arm. The first entry to the start arm (not identical with the start position!) which never contains food is also counted as a WMi error.
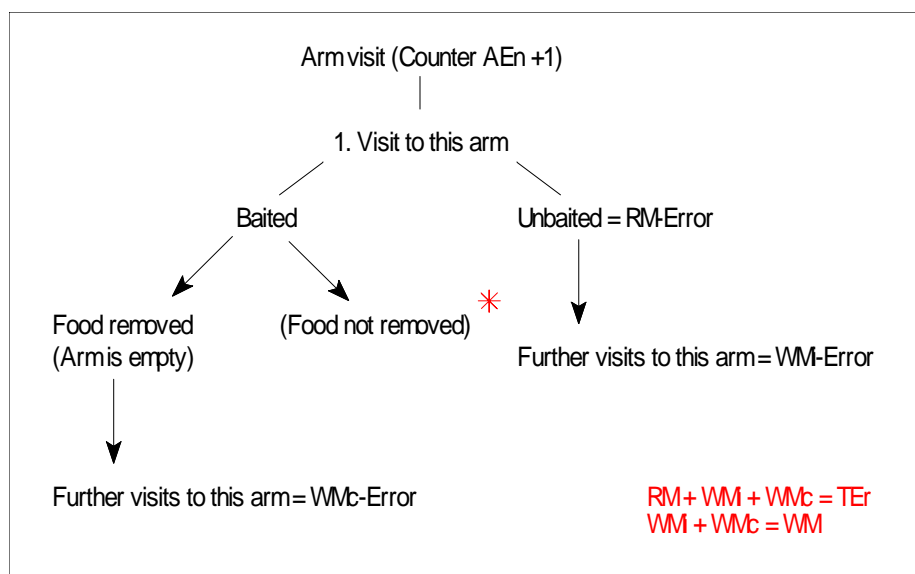


**Counting errors during a trial (=1 run)**

\*    It is assumed that the animal always removes the pellet during the first visit of a baited arm. If not, this visit is nevertheless counted as WMc.

## 5.5.3.   Movement analysis

In movement analysis experiments the **locomotion** of the animal in the 8-arm Radial Maze is observed. The maze can either be

- a maze which is baited in specific arms once or
- a maze which does **not** contain food (the animal is spontaneously alternating in the maze) or
- a system in which automatic feeders are used for constantly **refilling** all arms (continuously rebaited maze). In this case the animal learns that returning to a once-visited arm leads to additional food reinforcement.

Drug-induced effects on the locomotor pattern of animals in the maze may be an increased or reduced locomotor activity, an uneven distribution of locomotion, i.e. restriction to specific sectors of the maze or preference for distinct arms. The way the animal visits the arms may reveal specific spatial localization strategies. Unilateral brain injury usually produces a distinct propensity to go to adjacent arms, i.e. a stereotypic response strategy, resulting in reduced behavioral variability (perseverative locomotor patterns).

The following analysis algorithms are available:

- ***Arm Entries/Arm Bias***,
- ***Angles/Angle Bias*** and
- ***%Angle Frequency***.

Each analysis group generates its own results table.
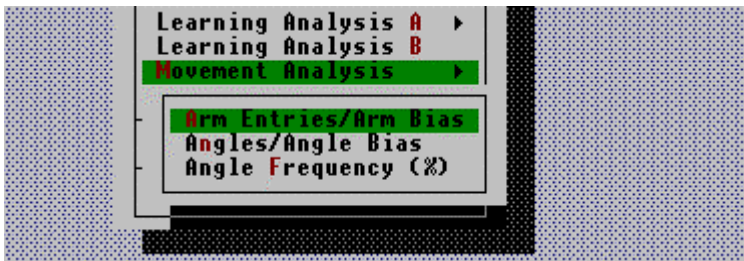


At the head of these tables the experiment number, the number of open arms or food places and the termination criterion are listed.

In addition the **AnimNo**, the **group**, the **date**, the **trial number** and the running number of the data record in the particular file are shown.

