The PEBL Manual

Programming and Usage Guide for
The Psychology Experiment Building Language
PEBL Version 2.1

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Chapter 1

About

PEBL (Psychology Experiment Building Language) is a cross-platform, open-source programming language and execution environment for constructing programs to conduct a wide range of archetypal psychology experiments. It is entirely free of charge, and may be modified to suit your needs as long as you follow the terms of the GPL, under which the source code is licensed. PEBL is written primarily in `C++`, but requires a few other tools (`flex`, `yacc`) and the 2.0 branch of the SDL libraries (`SDL`, `SDL_image`, `SDL_gfx`, and `SDL_ttf`) to use. In addition, a set of audio recording functions are available using the (now old and basically unmaintained) sdl_audioin library. Finally, the `waave` library optionally supports movie playback on linux and windows.

It currently compiles and runs on Linux (using `g++`), Mac OSX (using xcode), and Microsoft Windows (using `code:blocks` and `mingw`) platforms using free tools. It has been developed primarily by Shane T. Mueller, Ph.D. (smueller@obereed.net). This document was prepared with editorial and formatting help from Gulab Parab and Samuele Carcagno. In addition, much of the material in the chapter on the PEBL Test battery was contributed by Bryan Rowley. Contributions are welcome and encouraged.

Chapter 2

Usage

Most users will be able to download a precompiled version of PEBL and run experiments directly. Some advanced users may wish to compile their own version, however. The next section describes how to do this.

2.1 How to Compile PEBL 2.0

Currently, there is no automated compile procedure. PEBL requires the `SDL2`, `SDL2_image`, `SDL2_gfx` `SDL2_net`, `SDL2_audioin` and `SDL2_ttf` libraries and development headers. It also uses `flex` and `bison`, but you can compile without these tools. PEBL compiles on both Linux and Windows using the free `gcc` compiler; on windows this is most easily supported through the code:blocks IDE. Note that `SDL-image` may require `jpeg`, `png`, and a `zlib` compression library, while `SDL-ttf` uses `truetype 2.0`.

2.1.1 Linux

PEBL should compile by typing '`make`' in its base directory once all requisite tools are installed and the source distribution is uncompressed. Currently, PEBL does not use autotools, so its make system is rather brittle. Assistance is welcome.

On Linux, compiling will fail if you don't have an `/obj` directory and all the appropriate subdirectories (that mirror the main tree.) These will not exist if you check out from CVS.

2.1.2 Microsoft Windows

On Microsoft Windows, PEBL is designed to be compiled using the Free IDE `code:blocks`. A code:blocks project file is included in the source code directory. Email the PEBL list for more details.

2.1.3 Mac OSX

Originally, PEBL compiled to a command-line function. Since 0.12, PEBL will compile to a .app package using xcode. An xcode package is available in the source archive.

2.2 Installation

2.2.1 Linux

On Linux, there are .deb packages available for debian. However, it is fairly easy to compile and install from source. To begin, be sure that all the sdl packages are installed. Then, go to the main pebl directory and type:

```
>make
>sudo make install
```

Once installed, you can install the test battery into `Documents/pebl-exp.X` using the command pebl –install.

2.2.2 Microsoft Windows

In Microsoft Windows, we provide an installer package that contains all necessary executable binary files and `.dlls`. This installer places PEBL in `c:\Program Files\PEBL`, and creates a directory `pebl-exp.X` in `My Documents` with a shortcut that allows PEBL to be launched and programs that reside there to be run.

2.2.3 Macintosh OSX

For OSX, we provide a `.app` package that can be dragged into your Applications folder. The first time any user runs pebl, it gives the option to install the battery and other files into Documents
pebl-exp.X. Afterward, it will run the launcher from that directory.

2.3 How to Run a PEBL Program

The simplest way to run any PEBL script is via the launcher, which is available on all platforms. The launcher is covered in detail in Chapter 6. But, you can also launch experiments individually on each platform.

2.3.1 Linux

If you have installed PEBL into `/usr/local/bin`, you will be able to invoke PEBL by typing '`pebl2`' at a command line. PEBL requires you to specify one or more source files that it will compile and run, e.g., the command:

```
> pebl2 stroop.pbl library.pbl
```

will load the experiment described in `stroop.pbl`, and will load the supplementary library functions in `library.pbl`.
Additionally, PEBL can take the `-v` or `-V` command-line parameter, which allows you to pass values into the script. This is useful for entering subject numbers and condition types using an outside program like a bash script (possibly one that invokes dialog or zenity). A sample zenity script that asks for subject number and then runs a sample experiment which uses that input resides in the `bin` directory. The script can be edited to use fullscreen mode or change the display dimensions, for example. See Section section2.5: Command-Line Arguments.
You can also specify directories without a filename on the command-line (as long as they end with '/'). Doing so will add that directory to the search path when files are opened.

2.3.2 Microsoft Windows

PEBL can be launched from the command line in Windows by going to the `pebl\bin` directory and typing '`pebl.exe`'. PEBL requires you to specify one or more source files that it will compile and run. For example, the command

```
> pebl2.exe stroop.pbl library.pbl
```

loads the experiment described in `stroop.pbl`, and loads supplementary library functions in `library.pbl`.
Additionally, PEBL can take the `-v` or `-V` command-line parameter, which allows you to pass values in to the script. This is useful for entering condition types using an outside program like a batch file. the `-s` and `-S` allow one to specify a subject code, which gets bound to the gSubNum variable. If no value is specified, gSubNum is initialized to 0. You can also specify directories without a file (as long as they end with '\'). Doing so will add that directory to the search path when files are opened. See Section section2.5: Command-Line Arguments.
Launching programs from the command-line on Windows is cumbersome. One easy way to launch PEBL on Windows is to create a shortcut to the executable file and then edit the properties so that the shortcut launches PEBL with the proper script and command-line parameters. Another way is to write and launch a batch file, which is especially useful if you wish to enter configuration data before loading the script.

2.3.3 Macintosh OSX

The latest version of PEBL packaged for OSX is 0.12. It is compiled as an application bundle with both 32-bit and 64-bit architectures available. We do not support PPC architecture.

The simplest way to run PEBL is through the launcher, but you can also use Applescript to create your own sequences of experiments.
On OSX, PEBL can be run as a command-line tool, just as in linux. Once installed, the application is located at /Applications/pebl.app/Contents/MacOS/pebl2.

2.4 How to stop running a program

In order to improve performance, PEBL runs at the highest priority possible on your computer. This means that if it gets stuck somewhere, you may have difficulty terminating the process. We have added an 'abort program' shortcut key combination that will immediately terminate the program and report the location at which it became stuck in your code:
press `<CTRL><SHIFT><ALT><\>` simultaneously.

2.5 Command-line arguments

Some aspects of PEBL's display can be controlled via command-line arguments. Some of these are platform specific, or their use depends on your exact hardware and software. The following guide to command-line arguments is adapted from the output produced by invoking PEBL with no arguments:

Usage: Invoke PEBL with the experiment script files (`.pbl`) and command-line arguments.

Examples:

```
pebl2 experiment.pbl -s sub1 --fullscreen --display 800x600
      --driver dga
pebl2 experiment.pbl --driver xf86  --language es
pebl2 experiment.pbl -v 33 -v 2 --fullscreen --display 640x480
```

Command-Line Options

`-v VALUE1 -v VALUE2`

Invokes script and passes `VALUE1` and `VALUE2` (or any text immediately following a `-v`) to a list in the argument of the `Start()` function.
This is useful for passing in conditions, subject numbers, randomization cues, and other entities that are easier to control from outside the script. Variables appear as strings, so numeric values need to be converted to be used as numbers.

`-s VALUE`
`-S VALUE`

Binds `VALUE` to the global variable gSubNum, which is set by default to 0.

`--driver <drivername>`

Sets the video driver, when there is more than one. On all platforms, opengl and software should be available. In Linux, opengles is also available, and on windows, direct3d.

`--display <widthxheight>`

Controls the screen width and height (in pixels). Defaults to the current resolution of the screen. Unlike older versions of PEBL, after 0.12 any legal combination of width and height should work.

The screensize a PEBL script runs at depends on a number of things. If no –display size is given (e.g., when 'default' is chosen in the launcher), PEBL will try to determine the current screen size and use that, for both fullscreen and windowed mode. Otherwise, it will try to use the specified value.

However, these values are only a request. When the script starts, it sets the values of the global variables `gVideoWidth` and `gVideoHeight` based on either the specified values or the current screen size. These values can be changed in the script before the `MakeWindow` function is called, so that a script can require a particular screen size. Then, the window will be created with those dimensions, overriding any command-line parameters. For greatest flexibility, it is recommended that you do not hard-code screen size but rather make your test adapt to a large number of screen sizes.

Finally, if a screen size is selected that the video card cannot support (i.e., in fullscreen mode), `gVideWidth` and `gVideoHeight` will be set to the legal screen size closest to the one you requested. PEBL should never crash because you have specified the wrong screen size, but it should rather use one it can support. The values of `gVideoWidth` and `gVideoHeight` will be changed by MakeWindow to whatever screen size it actually uses.

`--depth`

Controls the pixel depth, which also depends on your video card. Currently, depths of 2,8,15,16,24, and 32 are allowed on the command-line. There is no guarantee that you will get the specified bit depth, and bit depths such as 2 and 8 are likely never useful. Changing depths can, for some drivers and video cards, enable better performance or possibly better video sychrony. Defaults to 32.

`--language`

Allows user to specify a language code that can get tested for within a script to select proper translation. It sets a global variable gLanguage, and is "en" by default.

`--windowed` or `--fullscreen` Controls whether the script will run in a window or fullscreen. The screen resolution a PEBL script runs at depends on a number of things. See the `--display` option above for more details.

2.6 System Status Output

To help you debug what is happening and determine the system settings, information about PEBL system settings are printed out to stderr.txt. When a window is created, the following information will be printed out.

Driver information

First, the available drivers will be described. All platforms should have opengl and software, along with additional platform-specific drivers.

```
=================================================
    Available drivers
=================================================
Render driver count: 3
Driver name (0): opengl
 the renderer uses hardware acceleration
 present is synchronized with the refresh rate
 the renderer supports rendering to texture
Driver name (1): opengles2
 the renderer uses hardware acceleration
 present is synchronized with the refresh rate
 the renderer supports rendering to texture
Driver name (2): software
 the renderer is a software fallback
 the renderer supports rendering to texture
=================================================
```

Next, specific information about the video display and system will be printed.

```
--------------------------------------------------------------------------------
 Application settings:
Script name:                               [PEBL Launcher 2.0]
Mon Jun 20 22:02:24 2016
--------------------------------------------------------------------------------
Display Mode:  Width  (pixels)                    [1000]
Display Mode:  Height (pixels)                    [700]
Display Mode:  Color Depth (bits)                 [32]
vsync mode:                                       [0]
Software renderer mode:                           [0]
Windowed:                                         [1]
Resizeable:                                       [0]
Driver hint (gDriverHint):                        [none]
Base font (gPEBLBaseFont):                        [DejaVuSans.ttf]
Base Mono font (gPEBLBaseFontMono):               [DejaVuSansMono.ttf]
Base serif (gPEBLBaseFontSerif):                  [DejaVuSerif.ttf]
Language (gLanguage):                             [en]
Parameter file (gParamFile):                      [/usr/local/share/pebl2/pebl-lib/params/launcher.pbl.par]
Busy/Easy wait: (gSleepEasy):                     [1]
Executable name: (gExecutableName):               [pebl2]
Resource path: (gPEBLResourcePath):               [/usr/local/share/pebl2]
Resource path: (gPEBLBasePath):                   [/usr/local/share/pebl2]
Working directory: (gWorkingDirectory):           [/home/username/Documents/pebl-exp.2.0]
Renderer information:
Driver name:                                      [opengl]
Software fallback:                                [no]
Hardware acceleration:                            [yes]
Vsync with refresh rate:                          [no]
Rendering to texture support                      [yes]
```

```
----------------------------------------------------------------------------
```

Chapter 3

How to Write a PEBL Program

3.1 Basic PEBL Scripts

PEBL has a fairly straightforward and forgiving syntax, and implements most of its interesting functionality in a large object system and function library of over 125 functions. The library includes many functions specific to creating and presenting stimuli and collecting responses. Efforts, however successful, have been made to enable timing accuracy at a millisecond-scale, and to make machine limitations easy to deal with.
Each PEBL program is stored in a text file. Currently, no special authoring environment is available. A program consists of one or more functions, and *must* have a function called `Start()`. Functions are defined with the following syntax:

```
define <function_name>(parameters)
{
  statement 1
  statement 2
  ....
  return value3
}
```

The parameter list and the return value are optional. For the `Start(par){}` function, `par` is normally bound to 0. However, if PEBL is invoked with `-v` command-line parameters, each value that follows a `-v` is added to a list contained in '`par`', which can then be accessed within the program:

```
define Start(par)
{
   Print(First(par))
}
```

A simple PEBL program that actually runs follows:

```
define Start(par)
{
 Print("Hello")
}
```

`Print()` is a standard library function. If you run PEBL from a command-line, the text inside the `Print` function will be sent to the console. On Windows, it will appear in the file '`stdout.txt`' in the PEBL directory. Although other functions do not need a parameter argument, the `Start()` function does (case values are passed in from the command-line).
A number of sample PEBL programs can be found in the `/demo` subdirectory.

3.2 Case Sensitivity

PEBL uses case to specify an item's token type. This serves as an extra contextual cue to the programmer, so that the program reads more easily and communicates more clearly.
Function names must start with an uppercase letter, but are otherwise case-insensitive. Thus, if you name a function `"DoTrial"`, you can call it later as `"DOTRIAL"` or `"Dotrial"` or even `"DotRail"`. We recommend consistency, as it helps manage larger programs more easily.
Unlike function names, variable names must start with an lowercase letter; if this letter is a 'g', the variable is global. This enforces a consistent and readable style. After the first character, variable names are caseinsensitive. Thus, the variable '`mytrial`' is the same as '`myTrial`'.
Currently, syntax keywords (like loop, if, define, etc.) must be lowercase, for technical reasons. We hope to eliminate this limitation in the future.

3.3 Syntax

PEBL has a simple and forgiving syntax, reminiscent of `S+` (or `R`) and `c`. However, differences do exist.
Table table3.1 shows a number of keywords and symbols used in PEBL. These need not appear in lowercase in your program.
Note that the '=' symbol does not exist in PEBL. Unlike other languages, PEBL does not use it as an assignment operator. Instead, it uses '`<-`'. Because it is confusing for users to keep track of the various uses of the = and == symbols, we've eliminated the '=' symbol entirely. Programmers familiar with `c` will notice a resemblance between PEBL and `c`. Unlike `c`, in PEBL a semicolon is not necessary to finish a statement. A carriage return indicates a statement is

Table 3.1: PEBL Symbols and Keywords

Symbol/Keyword	Usage
+	Adds two expressions together
-	Subtracts one expression from another
/	Divides one expression by another
*	Multiplies two expressions together
^	Raises one expression to the power of another
;	Finishes a statement, or starts a new statement on the same line (is not needed at end of line)
.	The property accessor. Allows properties to be accessed by name
:	Used to specify a default value in a function definition, and to access global function defin
<-	The assignment operator
( )	Groups mathematical operations
{ }	Groups a series of statements
[ ]	Creates a list
#	Comment—ignore everything on the line that follows
<	Less than
>	Greater than
<=	Less than or equal to
>=	Greater than or equal to
==	Equal to
<> != ~=	Not equal to
and	Logical and
break	Breaks out of a loop prematurely
not	Logical not
or	Logical or
while	Traditional while loop
loop	Loops over elements in a list
if	Simple conditional test
if...else	Complex conditional test
if...elseif...else	Extended conditional chain
define	Defines a function
return	Allows a function to return a value

complete, if the current line forms a complete expression. You may terminate every command with a '`;`' if you choose, but it may slow down parsing and execution.
Another difference between `c` and PEBL is that in PEBL, `{}` brackets are not optional: they are required to define code blocks, such as those found in `if` and `while` statements and loops.

3.4 Expressions

An expression is a set of operations that produces a result. In PEBL, every function is an expression, as is any single number. Expressions include:

```
3 + 32
(324 / 324) - Log(32)
not lVariable
Print(32323)
"String " + 33
nsuho  #this is legal if nsuho has been defined already.
```

Notice that `"String "` 33+ is a legal expresison. It will produce another string: `"String 33"`.
These are not expressions:

```
NSUHO          #Not an expression
( 33 + 33      #Not an expression
444 / 3342 +   #Not an expression
```

`NSUHO` is not a variable because it starts with a capital letter. The other lines are incomplete expressions. If the PEBL parser comes to the end of a line with an incomplete expression, it will automatically go to the next line:

```
Print("hello " +
       " world."
     )
```

This can result in bugs that are hard to diagnose:

```
a <- 33 + 323 +
Print(1331)
```

sets `a` to the string `"3561331"`.
But if a carriage return occurs at a point where the line does make a valid expression, it will treat that line as a complete statement:

```
a <- 33 + 323
 * 34245
```

sets `a` equal to 356, but creates a syntax error on the next line.
Any expression can be used as the argument of a function, but a function may not successfully operate when given bogus arguments.
If a string is defined across line breaks, the string definition will contain a linebreak character, which will get printed in output text files and textboxes.

```
text <- "this is a line
and so is this"
```

If you desire a long body of text without linebreaks, you must define it piecemeal:

```
text <- "This is a line " +
        "There is no line break before this line."
```

3.5 loop() syntax.

The main way of iterating in PEBL is via the loop syntax. ASome examples include:

```
loop(i, [1,2,3])
{
  Print(i)
}

loop(i, ["a","b","c"])
{
   Print(i)
}
loop(i,10)
{
  Print(i)
}
```

The loop function will execute the code in the brackets multiple times; once for each element of the list specified as the second argument. On each iteration, the variable named in the first argument will be bound to a different value. As of 2.0, the if the second argument is an integer, loop will automatically create a list and iterate over the values 1...N up to the specified number. So, the following two are identical:

```
loop(i, Sequence(1,1000,1))
{
  Print(i)
}

loop(i, 1000)
{
```

```
Print(i)
}
```

In the future, the second version may be altered to be faster or use less memory.

3.6 Variables

PEBL can store the results of expressions in named variables. Unlike many programming languages, PEBL only has one type of variable: a "Variant". This variable type can hold strings, integers, floating-point numbers, lists, graphical objects, and everything else PEBL uses to create an experiment. Unlike other languages, a variable need not be declared before it can be used. If you try to access a variable that has not yet been declared, PEBL will return a fatal error that stipulates as such.

3.6.1 Coercion/casting

Variants just hide the representational structure from the user. An actual string resides within the variant that holds a string. A long integer resides within the variant that holds an integer.
PEBL Variants are automatically coerced or cast to the most appropriate inner format. For example, `3232.2 + 33` starts out as a floating point and an integer. The sum is cast to a floating point number. Similarly, `"banana" + 33` starts as a string and an integer, but the combination is a string.

3.6.2 Variable Naming

All variables must begin with a lowercase letter. Any sequence of numbers or letters may follow that letter. If the variable begins with a lowercase 'g', it has global scope; otherwise it has local scope.

3.6.3 Variable Scope

As described above, variables can have either local or global scope. Any variable with global scope is accessible from within any function in your program. A variable with local scope is accessible only from within its own function. Different functions can have local variables with the same name. Generally, it is a good idea to use local variables whenever possible, but using global variables for graphical objects and other complex data types can be intuitive.

3.6.4 Copies and Assignment

Variables may contain various types of data, such as simple types like integers, floating-point ratio numbers, strings; and complex types like lists, windows, sounds, fonts, etc. A variable can be set to a new value, but by design, there are very few ways in which a complex object can be changed once it has been set. For example:

```
woof   <- LoadSound("dog.wav")
meow   <- LoadSound("cat.wav")
dog    <- woof
```

Notice that woof and dog refer to the same sound object. Now you may:

```
PlayBackground(woof)
Wait(50)
Stop(dog)
```

which will stop the sound from playing. If instead you:

```
PlayBackground(woof)
Wait(50)
Stop(meow)
```

woof will play until it is complete or the program ends.
Images provide another example. Suppose you create and add an image to a window:

```
mWindow <- MakeWindow()
mImage  <- MakeImage("test.bmp")
AddObject(mImage, mWindow)
Draw()
```

Now, suppose you create another variable and assign its value to `mImage`:

```
 mImage2 <- mImage
 Move(mImage2, 200, 300)
 Draw()
```

Even though `mImage2` was never added to `mWindow`, `mImage` has moved: different variables now point to the same object. Note that this does not happen for simple (non-object) data types:

```
a <- 33
b <- a
a <- 55
Print(a + "  " + b)
```

This produces the output:

```
55  33
```

This may seem confusing at first, but the consistency pays off in time. The '<-' assignment operator never changes the value of the data attached to a variable, it just changes what the variable points to. PEBL is functional in its handling of simple data types, so you can't, for example, directly modify the contents of a string.

```
a  <- "my string"    #assigns a string literal to a
b  <- a              #makes b refer to a's string literal
a  <- "your string"  #re-assigns a to a new string literal
b  <- a              #makes b refer to a's new string literal
```

3.6.5 Passing by Reference and by Value

The discussion in subsection3.6.4 on copying has implications for passing variables into functions. When a variable is passed into a function, PEBL makes a copy of that variable on which to operate. But, as discussed in subsection3.6.4, if the variable holds a complex data type (object or a list), the primary data structure allows for direct modification. This is practical: if you pass a window into a function, you do not want to make a copy of that window on which to operate. If the value is a string or a number, a copy of that value is made and passed into the function.

3.7 Functions

The true power of PEBL lies in its extensive library of functions that allow specific experiment-related tasks to be accomplished easily. For the sake of convenience, the library is divided into a number of subordinate libraries. This library structure is transparent to the user, who does not need to know where a function resides in order to use it. Chapter chapter5 includes a quick reference to functions; Chapter chapter10 includes a complete alphabetical reference.
To create your own function, you use the define keyword, followed by the (Uppercase) function name, the arguments, and the code delineated by brackets. Within a function, the passed-in arguments and any new parameters will have a scope local to that function. Any variables starting with a 'g' value will have global scope, and be available outside the function.
Version 2.0 introduces two important new features to functions: optional/default arguments and global-namespace functions.

Optional/Default arguments

When you define a function, you can specify a default value by following the variable name with a colon and the default value.

```
define FunctionName(arg1, arg2:0, arg3:10)
{
  Print(arg1+arg2+arg3)
}
```

When calling a function, it must be called with all its non-optional arguments, but if an optional argument is not given, it will take on the default value. Currently, if you cannot specify non-default values for arguments that occur after the first default value you use, so in the above situation, you can call FunctionName(1), Function(1,1,1), or FunctionName(1,1,1), but you can't skip the second argument.

Calling functions in the global namespace

PEBL has two types of functions: built-in functions written in C++, and a library of functiosn written in PEBL (located in the pebl-lib directory of the PEBL directory). For all functions, if you define a function with a name identical to an already-defined function, it will use your newly-defined function instead of the original. However, if the original was a compiled function, you can still access that function by pre-pending the name with a colon.
This is useful if you want to rename a function for debugging or other purposes, but still want to access the original. For example, supposed I wanted to log the time of each Draw() function, I could redefine Draw:

```
define Draw(x)
{
   Print("Draw command issued:" + GetTime())
   :Draw(x)
}
```

We use this in the Debug.pbl directory, which opens up a debugging window and prints to the window.

3.8 A Simple Program

The previous sections provide everything you need to know to write a simple program. Here is an annotated program:

```
# Any line starting with a # is a comment.  It gets ignored.

#Every program needs to define a function called Start()
#Start always needs a parameter
define Start(par)
{

 number <- 10   ##Assign a number to a variable

 hello  <- "Hello World"  ##Assign a string to a variable
 ##Create a global variable (starts with little g)
 gGlobalText <- "Global Text"

 ##Call a user-defined function (defined below).
 value <-  PrintIt(hello, number)
 ##It returned a value
 #Call a built-in function
 Print("Goodbye. " + value)
}

##Define a function with two variables.
define PrintIt(text, number)
{
  #Seed RNG with the current time.
  RandomizeTimer()
  #Generate a random number between 1 and number
  i <- RandomDiscrete(number)  #this is a built-in function
  ##Create a counter variable
  j <- 0
  ##Keep sampling until we get the number we chose.
  while(i != number)
  {
       Print(text + "  " + i + gGlobalText)
       i <- RandomDiscrete(number)
       j <- j + 1
  }

  return(j)  #return the counter variable.
}
```

More sample programs can be found in the `demo/` and `experiments/` directories of the PEBL source tree.

Chapter 4

Overview of Object Subsystems

In PEBL, complex objects are stored and automatically self-managed. These objects include lists, graphical display widgets like images and text displays, fonts, colors, audio files, and input or output files. Objects are created and modified with special functions, but many of their properties available directly for access and modification with a `variable.property` syntax. For example, the position of a textbox is controlled by `.X` and `.Y` properties, and can also be changed with the `Move()` function. To move the label `lab`, which is located at 100,100, to 150,100, you can either do `Move(lab,150,100)` or `lab.X <- 150`. The available properties and accessor function are listed in the decriptions of their relevant objects below.

4.1 Lists

Lists are incredibly useful and flexible storage structures that play an important role in PEBL. A list is simply a series of variables. It is the equivalent to a vector, array, or other similar data structure in many other programming languages.
Creating and accessing elements of lists can be accomplished in a number of ways. If you have a set of values you want to create a list from, you simply need to put them inside square brackets, separated by commas:

```
mylist <- [1,2,3,4,5,6,7,8,9]
```

Many functions related to experimental design return lists already created. Two simple functions are `Repeat` and `Sequence`:

```
list1 <- Repeat(0,10)       ##ten zeroes
list2 <- Sequence(0,20,2)   ##numbers 0 to 20 step 2
```

Accessing list items can be done in a number of ways. The simplest is using the `Nth()` function. For a slightly more complex example, suppose you want to print out every item in a list. Looping through, accessing, and printing all the items of a list using this approach:

```
list <- Sequence(1,9,1)
len <- Length(list)
i <- 1
while (i <= len)
 {
   item <- Nth(list,i)
   Print(item)
   i <- i + 1
}
```

Note that prior to PEBL 0.12, using Nth to access list items was inefficient. Since PEBL 0.13, you can use Nth to access list items in amortized constant time! But nevertheless, the above method of looping is verbose and error-prone. There is an alternative. Items from lists can be iterated over using the '`loop`' command:

```
list <- Sequence(1,9,1)
loop(item, list)
{
  Print(item)
}
```

These two code blocks produce identical output, but in the former block, each item of the list must be found on each iteration, but in the latter block, a list item is bound directly to '`item`' on each iteration. There is no appreciable difference in the efficiency of these two methods, but the second is simpler and in many cases easier to use, and avoids some errors (like forgetting to increment `i`).

4.1.1 Growing Lists

Oftentimes, you want to create a list one element at a time. For example, you may have a sampling scheme for stimuli and need to pick each consecutive randomly, or you want to record response times or accuracies one trial at a time. There are two ways you can do this. If you know how long your list will be, you can create a list with as many elements as you need, and then alter each element one at a time.

```
##I need ten items

items <- Repeat(0,10)
i <- 1
```

```
while(i <= Length(items))
{
  SetElement(items,i,Random())
}
```

Oftentimes, however, this is difficult because you do no know how long the list should be at the beginning. The `Append()` function is able to add an item to the end of a list, and you can use that to 'grow' a list one item at a time:

```
##I need ten items

items <- []
i <- 1
while(i <= 10)
{
  items <- Append(items,Random())
}
```

This ideom is used in many places in PEBL test batteries. However, it can be inefficient as the length of the list grows. This is because on each iteration, a new list is created that is 1 element longer than the previous list (and each element is copied to the new list). For small lists, even ones hundred of items long, this overhead is pretty small and you hardly notice. But as a list gets thousands of items long, this can start to slow things down, especially if you are doing something complex between each trial. As of PEBL 0.13, we support another function called PushOnEnd():

```
items <- []
i <- 1
while(i <= 10)
{
  PushOnEnd(items,Random())
}
```

`PushOnEnd` will alter `items` directly, and do so in a very efficient way. Notice that you don't need to copy the new list and overwrite itself. However, for ease of use, `PushOnEnd()` returns the current copy of the list, and so you can often use it as a drop-in replacement for Append (in cases where you are throwing away the original list). In tests, this method appears to be only 5-10% less efficient than using `PushOnEnd` alone, and so it should hardly be noticed.

```
items <- []
i <- 1
while(i <= 10)
{
  items <- PushOnEnd(items,Random())
}
```

A caveat when using lists: Some functions operate on lists to produce new lists (sub-lists, re-ordered lists, etc.). When the lists contain simple data types (numbers, strings, etc.), entirely new data structures are created. But when the data structures are complex (windows, sounds, images, etc.), the objects are not copied. Only new pointers to the original objects are created. So if you change the original object, you may end up accidentally changing the new object. Although that is relatively difficult, because PEBL allows only limited modification of existing data structures, it is still possible. This is a special case of the copy/assignment issue discussed in Section subsection3.6.4: Copies and Assignment.

4.1.2 Recursion on lists

Many mathematical functions that take a single argument can be applied either to a number or a list of numbers. When applied to an entire list, it will return the function applied to each element of that list. For example, `Ln(1)` return 0, but `Ln([1,1,1]` returns [0,0,0].
A list of functions that support this include:

- `Log10`
- `Log2`
- `Ln`
- `Exp`
- `Sqrt`
- `Tan`
- `Sin`
- `Cos`
- `ATan`
- `ASin`
- `ACos`
- `DegToRad`
- `RadToDeg`
- `Round`
- `Floor`
- `Ceiling`
- `AbsFloor`
- `Sign`
- `Abs`

In addition, a number of math functions that take two argumunts will apply themselves recursively to the first argument should it be a list. For example, `LogN([1,1,1],5)` will return [0,0,0]. Functions that support this include:

- `LogN`
- `Pow`
- `NthRoot`

4.2 Fonts

PEBL uses truetype fonts for the display of text in labels and other text widgets. In addition to the filename, font objects have the following properties: style (i.e., normal, bold, italic, underline), size (in points), foreground color, background color, and whether it should be rendered anti-aliased.
We distribute a series of high-quality freely available and redistributable fonts, including the DejaVu series, freefont series, and a few others. These include the typeface/files shown below table4.1:
These should always be available for use in experiments. The `fonts.pbl` script in the demo/ directory will display what symbols from each of these fonts looks like.
To use, you need only specify the font name in the `MakeFont()` function:

```
colorRed  <- MakeColor("red")
colorGrey <- MakeColor("grey")
myFont    <- MakeFont("VeraMono.ttf",0,22,colorRed,colorGrey,1)
```

This code makes a red 22-point anti-aliased font on a grey background. Other fonts may be used by specifying their absolute pathname or copying them to the working directory and using them.
Accessible font properties:

```
font.FILENAME
font.BOLD
font.UNDERLINE
font.ITALIC
font.SIZE
font.FGCOLOR
font.BGCOLOR
font.ANTIALIASED
```

Having the right fonts is important for translating PEBL scripts into new languages. Previously, this was challenging because the default font used in many scripts was Vera, and Vera has poor support for international characters. As of PEBL 0.11, a few things have changed to make international character support easier:

- Three new fonts that support international characters much better ("DejaVuSans.ttf", "DejaVuSansMono.ttf", and "DejaVuSerif.ttf") are now included and available.
- Three new global variables are set on initiation: `gPEBLBaseFont`, `gPEBLBaseFontMono`, and `gPEBLBaseFontSerif`, which are set by default to these three font names.
- Helper functions and battery tests are all updated to use these values to set up fonts.

Table 4.1: Typeface/Files Available in PEBL

Filename	**Description**
	FreeFont Fonts
`FreeSans.ttf`	Simple Clean sans serif font
`FreeSansBold.ttf`	
`FreeSansOblique.ttf`	
`FreeSansBoldOblique.ttf`	
`FreeMono.ttf`	Courier-like fontface
`FreeMonoBold.ttf`	
`FreeMonoOblique.ttf`	
`FreeMonoBoldOblique.ttf`	
`FreeSerif.ttf`	Similar to Times New Roman
`FreeSerifBold.ttf`	
`FreeSerifItalic.ttf`	
`FreeSerifBoldItalic.ttf`	
	Fontforge Fonts
`Caliban.ttf`	Helvetica-style
`CaslonRoman.ttf`	Quirky Roman Font series
`CaslonBold.ttf`	
`CaslonItalic.ttf`	
`Caslon-Black.ttf`	
`Humanistic.ttf`	Sharp, refined fontface
	SIL Fonts
`DoulosSILR.ttf`	Comprehensive font with roman and cyrillic glyphs
`GenR102.ttf`	Includes many latin alphabet letters
`GenI102.ttf`	
`CharisSILR.ttf`	Like doulos, optimized for printing
`CharisSILB.ttf`	
`CharisSILI.ttf`	
`CharisSILBI.ttf`	
	PEBL Fonts
`Stimulasia.ttf`	A small set of arrow/boxes
	Bitstream Vera Series (Deprecated in favor of DejaVu)
`Vera.ttf`	Sans serif Roman-style base font
`VeraMono.ttf`	Sans serif Roman-style mono-spaced base font
`VeraSe.ttf`	Serif Roman-style base font (similar to times)
`VeraBd.ttf`	Bold Vera
`VeraIt.ttf`	Italic Vera
`VeraBI.ttf`	Bold Italic Vera
`VeraMoBd.ttf`	Bold Vera Mono
`VeraMoIt.ttf`	Italic Vera Mono
`VeraMoBI.ttf`	Bold Italic Vera Mono
`VeraSeBd.ttf`	Bold Serif Vera
	DejaVu Series (Version of Vera with international characters)
`DejaVuSerif.ttf`	Serif Roman-style base font (similar to times)
`DejaVuSans.ttf`	Serif Roman-style base font
`DejaVuSansMono.ttf`	Sans serif Roman-style mono-spaced base font
	CJK Fonts
`wqy-zenhei.ttc`	All-purpose font with support for Chinese, Korean and Japanese

So now, many international characters will be handled by default. For character sets that aren't handled by DejaVu, simply needs to change `gPEBLBaseFont` to name a font that can handle your characters (and include that font in the program directory), and everything should work out fine.

4.3 Colors

Colors are PEBL objects. A color can be created by specifying its name using the `MakeColor()` function, or by specifying its RGB values using the `MakeColorRGB()` function. A list of colors and their respective RGB values can be found in the `Colors.txt` file in the documentation directory, or in the final chapter of the manual. There are nearly 800 from which to choose, so you can create just about anything you can imagine.
Accessible color properties:

```
color.RED
color.GREEN
color.BLUE
color.ALPHA
```

4.4 Windows

To run an experiment, you usually need to create a window in which to display stimuli. This is done with the `MakeWindow()` function. `MakeWindow()` will create a grey window by default, or you can specify a color. Currently, an experiment can have only one window.