### *5.5.3.1.   Arm Entries/Arm Bias*

Here the distribution of arm entries into specific arms is evaluated.

```
MAZE - Movement Analysis: Arm Entries and Arm Bias
Dr. Diaz-Heijtz, Astrid Lindgrens Children Hospital, Sweden

Exp. No.     =     12
Open Arms    =      8
Baited Arms  =      0
Termination  =  Duration (5min)
```

| Anim | Gr | Date | Trial | No | TTi | AEn | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 | AB |
|------|------|---------|-------|----|------|-----|----|----|----|----|----|----|----|----|-------|
| 25 | Male | 29.11.99 | 5 | 1 | 5:00 | 8 | 0 | 4 | 0 | 0 | 0 | 3 | 0 | 1 | 0.637 |
| 33 | Male | 29.11.99 | 3 | 1 | 5:00 | 24 | 2 | 2 | 3 | 4 | 3 | 2 | 3 | 5 | 0.373 |
| 71 | Male | 29.11.99 | 4 | 1 | 5:00 | 7 | 3 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0.515 |

The table shows the following **results parameters** calculated from the selected data records:

| | |
|---|---|
| **TTi** | Total Trial Time |
| **AEn** | Total Number of Arm Entries |
| **A1-A8** | Number of Entries to Arms 1-8 |
| **AB** | Arm Bias |

The total number of entries shows whether a substance induces psychomotor activation or reduced locomotor activity. If the start is not from the center then the start arm does *not* count as an arm entry.

A **preference for distinct arms** is expressed in the so-called arm bias. The arm bias **AB\*** is a summary measure defined as

$$\sqrt{\sum \left(Arm_n / AEn\right)^2}$$

**\*  LOH et al., Pharm Biochem Behav (44), 735-740, 1993**

where $Arm_n$ = number of entries into a particular arm n. A higher arm bias score indicates a higher frequency of entries into a fewer number of arms, which represents an uneven locomotor activity across the maze.

The minimum value is 0.35355 when each arm is visited once. The maximum score of 1.0 reflects perseverative re-entry into a single arm.

### *5.5.3.2.    Angle analysis*

The **sequence** of arm entries allows to evaluate the way in which the animal is moving through the maze. When leaving an arm, an animal has the option to either re-enter that arm (0° turn) or enter any of the remaining 7 arms, representing 4 different absolute angles of turn ($\pm$45°, $\pm$90°, $\pm$135° or 180° turn). If a differentiation is to be made between right- and left-handed turns the possible angles are: 45°, 90°, 135°, 180°,  225°, 270° and 315°.

### 1. Angles/Angle Bias
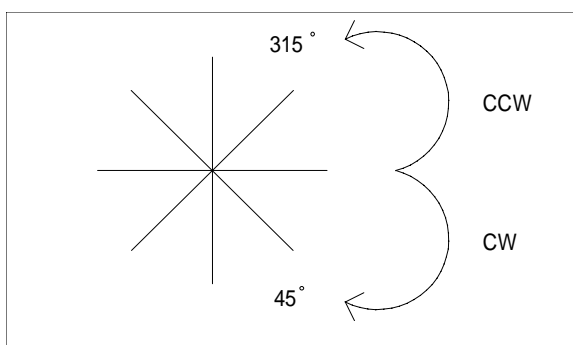


**Angles are calculated in clockwise (CW) direction**

This table shows the following **results parameters** calculated from the selected data records:

| | |
|---|---|
| **TAn** | Total Number of all Angles Moved |
| | TAn= AEn - 1 |
| **Number of individual angles visited** | |
| **AnB** | Angle Bias |

The way the animals alternate between the maze arms, i.e. the distribution of the angles of turn, is reflected by the **angle bias score**. This angle bias **AnB\*** is a summary score defined as

$$\sqrt{\sum \left( Angle_n / TAn \right)^2}$$

**\*  LOH et al., Pharm Biochem Behav (44), 735-740, 1993**

where *Angle_n* = number of visits to a particular angle n. Angle bias scores range from 0.44721 to 1.0. A strongly preferred angle of turn is expressed as an increased angle bias score (higher frequency of turns made at fewer different angles). A bias may be a result of a neurochemical asymmetry within the motor system.

The way in which the angles are presented depends on the setting of the *All angles* parameter in the *Analysis Parameters*.

```
MAZE - Movement Analysis: Angle Distribution and Angle Bias
Dr. Diaz-Heijtz, Astrid Lindgrens Children Hospital, Sweden

Exp. No.      =      12
Open Arms     =       8
Baited Arms   =       0
Termination   =  Duration (5min)

Anim    Gr    Date Trial  No TAn    0  45  90 135 180 225 270 315    AnB
  25  Male 29.11.99     5   1   7    0   0   2   0   5   0   0   0  0.769
  33  Male 29.11.99     3   1  23    2  18   0   0   0   0   0   3  0.798
  71  Male 29.11.99     4   1   6    0   1   4   0   0   0   0   1  0.707
```