4.5 Graphical Widgets

Graphical "widgets" are the building blocks of experimental stimuli. Currently, four widgets are available: images, labels, canvasses, and textboxes. More complicated widgets are in progress or planned. There are also a number of shapes that in some ways behave like widgets, but are technically not.
To be used, a widget must be created and added to a parent window, and then the parent window must be drawn. You can hide widgets with the `Hide()` function, and show them with the `Show()` function; however, this affects only the visibility of the widget: it is still present and consuming memory. Widgets can be moved around on the parent window using the `Move()` function. `Move()` moves the center of an image or label to the specified pixel, counting from the upper-left corner of the screen. `Move()` moves the upper left-hand corner of textboxes. For the sake of convenience, the `MoveCorner` function is available, which will move an image or label by its upper left-hand corner.
You should remove widgets from their parent window when you are finished using them.
All widgets have several properties available for controlling their behavior.

```
widget.name
```

```
widget.X
widget.Y
widget.WIDTH
widget.HEIGHT
widget.VISIBLE
widget.ROTATION
widget.ZOOMX
widget.ZOOMY
```

4.6 Images

PEBL can read numerous image types, courtesy of the `SDL_image` library. Use the `MakeImage()` function to read an image into an image object. As images are often used as stimuli, `Move()` centers the image on the specified point. To move by the upper-left hand corner, use the PEBL-defined `MoveCorner()` function:

```
define MoveCorner(object, x, y)
{
 size    <- GetSize(object)
 centerX <- x + First(size)/2
 centerY <- y + Last(size)/2
 Move(object, centerX, centerY)
}
```

Images have all the properties available for widgets, but the width and height can only be read, and not set. Width and height are controlled by the dimensions of the image file.

4.7 Canvases

A canvas is a blank rectangle, sort of like an 'imageless' image. As with an image, `Move()` centers the image on the specified point. A canvas appears similar to a Rectangle() shape, but differs in some important ways. First, a Canvas has a piece of video memory associated with it–shapes do not. This means that other objects can be added to a canvas, just as it can be added to a window. If you move the canvas around, the attached objects will move with the canvas.

Second, individual pixels of a canvas can be set, using the SetPoint() function. SetPoint works on images too, but not on text. This is because a Draw() command re-renders text, and so will wipe out any pixel damage you have done. This can be useful for making special-purpose drawing functions to create stimuli, especially noise distributions.

Finally, a canvas can be drawn on with another object. In fact, you can you another image as a brush. Add an image to a canvas, and anytime you call Draw() on the canvas (rather than without an argument), the image gets imprinted on the canvas. This will remain until you call ResetCanvas().

For example:

```
tb  <- MakeCanvas(600,400,d)
AddObject(tb,win)

##add the image to canvas, not win
pebl <- MakeImage("pebl.png")
AddObject(pebl,tb)

##Nothing will appear on the screen in these intermediate draws
Move(pebl,100,100)
Draw(pebl)
Move(pebl,200,100)
Draw(pebl)
Move(pebl,200,200)
Draw(pebl)
Move(pebl,100,200)
Draw(pebl)

Draw()  ##Now, we will see the canvas with 4 pebl images on it.
```

The draw-on trick can be used to add noise to a text stimulus. Make a label and add it to a canvas, use Draw() on the label, then hide the label, and add noise to the canvas by using SetPoint(). Anything drawn on the canvas won't get reset until the ResetCanvas() function is called.
Images have all the properties available for widgets. Size cannot be updated once the canvas is created.
Note that the background color can have an alpha value. If you use an alpha value of 0, the background will be invisible.

4.8 Shapes

PEBL allows you to define a number of shape objects that can be added to another widget. A demonstration script exercising these shapes is found in demo/shapes.pbl.
The following is a list of shape and their properties.

4.8.1 Circle

Description: A standard circle. Move commands move the center of the circle to the specified location.

Command: `Circle(<x>,<y>,<r>,<color>,<filled>)`

Properties: .name
.filled = 0,1 (whether it is filled)
.color (color)
.x (x position of center)
.y (y position of center)

.height (read-only height)
.width (read-only width)
.R (radius)

4.8.2 Ellipse

Description: An ellipse, with height and width differing. Cannot be pointed in an arbitrary direction. Move commands move the center of the shape to the specified location.
Command: `Ellipse(<x>,<y>,<rx>,<ry>,<color>,<filled>)`

Properties: .name
.filled = 0,1 (whether it is filled)
.color (color)
.x (x position of center)
.y (y position of center)
.height (read-only height)
.width (read-only width)
.rx (x radius)
.ry (y radius

4.8.3 Square

Description: A square. Move commands move the center of the shape to the specified location.
Command: `Square(<x>,<y>,<size>,<color>,<filled>)`

Properties:
.name
.filled = 0,1 (whether it is filled)
.color (color)
.x (x position of center)
.y (y position of center)
.height (read-only height)
.width (read-only width)
.dx, .dy, .size (Length of side)

4.8.4 Rectangle

Description: A Rectangle. Move commands move the center of the rectangle to the specified location.
Command: `Rectangle(<x>,<y>,<dx>,<dy>,<color>,<filled>)`

Properties: .name
.filled = 0,1 (whether it is filled)
.color (color)
.x (x position of center)
.y (y position of center)
.height (read-only height)
.width (read-only width)
.dx, (width) .dy, (height)

4.8.5 Line

Description: A Line. Move commands move the center of the line to the specified location.
Command: `Line( <x>, <y>,<dx>,<dy>,<color>)`

Properties: .color (color)
.x (x position of start)
.y (y position of start)
.width, (x length)
.height, (y length)

4.8.6 Polygon

Description: An arbitrary polygon.
Command: `Polygon( <x>, <y>,<xpoints>,<ypoints>,<color>,<filled>)`

Properties: .name
.color (color)
.x (x position of start)
.y (y position of start)

4.8.7 Bezier

Description: An arbitrary bezier curve.
Command: `Bezier( <x>, <y>,<xpoints>,<ypoints>,<steps>,<color>)`

Properties: .name
.color (color)
.x (x position of start)
.y (y position of start)

4.9 Text Labels

You can create a text label object with the `MakeLabel()` function, which requires specifying a font, and the foreground and background colors. Labels are only a single line of text. Like images, when you move them, they center on the specified point.
The text inside a label can be extracted with `GetText()` and set with `SetText()`. When you change a text object, it will not appear until the next time you call a `Draw()` function.
Text labels have all the regular widget properties, plus:

```
label.TEXT
label.FONT
```

The `.HEIGHT` and `.WIDTH` accessible, but cannot be changed because they are controlled by the text and the font size.

4.10 Text Boxes

A text box is a graphical widget that contains a body of text. Text automatically wraps when it is too long to fit on a single line. Like labels, the text inside a TextBox can be extracted with `GetText()` and set with `SetText()`. When a text object is changed, it rerenders immediately, but does not appear until the next time a `Draw()` function is called.
Textbox properties:

```
textbox.EDITABLE
textbox.CURSORPOS
textbox.DIRECTION
textbox.LINEHEIGHT
textbox.LINEWRAP
```

4.11 User-Editable Text Boxes

Text box editing can be performed using the `GetInput(<textbox>,<escape-key>)` function. This returns the text that is present in the box when the participant hits the key associated with `<escape-key>`. `<escape-key>` is just a text-based code that describes the keypress that should be checked for exit. Typical escape-key options include:

```
"<return>"
"<esc>"
"<backspace>"
"<kp_enter>"
" "
"A"
```

See the Keyboard Entry section below for a more complete list.
Translation from string to keyboard input is still crude, and is handled in `src/utility/PEBLUtility.cpp:TranslateString`

4.12 Audio

Currently, audio output is supported through a software mixer library, although there are no facilities for recording or analyzing audio input.
PEBL can load both raw and compressed audio filen, including .wav, .mp3, .ogg, .flac, and .midi files, which are handled seamlessly with the `LoadSound()` function. This returns an audio stream object that can be played with either the `PlayForeground()` or `PlayBackground()` functions. The `PlayForeground()` function returns once the sound is finished playing; `PlayBackground()` returns immediately and the sound plays in a separate thread. When using `PlayBackground`, playing can be stopped using the `Stop()` function.
The volume of an audio sample can be manipulated using `SetPanning`. Here, each channel (left and right) volume is set independently, from 0 to 1.0. Also, the `SetPlayRepeats` will repeat playback a sound until stopped. This could be good for a signal that is played until a response is made.

4.13 Movie Files

As of 2.0, Playback of movies is not enabled.
If compiled to support them, PEBL can read numerous video and audio media files `waave` library and ffmpeg. Use the `LoadMovie()` function to read a movie file into a movie object. The `Move()` function moves the upper left corner of the movie to the specified point. An audio file can be similarly loaded using the `LoadAudioFile` function.
Movie playback is done via a handler placed in the event loop. This handler is placed there with the `StartPlayback` function. Then, when the event loop runs, the movie will get updated in proper time sequence. The event loop is used for most WaitFor type events. This allows you to play a movie and wait for a response at the same time. Alternately, a complete movie file can be played in full (with no possibility for stopping early) using the PlayMovie() function.
Movies have a number of properties that can be set to change playback or determine aspects of the movie. These are all accessible via .property syntax, and can be printed by the PrintProperties function. Properties include:

- DURATION: time in ms
- FILENAME: filename
- HEIGHT: pixels high
- NAME: `<MOVIE>`
- PLAYBACKPOSITION: where playback is
- ROTATION: Inherited; will not work
- VISIBLE: whether hidden or visible
- VOLUME: volume on a logarithmic scale–can go from 0 to +infinity

- WIDTH: screen width in pixels
- X: upper left corner x
- Y: upper left corner y
- ZOOMX: scaling; not used (just set width)
- ZOOMY: scaling; not used (just set height)

4.14 Custom objects

Along with the built-in objects, PEBL lets you create your own object with properties that can be added, changed, and accessed using the .property notation. With appropriate use of the `CallFunction` command, you can also specify function handlers for functions such as `Move()`, `Draw()`, `Inside()`, or whatever you want. The object system in PEBL is fairly (and intentionally) primitive, without things you might expect from full-fledged object-oriented languages (i.e., accessor functions, inheritance, methods, constructors, etc.). Nevertheless, it can be very useful for encapsulating a lot of information about a computing object, and is used heavily in the GUI objects found in the launcher and other PEBL tools.

Use `MakeCustomObject(name)` to create a custom object. Then, a property can be added by assigning obj.name. For example, suppose you want an object to represent the x,y location of a point.

```
p1 <- MakeCustomObject("point")
p1.x <- 100
p1.y <- 100
```

Now, if you want to use access the x and y properties, do:

```
 Print("position is:" p1.x + ","+ p1.y)
```

An object can take a function name as a property. For example:

```
p1.inside <- "InsidePoint"
```

With the function InsidePoint defined as:

```
define InsidePoint(x,y,p)
{
  return (x==p.x and y==p.y)
}
```

If you had a bunch of objects, you could define the .inside property of each differently. Then, later, you could define InsideObject to check any of them:

```
define InsideObject(x,y,p)
{
   CallFunction(p.inside,[x,y,p])
}
```

4.15 Keyboard Entry

PEBL can examine the state of the keyboard, and wait for various keyboard events to happen. Functions such as `WaitForKeyDown()`, `WaitForAnyKeyDown()`, etc., allow you to collect responses from subjects. Most keys are specified by their letter name; others have special names:

"<left>"
"<up>"
"<down>"
"<right>"
"<enter>"
"<return>"
"<esc>"
"<backspace>" or "<back>"
"<kp_0>" through "<kp_9>", as well as "<kp_period>", "<kp_divide>", "<kp_multiply>", "<kp_minus>", "<kp_plus>", "<kp_equals>", "<kp_enter>" for keypad keys.

"<insert>","<delete>", "<home>", "<end>","<pageup>","<pagedown>" for other special keys.

Function keys "<F1>" through "<F15>".

Also, the traditional "modifier" keys can serve as normal keys:

<lshift>, <rshift> <numlock>, <capslock>, <scrollock>, <rctrl>, <lctrl>, <ralt>,<lalt>,<rmeta>,<lmeta>,<lsuper>, <rsuper>,<mode>,<compose>

4.16 Joystick Input

PEBL supports input with a joystick. In order to use a joystick, you first need to poll the computer to determine whether a joystick is attached, and create a joystick object. The file joysticktest.pbl in the demo directory creates a simple visual depiction of a fairly standard gamepad.

A joystick will have up to four types of inputs on it: buttons, axes, hats, and balls. But different joysticks are different, and so you may need to do some checking and testing for your particular setup. PEBL currently does not support force-feedback or rumble functions available on some joysticks.

Axes:

Each axis takes on a value between 1 and 32768. For a normal hand-grasp joystick , the first two axis will be determined by the relative x and y positions of the joystick. Gamepads often have triggers that are additional axis, or sometimes there are throttles (or gas/brake pedals in driving devices) that are mapped to axes. Find out how many axes exist with `GetNumJoystickAxes()`. Get the state of a particula axis with `GetJoystickAxisState()`.

Hats:

Hats are the little 8-way buttons that control direction on many game pads. They are sort of a digital axis, because each state is absolute. The entire hat state takes on a single integer number between 0 and 15. It is binary coded to specify whether each of the four major axes buttons are depressed:

- left: 8
- bottom: 4
- right: 2
- top: 1

The mechanics of the hat allows two buttons to be pressed simultaneously, indicating, for example, southeast or northwest. An example of how to extract the bitwise button states is found in the joysticktest.pbl file.

Buttons:

Usually, the state of each of the buttons on the joystick can be identified. Button state is coded so that 0=unpressed, 1=pressed. There can easily be a dozen or more buttons on a joystick, enabling some pretty elaborate response modes for experiments.

Balls:

Balls are very rare; you may have seen them in old-style arcade games like Arkenoid. No consumer joysticks available today appear to have balls that operate this way, and they have not been tested in PEBL. If you want to support trackballs, there are plenty of trackball mice that work as normal joystick controllers.
A number of functions are available for creating a joystick object and polling the joystick's current state:
Summary of joystick functions:

```
GetNumJoysticks()
OpenJoystick()
GetNumJoystickAxes()
GetNumjJoystickBalls()
GetNumJoystickButtons()
GetNumJoystickHats()
GetJoystickAxisState()
GetJoystickHatState()
GetJoystickButtonState()
```

Currently, the joystick state is not integrated into PEBL's event loop. Consequently, there are no functions such as WaitForJoystickButton(), and no way to create or monitor events. To use the joystick, you need to monitor the state of the device manually, and create a polling loop yourself, like:

```
##This will keep looping until you press the first button
js < OpenJoystick(1)  ##open the first joystick connected to the system
gCont <- 1
while (gCont)
  {
    state <- GetJoystickAxisState(js,1)
    Print(state)
    ##Do something with the axis1 here


    gCont <- GetJoystickButtonState(1)
  }
```

The file demo/joysticktest.pbl uses most of the available joystick functions to display a virtual gamepad on the screen as it captures input.

4.17 Files

Files are objects that can be read from or written to using several PEBL functions. To use a file object, create one using one of the functions listed below. Each function returns a file object:
`FileOpenRead()`
`FileOpenWrite()`
`FileOpenOverwrite()`
`FileOpenAppend()`
`GetNewDataFile()`
`ReadCSV()`

For example, you can use the command:
`myfile <- FileOpenRead("stimuli.txt")`
to create '`myfile`', a readable file stream.

`FileOpenWrite` is made with a safety backup. It will never overwrite an existing file; instead it will create a new file name by appending a number (i.e. 1) to the end of the base file name. The new filename will be saved as in the .filename property of the resulting file. The function `FileOpenOverwrite()` will overwite any existing files, and should not be used for data files when you have the chance for a collision in a subject code.
The function `GetNewDataFile()` offers another all-in-one path for creating a data file. It will take a base name and a subject identifier, a file extension, and a header. If the file has not previously been created, it will create the new file and add a header row. If it has been created before, it will ask you whether to append to the current data file (in which case it won't add a header row), or

select a new data file. Data files are created in separated subdirectories (one per participant) within the data directory of the experiment.
Because some of the FileOpen commands will create a file with a name you didn't ask for (to avoid overwriting), a successfully opened file has a property .filename that provides the actual file name selected.
Other Functions described below allow filestreams to be written to or read from. When you are finished, you can close a filestream Using the '`FileClose()`' function.
A number of related functions have been created to help make reading and writing to files easier. For example, the following functions enable reading an entire file into either a string variant, a list (with one list item per row), or a table:

```
ReadCSV()
FileReadCharacter()
FileReadLine()
FileReadWord()
FileReadTable()
FileReadText()
FileReadList()
FileExists()
```

4.18 Network Connections

PEBL has limited ability to open and communicate via TCP/IP connections, either some other system (e.g., for synchronizing with an e.e.g. or eyetracking computer), or another computer running PEBL (e.g., to create multi-subject game theory experiments or to have an experimenter controlling the task from another computer.)

4.18.1 TCP/IP Overview

TCP/IP is a protocol by which computers can talk to one another. It is fairly barebones, and PEBL tries to hide much of its complexity. The information you send from one computer to another is guaranteed to arrive in the correct order, at the potential cost of serious delays, especially if the computers are on different networks or in different locations. Furthermore, connecting PEBL to another computer in this way is a potential security risk. However, the ability to transfer information between computers opens up huge potential for the types of experiments that can be constructed.

4.18.2 Addresses and Ports

To do this, you first must open a network object to communicate with another computer. To do this, you must know (1) the IP number (like 127.0.0.1) or hostname (like myname.myschool.edu) of the computer you want to connect to, and (2) the port you want to connect on. You can even use the protocol to connect to another program running on your own computer, by specifying an IP address of 127.0.0.1, or the hostname "localhost". A port is a number–usually 2 to 5 digits, specifying a type of service on your computer. Many ports are frequently used for specific types of communication, but you can use any port you wish to communicate, as long as both computers know this port. Most ports on your computer should be blocked by default, so you may need to turn off your firewall or allow your chosen port to pass through the security or you may have trouble communicating.

To allow two PEBL programs to communicate, you need to decide that one computer is the "server" and the other is the "client". On the server, you execute the function `WaitForNetworkConnection(port)`, which listens on the specified port until the client tries to connect. After the server is started, the client calls `ConnectToHost(hostname, port)` or `AcceptNetworkConnection(port)` `ConnectToIP(ipnum, port)`, depending upon whether you are using the hostname or ip address. Typically, ip numbers are specified by four three-digit numbers separated by dots, like 196.168.0.1. This actually represents a 4-byte integer, and this 4-byte integer is what `ConnectToIP()` expects. To create that integer, use the function
`ConvertIPString(ipnum)`, which accepts an IP address specified in a string. So, you can use:

```
net <- ConnectToIP(ConvertIPString( "127.0.0.1"), 1234)
```

to create a connection to another program listening on port 1234 on your own computer. These functions all return a network object (e.g., `net`) that must be used in later communication.

4.18.3 Sending and Receiving Data

Once connected, the distinction between client and server essentially disappears. However, to communicate, one computer must send data with the `SendData(net, data)`, and the other must receive the data, using the
`GetData(net, size)` function. PEBL can only send text strings, and you must know the length of the message you want to receive. More complex communication can be done by creating a set of PEBL functions that encapsulate messages into text strings with templated headers that specify the message length. Then, to receive a message, you first read the fixed-length header, determine how much more data needs to be read, then read in the rest of the data.

4.18.4 Closing networks

If you are using a network connection to synchronize timing of two computers, you probably want to close the network connection with
`CloseNetworkConnection(net)` after you have synchronized, to avoid any extra overhead.

A simple example of an experiment that uses TCP/IP to communicate is the NIM game in demo/nim.pbl.

4.19 Parallel Port

Starting with Version 0.12, PEBL can send and receive information via a standard parallel (printer) port. These don't appear on many computers anymore, but you can still get them, and they are still important ways to interface with hardware devices such as EEG and MRI machines and homebrew button boxes. Currently, parallel port access is fairly limited to setting and getting the state of the 8 data bits. Parallel ports have a number of bits you can play with, but currently PEBL only supports the basic 8 data bits. Basically, you can set the state of the bits or read the state of the bits, which can either control things like LEDs, or be impacted by making connections between the ground and the data bit.
If you have a parallel port, it is mapped to one of three ports: LPT1, LPT2, or LPTX. To initialize access to a port, you must call OpenPPort with the name of your port: "

```
port <- OpenPPort("LPT1")
```

Parallel ports have two modes, input and output. To read data in, it needs to be in input mode; to change the state of the bits, it needs to be in output mode. Set the state with `SetPPortMode(port,"<input>")` or `SetPPortMode(port,"<output>")`.
To access the state of a port, use `GetPPortState(port)`. It will return a string of "|" separated 1s and 0s, which specify the state of each of the 8 bits.
To set the state of the port, use `SetPPortState(port,state)`. state should be a list of 8 0s or 1s:
SetPPortState(port, [0,0,0,0,0,0,0,1])
The internal c++ parallel port classes have substantially more flexibility, and can be adapted to do more complex access of parallel ports.

4.20 Serial Port

A number of devices are supported via the comport (serial port) library. This can include newer USB devices that simulate a comport.
The following functions are relevant:

- `OpenCOMPort(portnum,baud,mode)`
- COMPORTSENDBYTE(port,message)
- COMPORTGETBYTE(port)

The general process is to use OpenComPort to create the port, and then send and receive text strings from that port. These are sent one byte at a time. The mode argument is a 3-character string that specifies aspects of the mode (see Teunis van Beelen's rs232 library at `http://www.teuniz.net/RS-232/`. The first character is the data bits (5,6,7 or 8), parity (n=none, e=even, o=odd), and the third is the stop bit (1 or 2 bits).
Within the demo directory, there is some basic code for communicating with the cedrus response box that uses these functions. In addition, that script provide

a NumToASCII() function that can be useful in translating numbers to strings to communicate with a device.

4.21 The Event Loop

To assist in testing for multiple input events simultaneously, PEBL implements an event loop that will quickly scan multiple conditions and execute proper results whenever any one condition is met.

The event loop works by maintaining a list of triggers that can be satisfied by various conditions. The conditions typically specify a device or other data source to examine, such as the timer. On each cycle of the loop, all events are examined, and when any of them are satisfied, either a specified function will be executed, or the event loop will exit. Most of the timing and input functions use the event loop behind the scenes.

As of Version 0.12, simple means to program the event loop are available. Three functions include:

- `RegisterEvent()`. This allows you to specify a condition and a function name which executes whenever the condition is true.
- `StartEventLoop()`. This starts the event loop, with all available events.
- `ClearEventLoop()`. This clears out the event loop so other events can be used.

Note that because other functions, such as Wait(), use the event loop, you can pre-load extra events and start the event loop with one of these functions.

These are used in a number of test battery tasks. However, their use is currently somewhat experimental, and their names and arguments may change in the future, and so we will not provide a detailed description of their use here.

4.22 Parameter Setting

PEBL offers an interface to set a large set of experimental parameters from a text file. Furthermore, the PEBL launcher allows you to edit and save new parameter sets. This allows you to create common versions of a test that you call, without editing the PEBL script.

The PEBL parameter system is based on a custom object created with the `CreateParameters()` function. To use this, it requires you to set default parameters (in case the parameter file is not found or damaged). Create default parameters as a nested list containing property-value pairs. For example:

```
parameterpairs <- [["length",10],
                   ["trialsperblock",15],
                   ["numblocks",3]]
```

If you want to override these values, create a text file (typically saved in the params folder with the extension .par) that contains comma-separated values parname,value, like this:

```
length,5
trialsperblock,25
numblocks,5
```

Then, create a parameter object using `CreateParameters`:

```
gParams <- CreateParameters(pairlist, filename)
```

Any values in the .par file will override the values in the default list. PEBL tries to convert text values to numbers, and the value will be a number whenever the round-trip from text-to-number-to-text does not change the original value. Thus, avoid using floating-point values for parameters, and you may need to write "0.1" instead of ".1" if you do.
The PEBL launcher offers a way to set parameters. To do so, it needs more information, including the default values and a description. It looks for a .schema file in the params folder with the same name as the experiment. This file uses the | character to separate field (this allows you to use commas in the description):

```
length|10|The number of words per trial
trialsperblock|15|Trials in each block
numblock|3|Number of blocks.
```

Notice that quotes are not used in these files. The values in this file are ONLY relevant to the PEBL launcher. These are used to reset the values in a .par file or tell the experiment what typical values are. They can differ from the default values in the .pbl file, but for clarity they should not.

4.23 Errors and Warnings

PEBL does a great deal of error-checking to ensure that your program will run. If you crash with a segmentation fault, this is an error and you should report it. When a fatal error or non-fatal warning occurs, PEBL attempts to identify the location in your input file that led to the warning. On Linux, the warning and this location are printed to the command-line upon exit; on MS Windows or if you are using the launcher on any platform, they are printed to the file `stderr.txt`. In addition, when a fatal error is signalled, a dialog box will appear that displays the main message, after which PEBL will shut down.
You can do error checking in your own scripts with the `SignalFatalError()` function. This is especially useful in combination with the functions testing the type of object passed into the function. To ensure proper processing and ease of debugging, test the format of an argument passed into a function:

```
define MyFunction(par)
 {
  if(not IsList(par))
  {
   SignalFatalError("MyFunction passed a non-list variable.")
  }
```

```
  ##Do other stuff here
 }
```

Sometimes, you want to exit a program at a specific point, but don't want the error message dialog box to appear. You can use the `ExitQuietly(<message>)` function to do this.

4.24 Paths and Path Searching

Numerous functions and objects open files on your computer to read in information such as graphics, sounds, fonts, program files, and text files. When you attempt to open a file, PEBL will search in a number of places, in this order:

- The (current) working directory
- The directory of each file specified in the command line arguments
- media/fonts
- media/sounds
- media/images
- media/text

You can also specify other paths to be searched by specifying them on the command line. Be sure to end the directory with whatever is appropriate for your platform, e.g. '\' on Microsoft Windows or '/' on Linux.
On OSX, as of version 0.12, the media/ directory is located within the Resources/ subdirectory of the application package.

4.25 Controlling the Video settings

As part of PEBL 2.0, PEBL now uses hardware-accelerated graphics subsystems that permit better and more accurate control of the video system. For the most part, this should operate transparently, but the aspects of the video system can be controlled both by command-line arguments and can be overridden within a script using special global variables. The launcher works by using command-line arguments, but these can always be overridden within a script. For the most part, these global variables must be set before a `MakeWindow()` function is called. The video system has several distinct aspects:

4.25.1 Screen resolution

By default, the window will open up the same size as the current window. However, you can specify a specific resolution using the pulldown menu of the launcher, which also allows you to specify a custom screen size. This is most useful if you are debugging or running on a multi-screen setup. Regardless of what the specified screen resolution specified in the launcher, the selected screen resolution will be specified using the `gVideoWidth` and `gVideoHeight` global parameters, stores the specified values in pixels.

4.25.2 Fullscreen mode

When you are testing a script, you usually want it run in a window so you can more easily cancel the script or edit parameter values. When testing, you usually want to run in fullscreen mode because it will help prevent participants from trying to do other things on the computer. This is controlled with the –fullscreen and –windowed command line parameters, which is settable using the fullscreen checkbox in the launcher.

4.25.3 Video drivers

Depending on the platform, different graphics drivers may be available. The launcher tries to determine the available drivers and gives options of these in a drivers pulldown menu. These will typically include opengl and software. On windows, a direct3d option should be available; on linux, opengles may be available as well. Depending on your operating system, drivers, and hardware, you may have more or less success with one or another of the available drivers. The software driver is a fallback that should work if hardware drivers are causing troubles. The vsync option will only be available on a hardware-accelerated driver, such as opengl and direct3d.

4.25.4 Synchronize to vertical refresh signal (vsync)

For hardware-accelerated drivers, you are able to synchronize the Draw() functions to the blank between each screen refresh. On a typical 60-hz LCD screen, this means that the screen will refresh (roughly) every 16.67 ms. This is set within the launcher, which using the –vsyncon argument. It can be examined or overridden within a script by using the gVSync function (setting to 1 for on or 0 for off). This allows you to have very precise control over the timing of video stimuli.
When vsync is on, the Draw() command will block until the video update has happened. This gives you (typically) roughly 15 ms to perform any updating you need to do, but sometimes this is not enough, and you take care to record the presentation timing if you are relying on video display timing, to ensure you are getting the timing you are hoping for.
The test file in demo/tests/testrefresh.pbl will test the effective update frequency you are achieving with your current video settings.

4.25.5 Multiple windows

You can open multiple windows simply by calling the MakeWindow() function more than once. The window dimensions will be taken directly from the values of gVideoWidth
Multiple Windows PEBL can open multiple windows for testing. This can be useful if you want to have separate screens for a subject and an experimenter. You can open multiple windows by calling the MakeWindow() function more

than once. If you do this, each window should be set to its own parameter. Any Draw() command will update both windows.
For example, you can open a new window in several ways:

```
gWin <- MakeWindow()
```

Creates a window with the default (black) background, with the screen size identical to gVideoWidthxgVideoHeight, which may have been specified either earlier in the script or by the launcher program.

```
gWin <- MakeWindow("Red")
```

This creates a window with a red background. Note that you can use any on of hundreds of color names available.

```
color <- MakeColor("white")
 gWin <- MakeWindow(color)
```

This creates a window with a specified color object. This could allow you to reuse the color object, or use a custom RGB color with MakeColorRGB().

```
gWin <- MakeColor("black",300,300)
```

Here, the dimensions of the window are optionally fed into the MakeWindow() function.
Support for multiple windows is currently experimental. For example, mouse and keyboard events don't currently tell you which window they occurred on, although this will be possible in the future.
Although the gVideoWidth and gVideoHeight global variables are still available, these won't necessarily match any particular window if you create a window with the last method above. Thus, you can get the screen size of any window using the .width and .height arguments of the window.

4.26 StickyKeys

On Windows, there are several hidden control options that are useful for users with limited mobility or dexterity. These include stickykeys–for keys such as the shift key, control key, etc. clicking on them will latch them down (like shift-lock), so that they can be used without touching both keys at once. By default in many versions of Windows, clicking the left shift key five times in a row will bring up the dialog to turn on/off stickykeys.
Unfortunately, many of the PEBL tests use left/right shift keys as default manual entry keys. So, the first time you run a test, it will pop up the dialog in the middle of the test asking you whether you want to turn on stickykeys. If this happens, you should generally go to the control panel and turn this off.
As of 2.0, PEBL will disable this option. This means that if you want to use the left-shift shortcut to start stickykeys, you may be out of luck–especially within the test. There are ways to turn it back on again automatically, and future

versions of PEBL may attempt to do this, but currently it turns off when PEBL runs.

4.27 Provided Media Files

PEBL comes with various media files that can be specified from any script without including the complete path. If a user's file has the same name, it will be loaded before the PEBL-provided version. Table section4.2 describes the files included.

Table 4.2: Media Files Provided with PEBL

Name	Description
In 'media/fonts/':	
Listing of fonts appears in Table table4.1	
In 'media/images/':	
`pebl.bmp`	Demonstration bitmap image
`pebl.png`	Demonstration PNG image
`pebl2.png`	PEBL2 logo
`smiley-small.png`	25x25 smiley face
`frowney-small.png`	25x25 frowney face
`smiley-large.png`	100x100 smiley face
`frowney-large.png`	100x100 frowney face
`plus.png`	A green plus sign
`x.png`	A red x sign, matching the red plus
In 'media/sounds/':	
`buzz500ms.wav`	A 500-ms buzzer
`chirp1.wav`	A chirp stimulus
`boo.wav`	A really bad booing sound
`cheer.wav`	A pretty lame cheering sound
`beep.wav`	A simple beep
`boo.wav`	Boo–useful for errors
`cheer.wav`	A cheer-useful for correct feedback
`kaching.wav`	Sound of a coin in a jar
`knock.wav`	simple knocking/click sound
`0.wav` through 9.wav	Recording of numerals, used in digit span and others
`correct.wav`	correct feedback
`incorrect.wav`	Incorrect feedback
`H,R,N,K,X,Y,W.wav`	Female voice letters for n-back

Name	Description
In 'media/text/':	
`Consonants.txt`	List of all consonants, both cases
`Digits.txt`	List of digits 0-9
`DigitNames.txt`	List of digit names
`Letters.txt`	All letters, both cases
`Lowercase.txt`	Lowercase letters
`LowercaseConsonants.txt`	Lowercase Consonants
`LowercaseVowels.txt`	Lowercase Vowels
`Uppercase.txt`	Uppercase Letters
`UppercaseConsonants.txt`	Uppercase Consonants
`UppercaseVowels.txt`	Uppercase Vowels
`Vowels.txt`	Vowels (both cases)

Additionally, the PEBL Project distributes a number of other media files separately from the base system. These are available for separate download on the pebl website (http://pebl.sourceforge.net), and include a set of images (including shapes and sorting-task cards), and a set of auditory recordings (including beeps, the digits 0-10, and a few other things).

4.28 Special Variables

There are a number of special variables that be set by PEBL, and can later be accessed by an experiment. These are described in table table4.3.

Table 4.3: Special Variables in PEBL

Name	**Purpose**
`gKeepLooping`	Controls continued execution in event loop (unused).
`gSleepEasy`	Sets 'busy-waiting' to be either on or off. Busy-waiting can improve timing, but is often not needed and pegs CPU.
`gVideoWidth`	The width in pixels of the display (set by default or command-line option). Changing this before calling `MakeWindow` will change display width, if that width is available.
`gVideoHeight`	The height in pixels of the display (set by default or command-line). Change this before using `MakeWindow()` to change the display height
`gVideoDepth`	The bit depth of the video.
`gSubNum`	A global variable set to whatever follows the `--s` or `--S` command-line argument. Defaults to "0".
`gScriptName`	Specifies the name on the window, and some printed output.
`gVSync`	Determines whether script should be run with vsync on
`gLanguage`	A global variable specified on the command line which can be used by a script to target a specific language. Defaults to 'en'.
`gQuote`	A quotation mark: `"`. Use it to add quotes in text.
`gClick`	[x,y] location last click in WaitForClickOnTarget.
`gPEBLBaseFont`	Name of the default font to use in helper functions and most battery tasks. By default, set to "DejaVuSans.ttf". Change to override.
`gPEBLBaseFontMono`	Name of the default mono-spaced font By default, it is set to "DejaVuSansMono.ttf".
`gPEBLBaseFontSerif`	Name of the default serif font. By default, it is set to "DejaVuSerif.ttf".

Chapter 5

Function Quick Reference

Table chapter5.1 lists the functions available for use with PEBL. Those that are unimplemented are noted as such. If you want the functionality of an unimplemented function, or want functionality not provided in any of these functions, contact us, or better yet, contribute to the PEBL project by implementing the function yourself.