If the parameter is activated then all angles will be listed **individually**.

```
MAZE - Movement Analysis: Angle Distribution and Angle Bias
Dr. Diaz-Heijtz, Astrid Lindgrens Children Hospital, Sweden

Exp. No.      =      12
Open Arms     =       8
Baited Arms   =       0
Termination   =  Duration (5min)

Anim    Gr    Date Trial  No TAn    0 +-45 +-90 +-135 180    AnB
  25  Male 29.11.99     5   1   7    0   0    2    0    5  0.769
  33  Male 29.11.99     3   1  23    2  21    0    0    0  0.917
  71  Male 29.11.99     4   1   6    0   2    4    0    0  0.745
```

If the option is inactivated angles with identical absolute value are summarized. This also changes the bias score calculation.

## 2. Percentage Angle Frequency

```
MAZE - Movement Analysis: Percentage Angle Frequency
Dr. Diaz-Heijtz, Astrid Lindgrens Children Hospital, Sweden

Exp. No.       =      12
Open Arms      =       8
Baited Arms    =       0
Termination    =  Duration (5min)

Anim    Gr     Date Trial  No  TAn    0    45    90   135   180   225   270   315
  25  Male 29.11.99     5   1    7   0.0   0.0  28.6   0.0  71.4   0.0   0.0   0.0
  33  Male 29.11.99     3   1   23   8.7  78.3   0.0   0.0   0.0   0.0   0.0  13.0
  71  Male 29.11.99     4   1    6   0.0  16.7  66.7   0.0   0.0   0.0   0.0  16.7
```

This table shows the following **results parameters**:

| TAn          Total Number of All Angles Moved |
|---|
| **Percentage frequency of individual angles visited** |

The frequency of angles of turn is used to determine which particular angle of turn is preferred. The way in which the angles are presented depends on the setting of the *All angles* parameter in the *Analysis Parameters* window. If the parameter is activated then all angles will be listed individually (see above), if not, angles with the same absolute value are summarized:

```
MAZE - Movement Analysis: Percentage Angle Frequency
Dr. Diaz-Heijtz, Astrid Lindgrens Children Hospital, Sweden

Exp. No.       =      12
Open Arms      =       8
Baited Arms    =       0
Termination    =  Duration (5min)

Anim    Gr     Date Trial  No  TAn    0   +-45  +-90 +-135   180
  25  Male 29.11.99     5   1    7   0.0   0.0  28.6   0.0  71.4
  33  Male 29.11.99     3   1   23   8.7  91.3   0.0   0.0   0.0
  71  Male 29.11.99     4   1    6   0.0  33.3  66.7   0.0   0.0
```

### 5.5.4.   Analysis design

In the Analysis design complex tables and export files are created for **one** results parameter from the analyzed data records. A total of 42 different parameters are available (see **Appendix**).
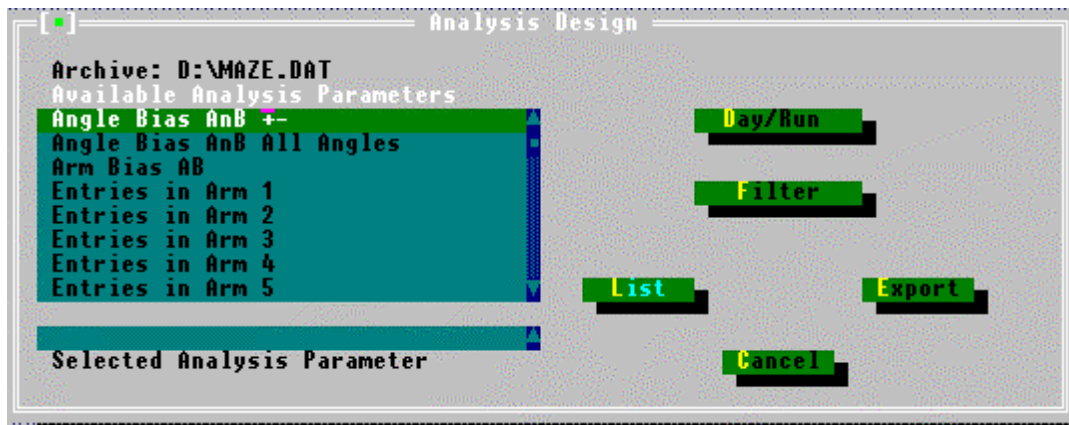
In contrast to the collective evaluations for learning analysis and movement analysis (individual analyses), in this case all the data are integrated which are contained in the set results drive (see *Archive* line) with **additionally** all the data contained in the further subsidiary directory level of the results drive.