Table 5.1: Function Quick Reference

Name	Arguments	Description
	Math Functions	
Log10	<num>	Log base 10 of <num>
Log2	<num>	Log base 2 of <num>
Ln	<num>	Natural log of <num>
LogN	<num> <base>	Log base <base> of <num>
Exp	<pow>	e to the power of <pow>
Pow	<num> <pow>	<num> to the power of <pow>
Sqrt	<num>	Square root of <num>
NthRoot	<num> <root>	<num> to the power of 1/<root>
Tan	<deg>	Tangent of <deg> degrees
Sin	<deg>	Sine of <deg> degrees
Cos	<deg>	Cosine of <deg> degrees
ATan	<num>	Inverse Tan of <num>, in degrees
ASin	<num>	Inverse Sine of <num>, in degrees
ACos	<num>	Inverse Cosine of <num>, in degrees
DegToRad	<deg>	Converts degrees to radians
RadToDeg	<rad>	Converts radians to degrees
Round	<num>, <precision> (opt)	Rounds <num> to nearest integer, or optionally power of 1/ten precision.
Floor	<num>	Rounds <num> down to the next integer
Ceiling	<num>	Rounds <num> up to the next integer

Name	**Arguments**	**Description**
`AbsFloor`	`<num>`	Rounds `<num>` toward 0 to an integer
`Mod`	`<num> <mod>`	Returns `<num>` mod `<mod>` or remainder of `<num>/<mod>`
`Div`	`<num> <mod>`	Returns `round(<num>/<mod>)`
`ToInteger`	`<num>`	Rounds a number to an integer, and changes internal representation
`ToFloat`	`<num>`	Converts number to internal floating-point representation
`ToNumber`	`<>`	
`ToString`	`<num>`	Converts a numerical value to a string representation
`Sign`	`<num>`	Returns +1 or -1, depending on sign of argument
`Abs`	`<num>`	Returns the absolute value of the number
`CumNormInv`	`<p>`	Returns accurate numerical approximation of cumulative normal inverse.
`NormalDensity`	`<x>`	Returns density of standard normal distribution.
`SDTDPrime`	`<hr>`,`<far>`, `<tol>`(opt)	Computes SDT dprime.
`SDTBeta`	`<hr>`,`<far>`, `<tol>`(opt)	Computes SDT beta.
`Order`	`<list>`	Returns a list of integers representing the order of `<list>`
`Rank`	`<list>`	Returns integers representing the ranked indices of the numbers of`<list>`
`Median`	`<list>`	Returns the median value of the numbers in `<list>`
`Min`	`<list>`	Returns the smallest of `<list>`
`Max`	`<list>`	Returns the largest of `<list>`
`Bound`	`<val>`, `<min>`, `<max>`	Returns val, bounded by min and max.
`StDev`	`<list>`	Returns the standard dev of `<list>`
`Sum`	`<list>`	Returns the sum of the numbers in `<list>`
`CumSum`	`<list-of-numbers>`	Returns the cumulative sums of a set of numbers
`VecSum`	`<list1>`,`<list2>`	Returns the pairwise sums of two lists of numbers
`VecTimes`	`<list1>`,`<list2>`	Returns the pairwise products of two lists of numbers
`Median`	`<list>`	Returns the median of a set of values

Name	Arguments	Description
Quantile	<list> <num>	Returns the <num> quantile of the numbers in <list>
SummaryStats	<data>,<cond>	Returns statistics (cond, N, median, mean, sd) computed on data for each distinct value of <cond>
SeedRNG	<num>	Seeds the random number generator with <num> to reproduce a random sequence
RandomizeTimer	-	Seeds the RNG with the current time
Random	-	Returns a random number between 0 and 1
RandomDiscrete	<num>	Returns a random integer between 1 and <num>
RandomUniform	<num>	Returns a random floating-point number between 0 and <num>
RandomNormal	<mean> <stdev>	Returns a random number according to the standard normal distribution with <mean> and <stdev>
RandomExponential	<mean>	Returns a random number according to exponential distribution with mean <mean> (or decay 1/mean)
RandomLogistic	<p>	Returns a random number according to the logistic distribution with parameter <p>
RandomLogNormal	<median> <spread>	Returns a random number according to the log-normal distribution with parameters <median> and <spread>
RandomBinomial	<p> <n>	Returns a random number according to the Binomial distribution with probability <p> and repetitions <n>
RandomBernoulli	<p>	Returns 0 with probability (1-<p>) and 1 with probability <p>
ZoomPoints	<[xs,yy]>, <xzoom>, <yzoom>	Zooms a set of points in 2 directions
ReflectPoints	<[xs,yy]>	Reflects points on vertical axis
RotatePoints	<[xs,yy]>,<angle>	Rotates point <angle> degrees
GetAngle	<x>,<y>	Returns the angle in degrees of a vector.
Dist	<x1,y1>,<[x2,y2]>	Returns distance between two points.
ToRight	<p1,p2,p3>	Determines whether p3 is te the right of line p1p2
GetAngle3	<a,b,c>	Gets angle abc.
SegmentsIntersect	<ax,ay, bx,by, cx,cy, dx,dy>	Determines whether line segment ab intersects cd.

Name	**Arguments**	**Description**
`NonOverlapLayout`	`<xmin,xmax, ymin,ymax, tol,num>`	Creates a set of num points that don't overlap, but fails gracefully
`LayoutGrid`	`<minx,maxx, miny,maxy, height,width, vertical>`	Creates [x,y] pairs in a grid for graphical layout

Name	**Arguments**	**Description**
	File/Network/Device Functions	
Print	<value>	Prints <value> to stdout, appending a new line afterwards. stdout is the console (in Linux) or the file stdout.txt (in Windows)
Print_	<value>	Prints <value> to stdout, without appending a newline afterwards
PrintList	<value>	Prints <list>, getting rid of ’[’, ’]’ and ’,’ characters.
Format	<object> <size>	Prints a number with specified spaces by truncating or padding
ZeroPad	<number> <size>	Pads the beginning of a number with 0s so the number is size long
FileOpenRead	<filename>	Opens a filename, returning a stream to be used for reading information
FileOpenWrite	<filename>	Opens a filename, returning a stream that can be used for writing information. Creates new file if file already exists
FileOpenOverwrite	<filename>	Opens a filename, returning a stream that can be used for writing information. Overwrites if file already exists
FileOpenAppend	<filename>	Opens a filename, returning a stream that can be used for writing info. Appends if the file already exists, opens if file does not
FileClose	<filestream>	Closes a filestream variable. Pass the variable name, not the filename
FilePrint	<filestream> <value>	Like Print, but to a file.
FilePrint_	<filestream> <value>	Like Print_, but to a file.
FilePrintList	<file><list>	Prints <list> to <file>, getting rid of ’[’, ’]’ and ’,’ characters.
FileReadCharacter	<filestream>	Reads and returns a single character from a filestream
FileReadWord	<filestream>	Reads and returns a ‘word’ from a file; the next connected stream of characters not including a ‘ ’ or a newline. Will not read newline characters

Name	**Arguments**	**Description**
`FileReadLine`	`<filestream>`	Reads and returns a line from a file; all characters up until the next newline or the end of the file
`FileReadList`	`<filename>`	Given a filename, will open it, read in all the items into a list (one item per line), and close the file afterwards
`FileReadTable`	`<filename>` `<opt-sep>`	Like `FileReadList`, but reads in tables. Optionally, specify a token separator
`GetNewDatafile`	`<id-code>`, `<window>`, `<basename>`, `<extension>`, `<header>`	Opens a data file in subnum directory
`ReadCSV`	`<filename>`	Opens a csv file returning a table with its elements
`FileReadText`	`<filename>`	Reads all of the text in the file into a variable
`EndOfLine`	`<filestream>`	Returns true if at end of line
`EndOfFile`	`<filestream>`	Returns true if at the end of a file
`GetDirectoryListing`	`<path>`	Returns a list of all the files/subdirectories in a path
`FileExists`	`<path>`	Checks whether a file exists
`IsDirectory`	`<path>`	Checks whether a file is a directory
`MakeDirectory`	`<path>,<dirname>`	Creates a directory in path
`AppendFile`	`<file1> ,<file2>`	Appends a file2 to file1
`CopyFile`	`<file>,<newfile>`	Makes a copy of a file
`DeleteFile`	`<file1>`	Deletes a file
`ConnectToIP`	`<ip> <port>`	Connects to a port on another computer, returning network object.
`ConnectToHost`	`<hostname>` `<port>`	Connects to a port on another computer, returning network object.
`WaitForNetwork Connection`	`<port>`	Listens on a port until another computer connects, returning a network object
`CloseNetwork Connection`	`<network>`	Closes network connection
`SendData`	`<network>` `<datastring>`	Sends a data string over connection.
`GetData`	`<network>` `<length>`	return a string from network connection
`ConvertIPString`	`<ip-as-string>`	Converts an ip-number-as-string to usable address
`OpenNetworkListener`	`<port>`	Opens a port for listening

Name	Arguments	Description
CheckForNetworkConnection	<network>	Checks for incoming connection
GetHTTPFile	<server>, <file>, <outputfile>	Gets and saves a file from a website
GetHTTPText	<server>, <file>	Gets a file from a website and saves it to a variable.
PostHTTP	<host>,<page>, <headers>, <content>	Post to a server form.
MD5Sum	<text>	Computes MD5 checksum on text
MD5File	<filename>	Computes MD5 Checksum on file.
WritePNG	<filename>, <object>	Makes a .png from a window or object
GetNumJoysticks	no argument	Determines how many joysticks are available
OpenJoystick	joystick_id	Gets a joystick object
GetNumJoystickAxes	joystick_object	Counts how many axes on a joystick
GetNumJoystickBalls	joystick_object	Counts how many balls on a joystick
GetNumJoystickButtons	joystick_object	Counts how many buttons on a joystick
GetNumJoystickHats	joystick_object	Counts how many hats on a joystick
GetJoystickAxisState	joystick_object, axis_id	Gets the state of a joystick axis
GetJoystickHatState	joystick_object, hat_id	Gets the state of a joystick hat
GetJoystick ButtonState	joystick_object, button_id	Gets the state of a joystick button
GetJoystickBallState	joystick_object, ball_id	Gets the state of a joystick ball
OpenCOMPort	<portnum>, <baud>	Opens a serial (com) port
COMPortGetByte	<port>	Gets a byte from the comport
COMPortSendByte	<port>,<byte>	Sends a character to the comport
OpenPPort	<portname>	Opens parallel port
SetPPortMode	<port> <mode>	Sets parallel port mode (input/output)
SetPPortState	<port> <state>	Sets parallel port state
GetPPortState	<port>	Gets state of parallel port data bits
Graphical Objects Functions		
MakeWindow	<colorname> (opt), <width>(opt), <height>(opt)	Creates main window, in color named by argument, or grey if no argument is named
MakeImage	<filename>	Creates an image by reading in an image file (jpg, gif, png, bmp, etc.)

Name	**Arguments**	**Description**
`MakeLabel`	`<text> <font>`	Creates a single line of text filled with `<text>` written in font `<font>`
`MakeTextBox`	`<text> <font> <width> <height>`	Creates a sized box filled with `<text>` written in font `<font>`
`MakeCanvas`	`<width>, <height>, <color>`	Creates a blank canvas to add objects to or draw on
`ResetCanvas`	`<canvas>`	Resets a canvas to its background, erasing anything drawn on the canvas
`EasyLabel`	`<text> <x><y> <win><fontsize>`	Creates a single line of text and adds it to win at `<x><y>`
`EasyTextBox`	`<text> <x> <y> <win> <fontsize> <width> <height>`	Creates a textbox and adds it to `<win>` at `<x><y>`
`MakeColor`	`<colorname>`	Creates a color based on a color name
`MakeColorRGB`	`<red> <green> <blue>`	Creates a color based on red, green, and blue values
`RGBToHSV`	`<color>`	Converts a color to HSV triple
`MakeFont`	`<ttf_filename> <style> <size> <fgcolor> <bgcolor> <anti-aliased>`	Creates a font which can be used to make labels
`SetCursorPosition`	`<textbox> <position>`	`Move` the editing cursor in a textbox
`GetCursorPosition`	`<textbox>`	Gets the position of the editing cursor
`GetAbsolutePosition`	`<widget>`	Gets the absolute window position of a widget
`SetEditable`	`<textbox> <status>`	Turns on or off the editing cursor
`GetTextBoxCursor FromClick`	`<relx>, <rely>`	Gets a cursor position (in characters) from a mouse click.
`GetText`	`<textobject>`	Returns the text in a textbox or label
`GetInput`	`<textbox> <escape-key>`	Allows a textbox to be edited by user, returning its text when `<escape-key>` is pressed.
`SetText`	`<textobject>, <text>`	Sets the text in a textbox or label
`SetFont`	`<textobject>, <font>`	Changes the font of a text object

Name	Arguments	Description
Move	<object> <x> <y>	Move an object (e.g., an image or a label to an x,y location)
MoveCorner	<object> <x> <y>	Moves an image or label by its upper corner.
GetSize	<object>	Returns a list of dimensions <x,y> of a graphical object.
GetLineBreaks	<textbox>	Computes the line breaks for a textbox text.
GetParent	<widget>	Gets the parent widget of a widget.
AddObject	<object> <parent>	Adds an object to a parent object (window)
RemoveObject	<object> <parent>	Removes an object from a parent window
RemoveObjects	<list-of-objects> <parent>	Removes a (possibly nested) list of objects from a parent window
Show	<object>	Shows an object
Hide	<object>	Hides an object
ShowCursor	<object>	Hides or show mouse cursor.
GetMouse CursorPosition		Gets [x,y] position of mouse
GetMouseState		Gets [x,y,b1,b2,b3] list of mouse state, including button states
SetMouse CursorPosition	<x>,<y>	Sets x,y position of mouse
Draw	<object> or no argument	Redraws a widget and its children
DrawFor	<object> <cycles>	Draws for exactly <cycles> cycles, then returns
Circle	<x> <y> <r> <color> <filled>	Creates circle with radius r centered at position x,y
Ellipse	<x> <y> <rx> <ry><color> <filled>	Creates ellipse with radii rx and ry centered at position x,y
Square	<x> <y> <size> <color> <filled>	Creates square with width size centered at position x,y
Rectangle	<x> <y> <dx> <dy><color> <filled>	Creates rectangle with size (dx, dy) centered at position x,y
Line	<x> <y> <dx> <dy> <color>	Creates line starting at x,y and ending at x+dx, y+dy
Polygon	<x> <y> <xpoints> <ypounts> <color><filled>	Creates polygon centered at x,y with relative points <xpoints>,<ypoints>

Name	**Arguments**	**Description**
`Bezier`	`<x> <y> <xpoints> <ypoints> <steps> <color>`	Creates bezier curve centered at x,y with relative points
`BlockE`	`<x> <y> <h> <w> <thickness> <orientation> <color>`	Creates a block E as a useable polygon which can be added to a window directly.
`Plus`	`<x> <y> <size> <w> <color>`	Creates a plus sign as a useable polygon which can be added to a window directly.
`MakeStarPoints`	`<r_outer> <r_inner> <npeaks>`	Creates points for a star, which can then be fed to Polygon
`MakeNGonPoints`	`<radius> <npeaks>`	Creates points for a polygon, which can then be fed to Polygon
`ThickLine`	`<x1> <y1> <x2> <y2> <thickness> <color>`	Creates a thick line between two points
`MakeAttneave`	`<radius>, <numpoints>, <minangle>, <maxangle>`	Makes a complex "Attneave" polygon
`ConvexHull`	`<list-of-pts>`	Returns a convex subset of points for a set
`KaneszaSquare`	`<squaresize>, <circleradius>, <fg>, <bg>`	Creates a 'Kanesza Square' stimulus.
`KaneszaPolygon`	`<points>, <circTF>, <circleradius>, <fg>, <bg>,<show>`	Create generic Kanesza polygon.
`Inside`	`<[x,y]> <object>`	Determines whether a point is inside a graphical object
`SetPixel`	`x,y,color`	Sets the color of a pixel on an image or canvas to `color`
`SetPoint`	`x,y,color`	Sets the color of a pixel on an image or canvas to `color`
`GetPixelColor`	`<obj>,x,y`	Gets the color of a specified pixel on a widget
`MakeGabor`	`<size>, <freq>, <sd>, <angle>, <phase>, <bglev>`	Creates a 'gabor patch' with specified parameters

Name	Arguments	Description
	Sound Objects Functions	
LoadSound	<filename>	Loads a soundfile from the filename, returning a variable that can be played
PlayForeground	<sound>	Plays the sound 'in the foreground', not returning until the sound is complete
PlayBackground	<sound>	Plays the sound 'in the background', returning immediately
SetPanning	<sound>, +<left>+, +<right>+	Sets volume of left and right channel.
SetPlayRepeats	<sound>, +<reps>+	Sets a repeat count on a sound playback.
Stop	<sound>	Stops a sound playing in the background from playing
MakeSineWave	freq, duration, amplitude	Creates a pure sine wave.
MakeAudioInputBuffer	<time-in-ms>	Creates a buffer to record audio input
SaveAudioToWaveFile	<filename>, <buffer>	Saves buffer to a .wav file format
GetVocalResponseTime	<buffer>, <threshold>, <duration>	A simple voice key
LoadMovie	<movie_filename> <window>, <width>,<height>	Load a movie file
LoadAudioFile	<audio_filename>	Load an audio file
PlayMovie	<movie>	Plays a movie until its end
StartPlayback	<movie>	Initiates playback in background, updated with Wait()
PausePlayback	<movie>	Pauses playback of movie
	Graphical User Interface Functions	
GetTime	<>	Gets a number, in milliseconds, representing the time since the PEBL program began running.
MakeButton	<label><x>,<y> <win>,<width>	Makes a button for clicking on.
PushButton	<button><[x,y]>	Pushes a button and releases.
MakeCheckBox	<label><x>,<y>, <win>,<width>	Makes a two-state checkbox on a button background.
ClickCheckBox	<checkbox><[x,y]>	Handles checkbox click and updates state.