- Selecting the analysis parameter from the selection list
- Selecting the days and runs to be included in the analysis
- Setting the filter (if necessary)
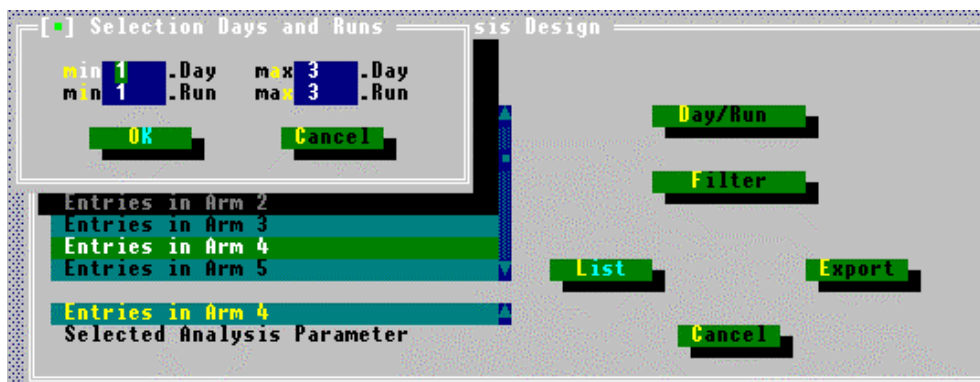


When the ***Day/Run*** button is pressed a window opens in which the days and runs to be analyzed must be defined. For each animal the count begins with the first day. It does not matter whether the runs of different animals took place on the same or different calendar days. Each change of date is recognized as being a further day (DAY1, DAY2, DAY3, etc.). *One* analysis list can contain a maximum of 10 days.

For each day the counting of the runs starts again at 1 (nth run in a day).

After selection the results list is created by pressing the *List* button.

```
Complex Data Analysis
Dr. Diaz-Heijtz, Astrid Lindgrens Children Hospital, Sweden

Exp. No      :    1
Open Arms    :    8
Baited Arms  :    4
Termination  : Food
Parameter    : Entries in Arm 4
Run number   :  1 -    3

AnimNo     Gr    Day1    Day2    Day3
    2      sal   3.00    6.00    2.00
    3      sal   5.00    3.00    2.00
    4      sal   3.00    2.00    2.00
    5      sal   3.00    3.00    4.00
   10      sal   3.00    4.00    3.00
   11      sal   4.00    2.00    0.00
   13      sal   4.00    3.00    6.00
   16      sal   7.00    2.00    3.00
   18      sal   5.00    6.00    3.00
   19      sal   3.00    3.00    6.00
```

If several runs are selected per day then the **total** of the results parameters is calculated for all runs and shown in the table.

The data sequence in the analysis table is determined by the structure of the subdirectories. Each subdirectory is treated separately and listed as a block. Within the blocks sorting is carried out according to increasing animal number.

At the head of the tables the experiment number, the number of open arms or food places and the termination criteria are listed. In addition the **AnimNo** and the **group** are shown.

The table can be printed out and exported.


### 5.5.4.1.   Data export

The results table created in the Analysis design can be stored in the form of an export file for further analyses with commercially available spreadsheet programs. Data export is started by pressing the *Export* button in the Analysis design window.
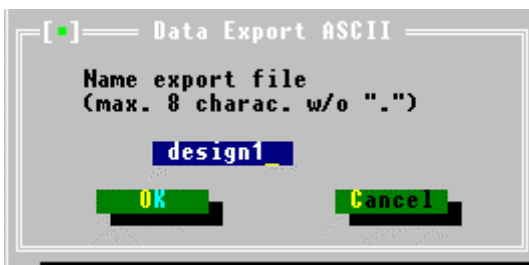