Name	**Arguments**	**Description**
SetCheckBox	<checkbox><state>	Sets checkbox state.
MakeScrollingTextBox	<text>, <x>, <y>, <win>, <fontsize>, <width>, <height>, <linewrap>	Make a box for text that can be scrolled if too long.
SetScrollingText	<obj><text>, <linewrap>	Changes text of a scrolling textbox.
MakeScrollBox	<opts>, <header>, <x>, <y>, <win>,<fontsize>, <width>, <height>, <selected>	Make a scrolling selection box.
UpdateScrollBox	<obj>	Recalculates scrollbox layout.
DrawScrollBox	<obj>	Draws a scrollbox.
ClickOnScrollBox	<obj>, <click>	Handles click on scrollbox.
PopuUpMessageBox	<label><win>	Makes a small message box at the mouse location.
PopuUpEntryBox	<label><win><[x,y]>	Makes a small entry box at [xy] location.
MakePullDown	<optionlist>, <x>,<y>, <win>, <fontsize>, <width>, <selected>,	Make a pulldown selection box for a list.
PullDown	<obj><[x,y]>	Handle click on a pulldown.
UpdatePullDown	<obj>, <newlist>	Updates the list of a pulldown.
DrawPullDown	<obj>	Redraws a pulldonw if state changes.
MakeTextlist	<list>, <listoffset>, <prebuffer>	Creates a text body from a list.
InsideTB	<[xy]><obj>	Determine inside for a textbox-style object (location is upper left)
MakeMenu	<header>, <x>, <y>, <win>, <fontsize>, <width>, <subitems>, <functions>	Creates menu with suboptions.

Name	**Arguments**	**Description**
`MakeMenuItem`	`<text>`, `<x>`, `<y>`, `<win>`, `<fontsize>`, `<width>`, `<function>`	Creates menu sub-item.
`ClickOnMenu`	`<obj>`, `<[x,y]>`	Handles menu click, calling the .clickon function of menu.
`OpenSubMenus`	`<obj>`, `<[x,y]>`	Opens the sub-menus of a menu.
	Custom and Built-in Object Functions	
`VariableExists`	`<variable-name>`	Tests whether a variable exists.
`PrintProperties`	`<object>`	Prints a list of all available properties of an object (for debugging)
`GetPropertyList`	`<object>`	Gets a list of all the property names of an object
`PropertyExists`	`<object> <prop>`	Determines whether a particular property exists
`SetProperty`	`<object> <prop> <value>`	Sets property of an object
`GetProperty`	`<object> <prop>`	Returns value of property
`MakeCustomObject`	`<name>`	Creates custom object.
`IsCustomObject`	`<object>`	Tests whether object is a custom object.
`DrawObject`	`obj`	Calls the .draw property of an object
`MoveObject`	`obj`, `x`, `y`	Calls the .move property of an object
`Clickon`	`obj`, `[x,y]`	Calls the .clickon property of an object
	Misc Event Functions	
`GetTime`	`<>`	Gets a number, in milliseconds, representing the time since the PEBL program began running.
`Wait`	`<time>`	Pauses execution for `<time>` ms
`IsKeyDown`	`<keyval>`	Determines whether the key associated with `<keyval>` is down
`IsKeyUp`	`<keyval>`	Determines whether the key associated with `<keyval>` is up
`IsAnyKeyDown`	`<>`	Determines whether any key is down.
`WaitForKeyDown`	`<keyval>`	Waits until `<keyval>` is detected to be in the down state
`WaitForAnyKeyDown`	`<>`	Waits until any key is detected in down state
`WaitForKeyUp`	`<keyval>`	Waits until `<keyval>` is in up state.
`WaitForAllKeysUp`		Waits until all keys are in up state

Name	**Arguments**	**Description**
`WaitForAnyKeyDown WithTimeout`	`<time>`	Waits for a key to be pressed, but only for`<time>` ms
`WaitForKeyListDown`	`<list-of-keyvals>`	Waits until one of the keys is in down state
`WaitForKeyPress`	`<key>`	Waits until `<key>` is pressed
`WaitForAnyKeyPress`	`<>`	Waits until any key is pressed
`WaitForKeyRelease`	`<key>`	Waits until `<key>` is released
`WaitForListKeyPress`	`<list-of-keys>`	Waits until one of `<list-of-keys>` is pressed
`WaitForListKeyPress WithTimeout`	`<list-of-keyvals>` `<timeout>`	Waits for either a key to be pressed or a time to pass.
`WaitForMouseButton`		Waits until any of the mouse buttons is pressed or released, and returns message indicating what happened
`WaitForMouseClick WithTimeout`	`<timeout>`	Waits until any of the mouse buttons is pressed, or a prespecified timout has elapsed.
`WaitForClickOnTarget`	`<target>`	Waits until any of a set of target objects are clicked.
`WaitForClickOnTarget WithTimeout`	`<target>`, `<timeout>`	Waits with a max time for a set of targets to be clicked.
`WaitForDownClick`		Waits for mouse button to be clicked
`RegisterEvent`	`<>`	Registers events to trigger based on particular conditions
`StartEventLoop`	`<>`	Starts the event loop
`ClearEventLoop`	`<>`	Clears all trigger events from event loop
`SignalFatalError`	`<message>`	Halts execution, printing out message
`ExitQuietly`	`<message>`	Halts execution, printing a message to terminal but not a pop-up
`TranslateKeyCode`	`<>`	Converts a keycode to a key name
`TimeStamp`		Returns a string containing the current date and time
`GetPEBLVersion`	`<>`	Returns a string indicating which version of PEBL you are using
`GetSystemType`	`<>`	Identifies the type of operating system being used.
`CopyToClipboard`	`<text>`	Puts argument in system clipboard.
`CopyFromClipboard`	`<>`	Copies text from system clipboard.
`GetVideoModes`	opt:`<screen>`	Gets list of available screen resolutions
`GetDrivers`		Gets a list of possible video drivers
`GetCurrent ScreenResolution`	`<>`	Gets the current widthxheight of the screen

Name	**Arguments**	**Description**
SystemCall	<command> <optional-args>	Executes command in operating system
LaunchFile	<file>	Launches a file using platform-specific handlers
GetNIMHDemographics	<code> <window> <file>	Asks NIMH-related questions
GetSubNum	<window>	Asks user to enter subject number
MessageBox	<text> <win>	Pops up a message, overtop the entire screen, and waits for a click to continue.
GetEasyInput	<text> <win>	Gets typed input based on a prompt.
GetEasyChoice	<text>, <choices>, <output>, <window>	Simple multiple choice
GetEasyMultiChoice	<text>, <choices>, <output>, <window>, <min>(opt), <max>(opt)	Simple select-multiple choice
CountDown	<window>, <bg>(opt)	Displays a 3 2 1 countdown on screen
IsAudioOut	<variant>	Tests whether <variant> is a AudioOut stream
IsCanvas	<variant>	Tests whether <variant> is a Canvas
IsColor	<variant>	Tests whether <variant> is a Color
IsFileStream	<variant>	Tests whether <variant> is a FileStream
IsFloat	<variant>	Tests whether <variant> is a floating-point number
IsFont	<variant>	Tests whether <variant> is a Font
IsImage	<variant>	Tests whether <variant> is an Image
IsInteger	<variant>	Tests whether <variant> is an integer-type number
IsLabel	<variant>	Tests whether <variant> is a Text Label
IsList	<variant>	Tests whether <variant> is a List
IsNumber	<variant>	Tests whether <variant> is a number
IsTextBox	<variant>	Tests whether <variant>is a TextBox
IsText	<variant>	Tests whether <variant> is a text string

Name	**Arguments**	**Description**
IsShape	<variant>	Tests whether <variant> is any drawing shape, such as a circle, square or polygon
IsString	<variant>	Tests whether <variant> is a string
IsWidget	<variant>	Tests whether <variant> is any Widget
IsWindow	<variant>	Tests whether <variant> is any Window
	List Manipulation Functions	
Shuffle	<list>	Returns a new list with the items in list shuffled randomly.
ShuffleRepeat	<list> <times>	Generates a list of n shuffled versions of <list>
ShuffleWithout Adjacents	<nested-list>	Shuffle specifying items that should not appear adjacently
Repeat	<item> <n>	Repeats an item n times in a list
RepeatList	<list> <n>	Makes a new list containing the elements of <list> repeated <n> times
Sequence	<start> <end> <step>	Makes a sequence of numbers from <start> to <end>, with <step>-sized increments
ChooseN	<list> <n>	Returns a sublist of <n> items from a list, in the order they appear in the original list
Sample	<list>	Picks a single item randomly from <list>.
SampleN	<list> <n>	Returns a randomly-ordered sublist of <n> items from a list
SampleN WithReplacement	<list> <n>	Returns a sublist of <n> items from a list
DesignLatinSquare	<list1> <list2>	Simple latin square
LatinSquare	<list>	A simple latin square constructor
DesignGreco LatinSquare	<list1> <list2> <list3>	Create design
DesignBalanced Sampling	<list> <number>	Sample equally from list
DesignFull Counterbalance	<list1> <list2>	Create all combinations
CrossFactorWith outDuplicates	<list>	Returns a list of all pairs of items in the list, excluding pairs that where an element appears twice.
Rotate	<list> <n>	Rotates a list by <n> items.

Name	**Arguments**	**Description**
FoldList	<list> <n>	Folds list into length-n sublists.
Flatten	<list>	Flattens a nested list completely
FlattenN	<list> <n>	Flattens n levels of a nested list
Length	<list>	Returns the number of elements in a list.
First	<list>	Returns the first item in a list.
Last	<list>	Returns the last item in a list.
Merge	<list1> <list2>	Combines two lists.
Append	<list> <item>	Returns new list combining `<list>` and `<item>`
PushOnEnd	<list> <item>	Adds `<item>` to `<list>` efficiently
List	<item1> <item2>...	Makes a list out of items
Sort	<list>	Sorts a list by its values.
SortBy	<list> <key>	Sorts list by the values in `<key>`
Nth	<list> <n>	Returns the nth item in a list.
Subset	<list> <list-of-indices>	returns a subset of items from a list
SetElement	<list>, <index>, <value>	Sets an element of list to value
Match	[list],<item>	Returns a list of 0/1s, indicating which elements of list match item.
Filter	[list], <indicators>	Filters a list based on a 0/1 list produced by Match.
Levels	[list]	Returns a sorted list of unique elements in list.
Rest	<list>	Returns a list minus its first element
ExtractListItems	<list> <list-of-indices>	Gets a subset of items from a list
IsMember	<item> <list>	Checks whether `<item>` is a member of `<list>`
Replace	<template> <replacementList>	Replaces items in a data structure
Lookup	<key> <keylist> <database>	returns element in `<database>` corresponding to element of `<keylist>` that matches `<key>`.
Transpose	<list-of-lists>	Transposes a list of equal-length lists.
SubList	<list> <start> <finish>	Returns a sublist of a list.
RemoveSubset	<list> <list-of-pos>	Removes items at positions `<list-of-pos>` from a list.
ConcatenateList	<list>, <sep>(opt)	Combines list
ListToString	<list>,	

Name	**Arguments**	**Description**
	`<sep>` (opt), `<prebuffer>`(opt)	Concatenates all elements of a list into a single string
`ModList`	`<list>`, `<pre>`, `<post>`	Adds pre- and post- elements to each list member
`Insert`	`<list>,<item>,<pos>`	Inserts `<item>` into `<list>` at `<pos>`
`ListBy`	`<list>,<conds>`	Segments a list into sublist by the values of a second list
String Management Functions		
`CR`	`<num>`	Returns string with `<num>` linefeeds.
`Tab`	`<num>`	Returns string with `<num>` tabs.
`Format`	`<value> <num>`	Makes string from value exactly `<num>` characters by truncating or padding.
`Enquote`	`<text>`	Returns string surrounded by quote marks.
`Uppercase`	`<string>`	Returns uppercased string
`Lowercase`	`<string>`	Returns lowercased string
`ReplaceChar`	`<string> <char> <char2>`	Substitutes `<char2>` for `<char>` in `<string>`.
`SubstituteStrings`	`<text>,<replist>`	Makes multiple substitutions in text
`SplitString`	`<string> <split>`	Splits `<string>` into a list of `<split>`-delimited substrings
`SplitStringSlow`	`<string> <split>`	Splits `<string>` into a list of `<split>`-delimited substrings
`StringLength`	`<string>`	Returns the length of a string
`SubString`	`<string> <position> <length>`	Returns a substring
`FindInString`	`<string> <key> <pos>`	Returns position of `<key>` in `<string>`, starting at position `<pos>`
`StripSpace`	`<string>`	Strips whitespace from the start and end of `<string>`.
`StripQuotes`	`<string>`	Strips quotation marks from the start and end of `<string>`.

Chapter 6

PEBL User Interface Functions

As PEBL matured, there was a need to create a number of cross-platform tools, including the launcher, the data combiner, a customized launcher, and the like. Because PEBL is already a cross-platform toolkit, we decided to implement a set of UI primitives to make this possible, within PEBL itself. These functions are primarily defined in pebl-lib
UI.pbl. An example application using most of these graphical primitives is provided in demo
ui-demo.pbl.
This chapter is a basic overview and tutorial for these functions. Many of these functions are sort of secondary to the main functions related to experiment design, and so in some cases they are not documented in the main reference section.

6.1 Overview

The UI objects described here share a number of things in common. They are 'custom' objects with methods defined within the object, so that the Draw, Move, Add, Remove, Clickon, and inside, functions will work directly on them, overriding the base function names.
Thus, if you create an object, although it really is a data structure usually containing various pieces of information and graphical output, you can use common functions to interact with it:

```
button <- MakeButton("Buttonname",100,100,gWin,150)
AddObject(button,gWin)
Move(button,300,300)
```

Each object has an associated function called with the 'ClickOn' method that handles a click on the object. It takes two arguments; the object itself, and the xy mouseclick event. Thus, you can create a bunch of UI elements of different types, then use a single loop to handle any event there. For example, if items holds a list of graphical elements defined earlier:

```
cont <- 1
items <- [done,sb,check,pulldown,pulldown2,
          testmessage,testentry,textscroll,
           menu1,menu2,menu3,menu4]

while(cont)
{

  resp <-  WaitForClickOnTarget(items,
                     Sequence(1,Length(items),1))
  obj <- Nth(items,resp)
  CallFunction(obj.clickon,[obj,gClick])
  Draw()

  #Exit condition:
  cont <- (resp>1)
}
```

Here, gClick holds the keypress event at the end of WaitForClickOntarget.

6.2 TextEntry

A textentry is a single-row text box that allows the user to enter text when they click on it. It has a label that is above the text entry box (with unimplemented layout parameter that in the future will let you change the layout). and its property .value will contain the text entered. When one clicks on it, it will do a standard text entry. One must hit enter to input the value, and nothing else can happen until enter is clicked. If you want to set the value, you can use SettextEntry().

6.2.1 Usage

```
te <- MakeTextEntry(label,x,y,win,width,defaultval)
```

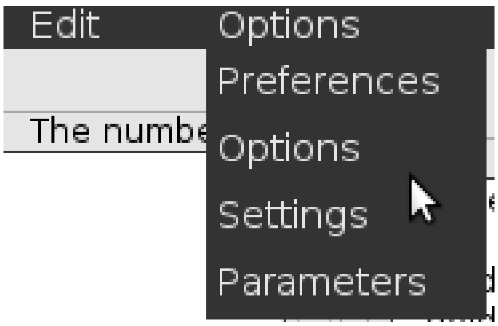
6.2.2 Methods and related functions

Below is a list of functions related to TextEntry

	MakeTextEntry(label,x,y,win,width,default,<layout>)	Creates entry box
Clickon	GetTextEntryInput(obj,event)	Gets text-based input.
Inside	InsideTB(obj,evt)	Tests whether click is inside menu
	SetTextEntry(obj,text)	Sets the value manually

6.3 Menu

A Menu appears as a labeled box, and when clicked on a set of options will pull down to be clicked on. When one of this is clicked, a specified function will be executed. Often, you put these on the top of the screen in a menu bar, which needs to be generated manually. See ui-demo.pbl in demo directory for examples.



6.3.1 Usage

A menu is created as a set of MenuItems (which is hidden from the user.) Along with specifying the location and text for the items, you need to specify function names to be called when a target is clicked. When clicked, the function gets called with (obj, click), so you can handle the drawing.

```
menu <- "FILE", 10,10,gWin,12,100,["Load","Save","Edit"],
                                  "Loadfile","Savefile","Editfile"])
```

In the example above, a 'FILE' menu will be displayed. When clicked on, subitems 'Load', 'Save', and 'Edit' will appear, which will execute the functions 'Loadfile', 'Savefile', and 'Editfile'.

6.3.2 Methods and related functions

Below is a list of functions related to menu creation. The main menu uses a sub-object called menuitem that has its own hide/show methods. You may wish to use a menuitem directly in some cases, but its usage is not documented here.

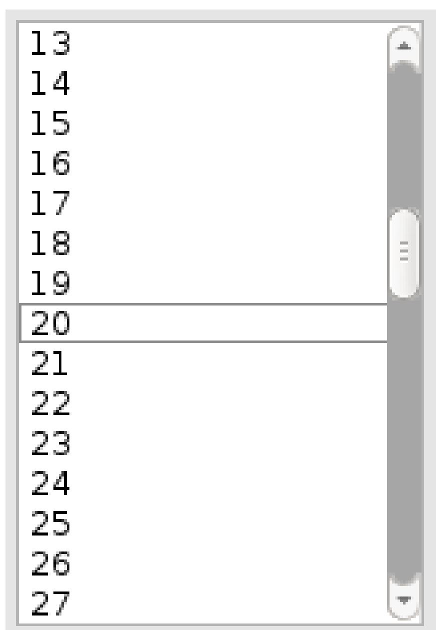
	MakeMenu(header,x,y,win,fontsize, width,subitems,functions)	Creates menu
Clickon	OpenSubMenus(obj,event)	Opens the menu and accepts clicks on menuitems
Show	ShowMenu(obj,evt)	Shows menu
Hide	HideMenu(obj,evt)	Hides menu
Inside	InsideMenu(obj,evt)	Tests whether click is inside menu
	MakeMenuItem	Helper function
	RemoveMenuItem	Helper function

6.4 PullDown

A Pulldown is a list of items that folds up to the chosen item. It is thus simliar to a scrollbox when open, and uses some of the same mechanics.

The important properties of a pulldown are the .selected and .list. The .selected property tells you the index of the currently selected list element. The .list property gives you the list of elements, so that Nth(obj.list,obj.selected) will give you the text of the selected list item.

Closed pulldown: 

Open pulldown: 

6.4.1 Usage

Once created, you can let the clickon method handle selection, and then identify .list and .selected properties when needed. If you need immediate results when selecting something, you will need to reset the .clickon property to name your

special handler, which should call PullDown().
The .maxitems property of a pulldown specifies how many items are shown when the pulldown is open. If there are more than this, it will allow you to scroll through the options. This can be set after the pulldown is created.

```
pulldown <- MakePulldown(["small","medium","large"],
                         gWin,12,120,1)


  Pulldown(pulldown,[0,0])) ##Simulate click on pulldown
 ##Suppose you want to update the list:

 UpdatePulldown(pulldown,["small","medium","large","extra-large"])
```

6.4.2 Methods and related functions

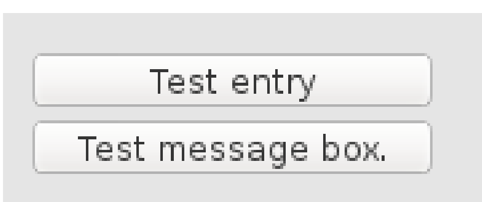
The following methods and related functions operate a pulldown:

	MakePullDown(opts, x,y,win,fontsize, width,selected)	Creates pulldown
Clickon	Pulldown(obj,event)	Opens the menu and accepts clicks on menuitems
Draw	DrawPulldown(obj)	Redraws the pulldown object
Inside	InsidePulldown(obj,evt)	Tests whether click is inside pulldown
	UpdatePulldown	Helper function
	SelectPulldownByText(obj,text)	Tries to select the first item in pulldown that matches text

6.5 Button

A Button is created with the MakeButton function, which takes the arguments:

```
MakeButton(label,x,y,win,width)
```



The button is centered on x,y, and the width (in pixels) must be specified. If the label is too wide for the width, it will be scaled (shrunk) horizontally, which could make it look strange, but less strange that truncating or cutting off the edges.

6.5.1 Methods

Button has several methods bound to the following functions:

Clickon	PushButton(obj,event)	Animates a 'click' and returns to normal
Draw	DrawButton(obj)	Draws the graphical elements
Move	MoveButton(obj,x,y)	Moves button to new center location

6.5.2 Usage

Note that by default, the clickon method will just simulate a click and do nothing else. To link it to another function, you need to reset the clickon property of the button to name your own function. This function should probably call PushButton, as shown below. In the main Start() function, you might define the button as such:

```
button <- MakeButton("quit",100,100,gWin,150)
button.clickon <- "HandleQuit"
```

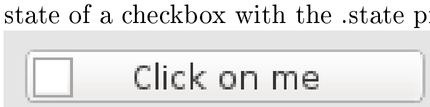
then, later, define the function HandleQuit:

```
define HandleQuit(button,xy)
{
   PushButton(button,xy)
   ExitQuietly("Exiting the program")
}
```

An example of this is found in ui-demo.pbl

6.6 Checkbox

A Checkbox is basically a button that has two states, 0 (unchecked) and 1 (checked) In fact, it reuses the mothods for a Button. You can interrogate the state of a checkbox with the .state property.



6.6.1 Usage

Like a button, a checkbox is created with a label, x,y, center position, the window, and a width:

```
box <- MakeCheckBox(label,x,y,win,width)
```

Its .state property starts at 0 and will appear unchecked, and if the ClickOn() method is called, will change to 1 and appear checked (if it is 1, it will change to 0/unchecked). By default, the clickon function just changes the state. You may override this with your own custom callback function that has another effect, which may want to call ClickCheckBox(). There is also a SetCheckBox(obj,state) function you can use to force the state to a specific value.

Typically, this would be used for parameter settings, and when you are ready to 'execute', you would look at the .state of the button to decide what to do.

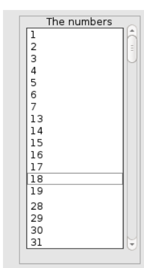
6.6.2 Methods and associated functions

The following methods and functions operate a checkbox:

Creation	MakeCheckBox(label,x,y,win,width)	Creation
Clickon	ClickCheckBox(obj,event)	Changes the state of a checkbox
	SetCheckBox(obj,state)	Sets value to specific 0/1 state
Draw	DrawButton(obj)	Draws the graphical elements
Move	MoveButton(obj,x,y)	Moves button to new center location

6.7 Scrollbox

This is a workhorse object that lists a bunch of elements, allows selecting, and potentially editing them.



It has several properties of interest: .list, which is the list of items in the scrollbox; .editable, which determines whether a second-click on an element should permit editing (by calling EditScrollboxValue), .selected, which specifies the element of the list that is selected.

6.7.1 Usage

```
sb <-   MakeScrollBox(opts, header,x,y,win,fontsize,
                 width,height,selected)
```

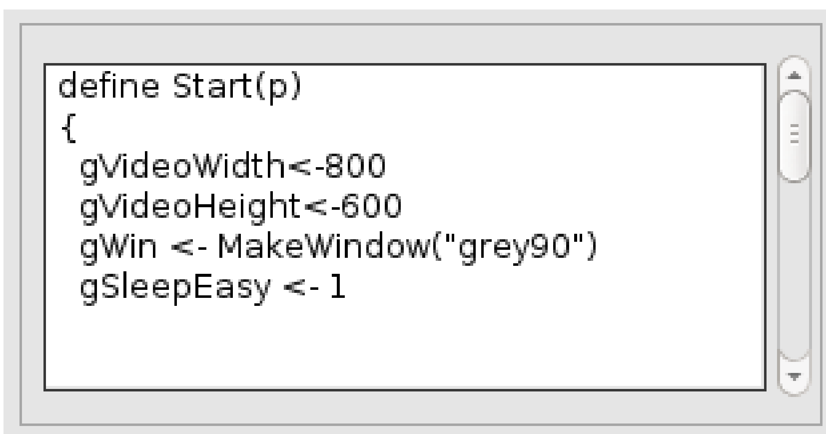
6.7.2 Methods and related functions

Below is a list of functions related to ScrollingTextBox

	MakeScrollBox(opts,header,x,y,win,fontsize,width,height,selected)	Creates scrollbox
Clickon	ClickonScrollBox(obj,event)	Handles click
Draw	DrawScrollBox(obj,evt)	Manages drawing
Inside	InsideTB(obj,evt)	Tests whether click is inside scrollbox
	UpdateScrollbox(obj)	Handles updating when .list is changed.
	EditScrollboxValue(win,click, default,selected)	Allows editing of a value, called by clickonscrollbox.
	UpdateCapturedScrollBoxThumb(obj, p)	Allows moving thumb
	ClearScrollboxThumbCapture(obj, p)	Helper; clears capture

6.8 ScrollingTextBox

A scrolling text box is useful for displaying long text that permits scrolling through. The scrolling UI only appears of the length of the text is longer than the size of the box. It is useful for loading a text file. The linewrap argument specifies whether a long line should wrap around or just be truncated at its end. It is based on a scrollbox, which allows selection/action for clicking on specific lines.



6.8.1 Usage

```
stb <-  MakeScrollingTextBox(text,x,y,win,fontsize,width,height,linewrap)
```

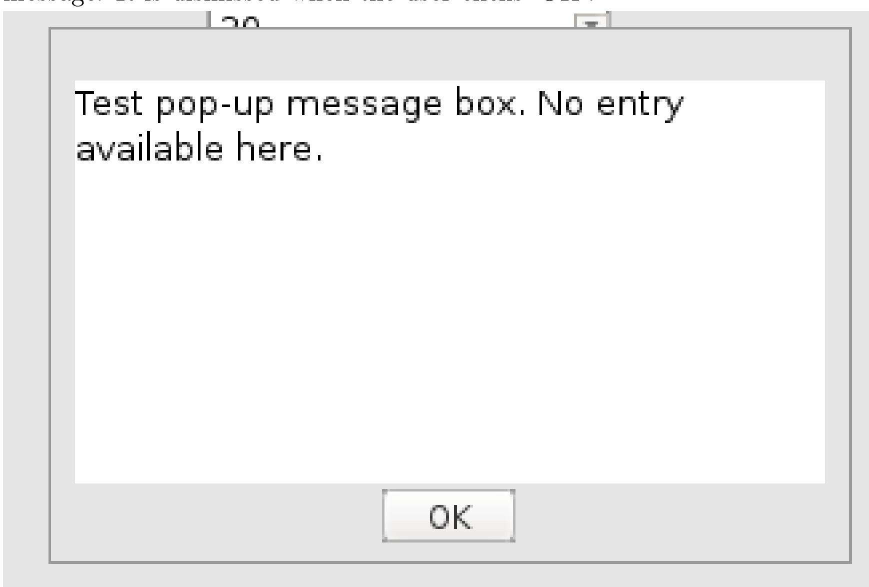
6.8.2 Methods and related functions

Below is a list of functions related to ScrollingTextBox

	MakeScrollingTextBox(text,x,y,win,fontsize,width,height,linewrap)	Creates scrolling text
Clickon	ClickonScrollingTextBox(obj,event)	Handles click
Draw	DrawScrollingtextBox(obj,evt)	Manages drawing
Inside	InsideTB(obj,evt)	Tests whether click is inside scrolling textbox
	UpdateScrollingTextBox(obj)	Updates box after elements are changed

6.9 PopupMessageBox

This create a small pop-up box at the point of the cursor to give a short message. It is dismissed when the user clicks 'OK'.



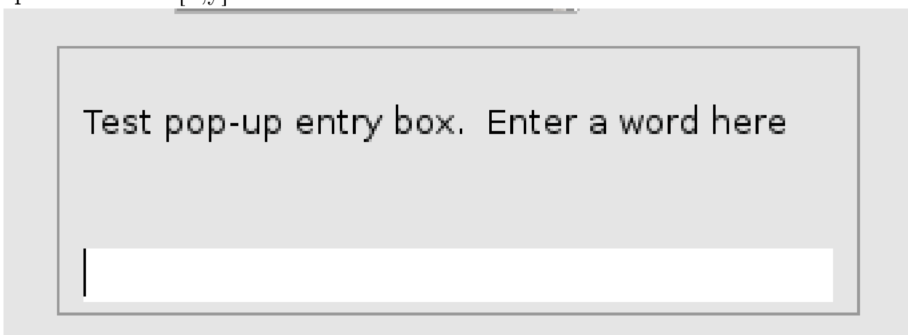
6.9.1 Usage

By default, the message box is 300x200. You can specify width and height arguments to change the size. It will query the location of the mouse and place the box at that location (attempting to stay on the screen).

```
PopupMessageBox("Click OK to continue.",gWin)

PopUpMessageBox("Thank you", gWin,350,250)
```

6.10 PopUpEntryBox

This is like a PopUpMessagBox, but collects a text entry, exiting when the user hits the enter key. By default it is 300x100 pixels. It will appear at a location specified in an [x,y] coordinate list.



6.10.1 Usage

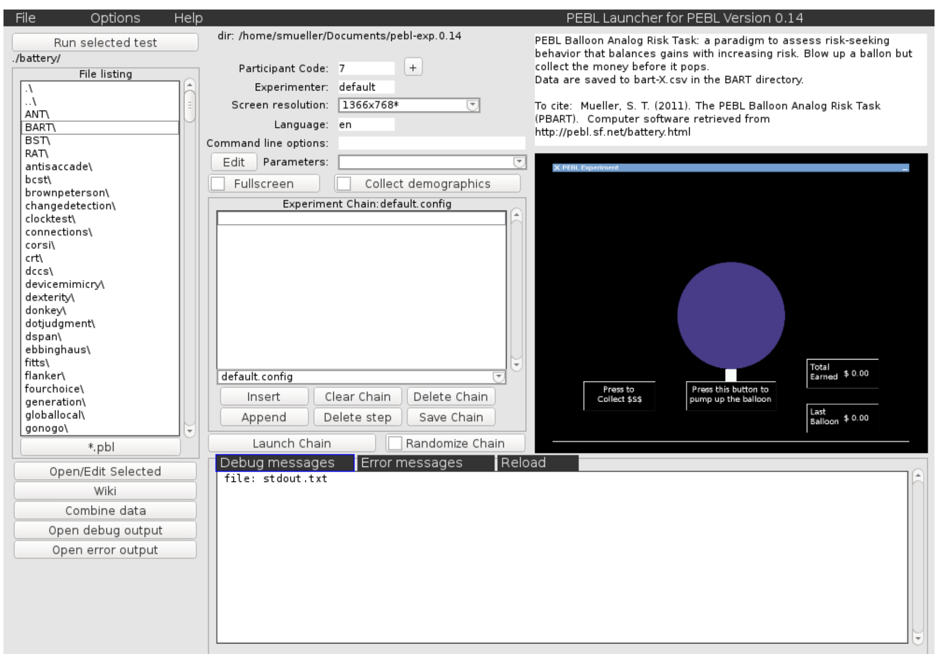
```
entry1 <-   PopUpEntryBox("Please enter your birthplace",gWin,[100,100])
entry2 <-   PopUpEntryBox("Please enter your name",gWin,[100,100],
                           "defaultname",300,200)
```

Chapter 7

The PEBL Launcher

The PEBL Launcher is the best way to navigate and launch PEBL experiments, especially for novices or research assistants. It allows one to specify a few specific options that are frequently changed, navigate through the PEBL Test Battery, and create and save 'experiment chains' to let you run multiple experiments in a row.

Figure 7.1: Screenshot of of PEBL Launcher.



7.1 History of the Launcher

Prior to 2011, a front-end launcher was only available for PEBL on Windows. It was written in Visual Basic 6, which was old-fashioned, single-platform, no longer supported by Microsoft, and created a situation where a critical piece of PEBL infrastructure depended on a non-free tool. The main obstacle to a new launcher has always been: PEBL needs a cross-platform launcher using a free software, and we don't want to have to distribute a whole additional interpreter. This means that Python, wxBasic, TCL/TK, etc. were out of the consideration. Why couldn't there be an easy-to-use cross-platform programming tool we could use?

As of PEBL Version 0.12, we found one: PEBL itself. PEBL is not really designed to create GUI applications, but it can be beat into submission to do so. For Version 0.12, enough filesystem access functions and other features were available to make a reasonable launcher.

For PEBL 0.14, the launcher received a major overhaul. With the advent of custom objects, we added a bunch of GUI objects (buttons, scrolling text boxes, checkboxes, menus, etc.) that enabled a much more polished version of the launcher that integrates better with other desktop options. This allowed streamlining the launcher, adding functionality, improving its usefulness in the research lab. This includes the ability to set and change script-based parameters, which allows an experimenter to better tailor the PEBL battery tests to their particular needs.

7.2 How it works

The simplest usage of the Launcher is that you use the file selector on the left to choose a .pbl file, then click the button 'Run selected script" to run that experiment. ONLY .pbl files and directories will appear in the file window.

7.3 Features

7.3.1 File browser

On the left is a file browser. It will only show .pbl files and subdirectories. To navigate to a subdirectory, simply click on the directory to select it, then click on the selected directory. To move back up a directory, click on the '..\' row. When you have a .pbl file selected, you can use the 'Run selected script' button to launch it.

Figure 7.2: The File Browser.

7.3.2 Participant code

This will allow you to select the participant code you want sent to any experiments you are about to run. By default, PEBL saves the last experiment code when you exit, and then reloads it the next time, incrementing by one. This makes it easier to avoid colliding participant codes and overwriting data. Participant code need not be a number, but the launcher currently does not understand how to increment non-numeric codes, and will probably restart at 1. The plus button next to the code box will increment the current number by 1, which is useful if you are running multiple sessions in a row.

The automatic incrementation of participant code can be turned off by opening the fileselect.pbl file and changing the variable gAutoSubcode from 1 to 0.

When an experiment is launched, the specified code will be fed into the experiment using the -s command-line option, and will be bound to the gSubNum variable. Some of the standard experiments will ask you to enter a participant code regardless of whether you have one selected. If that is the case, you should be able to edit the script to remove the request to specify a participant code. However, most experiments in the test battery should only ask the experimenter to specify a participant code if the participant code is '0', which is what it will be when no -s command is given. So, if you are using code 0, many of the experiments will ask you to enter a code after they launch.

7.3.3 Experimenter code

Many times, you may wish to keep track of the experimenter or research assistant who collected the data. Have them enter their name in the 'experimenter' window. The name will be saved on exit. The experimenter code will be saved to the runlog file (see below).

7.3.4 Language

Some experiments have instructions and stimuli that are translated into different languages. Enter your two-character language code in the language box to tell the experiment what language to use. If your chosen language is not available, the experiment will fall back to English. For Chinese and related languages, setting this will also change the default fontface used. If you want to translate an experiment into your own language, ask on the PEBL mailing list.