The file contents is then shown in a list window.

```
  2  1   3      1      1 23.02.98    sal    EnA4    3.000    6.000    2.000
  3  1   3      1      1 23.02.98    sal    EnA4    5.000    3.000    2.000
  4  1   3      1      1 23.02.98    sal    EnA4    3.000    2.000    2.000
  5  1   3      1      1 23.02.98    sal    EnA4    3.000    3.000    4.000
 10  1   3      1      1 23.02.98    sal    EnA4    3.000    4.000    3.000
 11  1   3      1      1 23.02.98    sal    EnA4    4.000    2.000    0.000
 13  1   3      1      1 23.02.98    sal    EnA4    4.000    3.000    6.000
 16  1   3      1      1 23.02.98    sal    EnA4    7.000    2.000    3.000
 18  1   3      1      1 23.02.98    sal    EnA4    5.000    6.000    3.000
 19  1   3      1      1 23.02.98    sal    EnA4    3.000    3.000    6.000
```
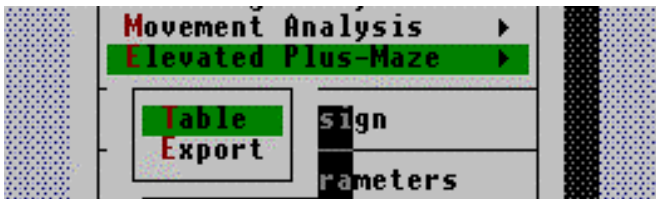**ASCII file / separator blank**

## 5.6. Elevated Plus-Maze evaluation



### 5.6.1. Results Table

The head of the evaluation table contains the experiment number and the start position. In addition the **AnimNo**, the **group**, the **date**, the **trial number** and the running number of the trial in the particular file (**No**) are shown.

```
Elevated Plus-Maze
Experiment No.: 44
Start Position: 0

Anim   Gr     Date Trial  No  TA CA OA %OA   TT   CT  %CT  CIT %CIT   OT  %OT
  3          10.11.99   33   1  10  0 10 100  300   33   11    0    0  267  100
```

The table shows the following **results parameters** calculated from the selected data records:

| | |
|---|---|
| **TA** | Total number of arm entries (CA + OA) |
| **CA** | Entries to closed arms (Arm nos. 4+8)* |
| **OA** | Entries to open arms (Arm nos. 2+6)* |
| **%OA** | Percentage frequency of entries to open arms (OAx100/TA) |
| **TT** | Total trial duration (AT**+CT) in seconds |
| **CT** | **Center Time=** Duration of stay on platform in seconds |
| **%CT** | Percentage share of CT in total trial duration (CTx100/TT) |
| **CIT** | **Closed Time=** Duration of stay in closed arms |
| **%CIT** | Percentage share of CIT in total **arm-stay** duration (CITx100/AT) |
| **OT** | **Open Time=** Duration of stay in open arms |
| **%OT** | Percentage share of OT in total **arm-stay** duration (OTx100/AT) |

\*   Do not confuse these open/closed arms with the "closed door arms" of the parameter window
\*\*  AT = total arm-stay duration (on both types of arm)


## 5.6.2.   Export


The evaluation table of the Elevated Plus-Maze can be written into an export file. The same procedures as are described under section 5.5.1.4. apply.

---

## Appendix I

### Results parameters for Analysis design (Radial Maze)

---

Total trial time TTi
Total stay duration in arms ATi
Total stay duration in center CTi

Number of entries Arm 1
Number of entries Arm 2
Number of entries Arm 3
Number of entries Arm 4
Number of entries Arm 5
Number of entries Arm 6
Number of entries Arm 7
Number of entries Arm 8
Total number of arm entries AEn
Arm bias AB

Number of angles 0 degrees
Number of angles ± 45 degrees
Number of angles ± 90 degrees
Number of angles ± 135 degrees
Number of angles 45 degrees
Number of angles 90 degrees
Number of angles 135 degrees
Number of angles 180 degrees
Number of angles 225 degrees
Number of angles 270 degrees
Number of angles 315 degrees
Total number of all angles moved TAn
Angle bias AnB

Percentage angle 0 degrees
Percentage angle ± 45 degrees
Percentage angle ± 90 degrees
Percentage angle ± 135 degrees
Percentage angle 135 degrees
Percentage angle 180 degrees
Percentage angle 225 degrees
Percentage angle 270 degrees
Percentage angle 315 degrees
Percentage angle 45 degrees
Percentage angle 90 degrees

Reference-Memory-Error RM
Working-Memory-Error WM= WMc+ WMi
Working-Memory-correct-Error WMc
Working-Memory-incorrect-Error WMi
Total errors TEr=RM+WM

**TSE
Technical & Scientific
Equipment GmbH**

**Saalburgstr. 157
D-61350 Bad Homburg / Germany**

**Phone:        +49 (0) 6172-789-0
Fax:           +49 (0) 6172-789-500
E-mail:        info@TSE-Systems.de
Internet:      http://www.TSE-Systems.de**