7.3.5 Commmand Line Options

There are a number of command line options available for PEBL that are not present as options in the launcher. If you want to use any, you can type them in the "Command line Options" box and the launcher will pass them to PEBL. You can use these to specify -V options that pass parameters into your experiment (e.g., controlling whether a practice or a test round is given).

7.3.6 Edit and Parameters

The Edit button will let you edit the parameters used in the test. When you edit and save the parameter set, it will then appear as an option in the parameters pulldown. Before you run an experiment, you can select the parameter set you want to use from the pulldown (or save it permanently to an experiment chain).

7.3.7 Fullscreen Mode

If you want to launch your experiment in full-screen mode to improve video latency and to avoid distractions, check this box. The secret escape key combo is ctrl-alt-shift-\: hit these four to abort out of an experiment before it is complete.

7.3.8 Demographics Collection

The U.S. NIMH requires a number of demographic variables for research they fund. Checking this box will collect this data and save it to a data log file called demographics-log.csv, prior to running your experiment or experiment chain.

7.3.9 Experiment Chains

The launcher allows you to set up a 'chain' of experiments that get run in sequence. All the experiments will be run consecutively, with an identical subject code. This is accomplished by running a separate instance of PEBL for each experiment. This can sometimes lead to a 'flash' between each experiment if running in fullscreen mode. Below the experiment chain window is a pulldown that lets you select the particular chain you want to use. The default chain is loaded by default, and is also responsible for setting the parameter sets above.

7.3.10 Saving Experiment Chains

When you exit the launcher, the current experiment chain will get saved in the the current config file. By default, this file is called default.config. This same file is loaded when the launcher starts again, restoring your settings. By hitting the 'save chain' button, you will be asked to enter a new name to save the current configuration under. Similarly, 'Delete chain' will delete the file in which the current chain is saved. A chain can be loaded at start-up (by specifying the name of the config file with the -v command-line option).

7.3.11 Editing Experiment chains

A chain can be edited by inserting, appending, or deleting steps, or clearing the entire chain, using the buttons below the experiment chain box. Be sure to save the chain after editing so your edits will be saved.

7.3.12 Loading Experiment Chains

A previously saved experiment chain can be loaded by selecting the chain name from the pulldown selection box.

7.3.13 Description and Screenshot

On the right side of the launcher is a window that will show a screenshot and print a description of a script when it is highlighted. These need to be created by hand for each script. The launcher does its best to show you a preview of the test inside any directory. But to run an experiment, you need to select a .pbl file in the file window on the left. So, even if a screenshot appears on the right, you need to select the actual .pbl file to run the experiment.

7.3.14 Message feedback windows

Whenever a PEBL script runs, error and debug messages are saved to files called stdout.txt and stderr.txt, within the directory the file is run from. When a test is completed, PEBL will look for and try to load these files in the tabbed window at the bottom of the launcher. stdout.txt typically contains any messages saved using the Print() command, and is useful for debugging code. If an experiment crashes, it will be logged in the stderr.txt file and the Error messages tab. In addition, a lot of bookkeeping information is saved to that file, which can help diagnose other possible problems. If you need to access these files directly to help report bugs, you can open them using the 'Open Debug Output' and 'Open error output' buttons.

7.3.15 Other buttons

The launcher has a number of other buttons to help you use PEBL. These include:

- *Open/Edit selected* On the lower left, there is a button labeled "Open/Edit selected". This will open a selected .pbl script in a text editor, and will open a directory in your system's file manager. An easy way to look at or make changes to the script, or to locate data files after a script is run.

- *Wiki* This will launch a web browser that will take you to the PEBL wiki page that is related to the currently selected test. THis should help provide information about the test, its background, parameters, and data format.

- *Combine data* This will launch a data combining utility described below. It will help merge all your data files together into a single spreadsheet.

- *Open debug output* Whenever an experiment is run, any time you use the Print() function, it will print the resulting text to a file names stdout.txt the directory it was run in. This button will open that file.

- *Open error output* Whenever an experiment is run, the error and status messages are saved to a file called stderr.txt in the directory it was run in. This button will open that file.

7.3.16 Menu

A lot of functionality is present in menus at the top of the window.

- *File/Exit* This will exit the launcher and save the current configuration options to the named experiment chain.

- *Options/change launcher size.* The launcher has trouble running on netbooks with only 600 pixels vertical distance. This will make a 'small' launcher that is more compact, but only works next time the launcher is opened.

- *Help/About* This provides a short description of the launcher.

- *Help/Manual* This opens the PEBL .pdf manual. The manual is located in different places on each platform, and will change names for each release.

- *Help/Website* This will take you to the main PEBL website.

- *Help/Wiki* This button will take you to the PEBL wiki, and do its best to find a WIKI page related to the experiment you are looking at. They won't always exist, and if not, you can always sign in and make your own.

- *Help/Tutorial* This will open a wiki page containing a basic PEBL usage tutorial.

- *Help/Review* This will let you provide feedback about PEBL
- *Help/Donate* This will let you donate funds to help support PEBL development.

7.4 Launching an experiment

To launch an experiment, navigate through the directories in the file listing box. Only directories and files with the .pbl extension are shown in this box. To open a directory, click once to move the highlight box onto the directory name, and a second time to open the directory. When a new directory is opened, the first available .pbl file will be automatically selected. To run that script, just press the 'Run Selected script' button above the file select box. It will run with the specified parameter, including subject code, language, fullscreen mode. In addition, if the 'collect demographics' button is selected, a demographic survey will happen prior to the study running.

7.5 Launching an experiment chain

If you have a series of experiments you want to run, create an experiment chain and launch it using the 'Launch chain' button above the experiment chain selection box. Tip: Use experiment chains even if you are are running just single experiment, with just a single experiment selected. This give faster access and is less error-proned.

7.6 Translating the Launcher

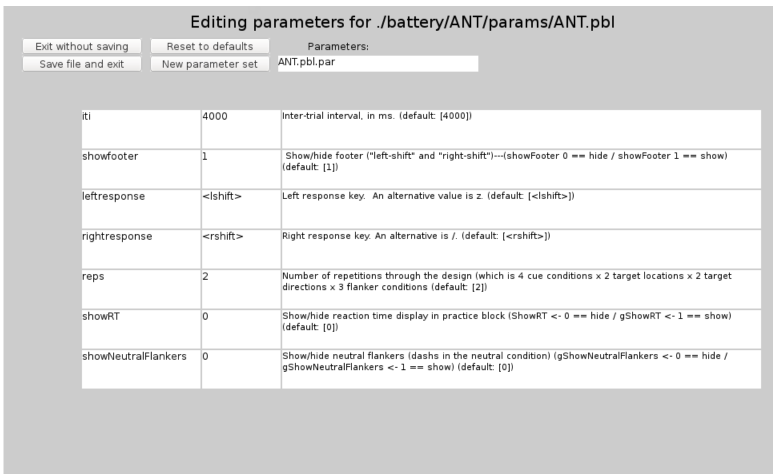
You can translate the launcher to your own language. Open the launcher file (fileselect.pbl), and go to the end of the script, to a function named "GetStrings":

```
define GetStrings(lang)
{
   lang <- Uppercase(lang)
   if(lang == "EN")
   {
      gRunText <- "Run selected script"
      gOpenText <- "Open"
      gExitText <- "EXIT"
      gViewDebugText <- "View debug output"
      gViewErrorText <- "View error output"
      gAddToChainText <- "Add to Chain"
      gClearChainText <- "Clear Chain"
      gSaveChainText <- "Save Chain"
....
```

The labels used in the launcher all appear here. You should be able to just translate the text of each on into the language of your choice. Send the translations back to the author so they can be incorporated into the next launcher version. You can also make a section in the if statement for your particular language. When you change the language in launcher, it will save that option and use your language of choice next time.

7.7 Utility:Parameter setting

Version 0.14 of the PEBL Launcher allows you to set parameters from tests before launching. A basic screenshot is shown below:



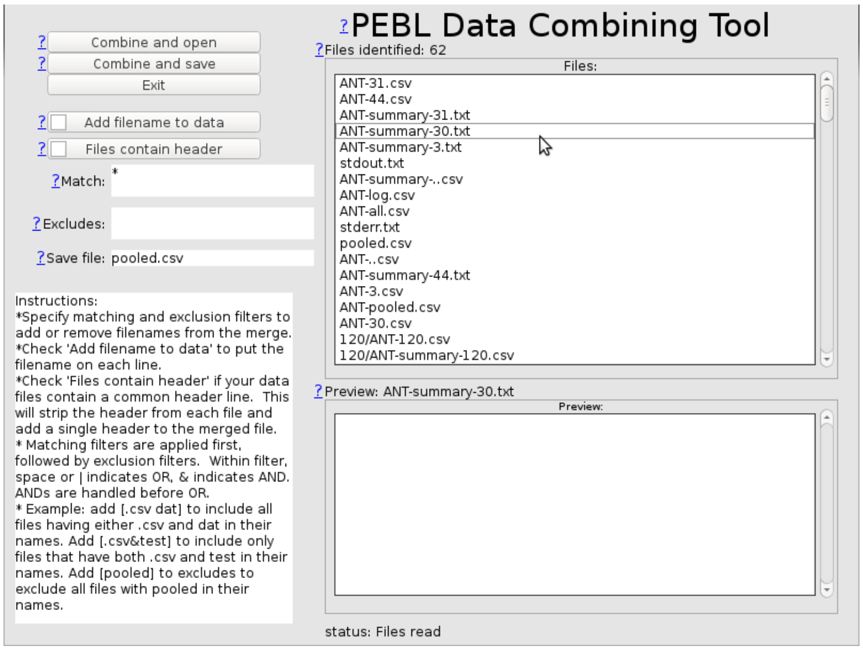
Here, the first column shows the name of the parameter. The second is the current value, which can be edited by clicking on the box and typing a new value. When complete, hit enter and the new set will be recorded. The rightmost column provides a basic description of the parameter, and its default value.

To create a new parameter set, write the name of the parameter set you want to use in the box at the top of the screen. Then, when you hit 'Save file and exit', it will be saved to this parameter file. There is no need to include .par in the filename, as it will be added if you do not add it yourself. To edit a current parameter set, select the parameter set you want and press 'edit' in the main window.

7.8 Utility: Combining data files

Once an experiment is done, the data files are typically stored within the data directory in which the test appeared. Furthermore, each participant may be saved in his or her own subdirectory. On some tests, a merged or pooled data file is also saved, but this is not always the case. In order to merge all of you data into one master file, you can use PEBL's data combining tool, accessible through a button on the lower left of the launcher.

To use this, navigate to the data directory of your tests, and click the 'Combine data' button. A screen like the one below should open.



On the upper right, a list of all files within the selected directory (and subdirectories) will be displayed. You want to choose some (but probably not all) of these. You can choose a subset by typing match values into the match and exclude boxes on the left. Currently, the * indicates all files will match. You may want to just include .csv files, in which case deleting the * and typing csv into the box will bring up only files with csv in their name. You may want to exclude summary files, in which case you can type summary into the excludes box. Each time you change the selection criteria and hit enter, the list of files will update. A preview of any of the files can be seen in the lower right window. IN the match and exclude boxes, spaces act as logical 'or's. matching with the following '* csv' will match all files, because the first * will match all files. Or can also be specified using the | character. The & character can be used to specify AND criteria. To match csv files from participant 300, you would enter '`300&csv`'. The matches are process before the excludes.

Once you have selected the right files using match and exclude criteria, you should determine whether the files have a header. If they have a header, you probably want to remove the header, including just once in the merged file. The combiner is not smart enough to detect this on its own, so you must check 'files contain header' if you want the header stripped from each individual data set and added to the final merged set.

Finally, especially if your data does not have a participant code in it, you may check 'add filename to data' which will add a column at the beginning of the data indicating the source file of each row of data.

Once you are ready, you can choose 'combine and save' which will save the data to the filename you specified in 'save file'. If you use the combiner more than once, be sure to exclude 'pooled' from your match list so you don't get multiple copies of your data. You can also choose 'combine and open', which will create the pooled file, but then try to open in with whatever program is associated with that file type (i.e., microsoft excel for .csv files).

Chapter 8

The PEBL Psychological Test Battery

This chapter contributed by Bryan Rowley in collaboration with Shane Mueller

8.1 About the PEBL Test Battery

This site is for a battery of psychological tests implemented in PEBL and distributed (and redistributeable) freely. They are designed to be easily used on multiple computing platforms, running natively under Win32, Linux, and OSX Operating Systems. The tests are designed to implement a wide range of computer-administered psychological tests and experiments of interest to neuropsychological, cognitive, clinical communities.

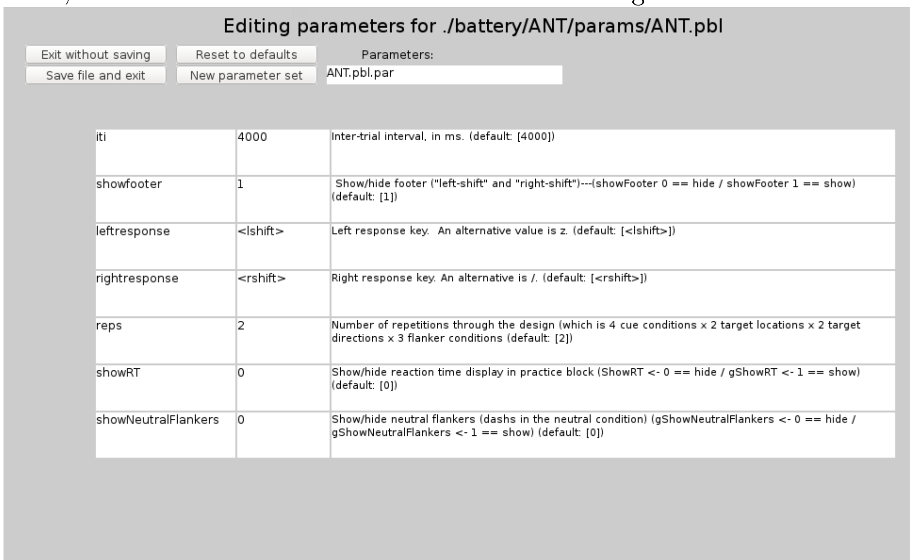
The current version of the battery is designed to work with PEBL version 2.0 and was released in 2016. It is distributed with PEBL 2.0, and is automatically installed in My Documents\pebl.2.0\battery on windows.

These tests are designed to implement a wide range of tests that are used throughout the psychological, neuropsychological research and clinical communities. Some are reimplementations of tests that are only available on limited computing platforms or cost hundreds of dollars. Each experiment saves the complete data set for later analysis, and many compute basic analyses that it writes in report format.

8.2 Setting Parameters of Battery Tests

More details of parameter-setting are available within the next chapter that covers the launcher.

The tests within the battery typically expose the most important instrumentation variables that control important aspects of the test. These often include the number of trials, the make-up of stimuli, etc. For example, the following shows parameters for the ANT test, which is opened when you hit the 'edit' button near the parameters pulldown when you have a parameter-enabled test selected in the file window. In this test, the leftmost column indicates the name of the parameter; the next column indicates its current value, and the final column describes the value along with its default value.

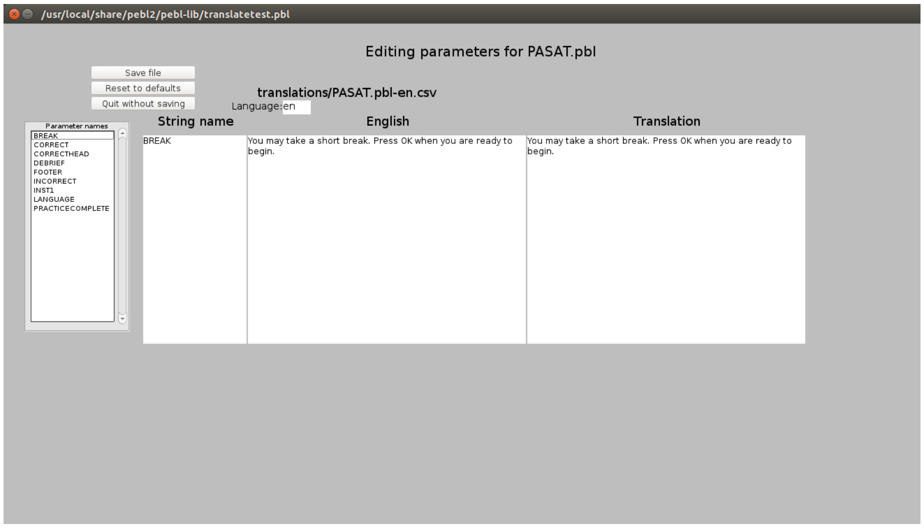


If you want to create a custom parameter set, edit these values and click 'Save file and exit'. This will create a default parameter file that will be used. You can also type a a new name, and save it, and then select the new name in the parameters pulldown. You can then create an experiment chain and select one parameter set or another to make setup easier and error-free.

8.3 Translating or changing test instructions

Most of the tests within the test battery permit translating any participant-visible text. This usually includes instructions, debriefing, and headers/stimuli/labels. Each test needs to be designed to permit this, but most of the tests in the battery have (most that don't involve primarily English stimuli/materials, such as memory tests).

To translate a test, first be sure the 'language' entry box is named according to the two-letter code associated with your language of choice. By default, it will choose en for English. Then, select the test within the file section scrollbox, and click on the 'translate test' button on the lower right of the window. This will bring up the following screen:



If the language selection is correct, you are fine; otherwise edit the language to be whatever two-letter code you want to use. If you choose en, you will edit the default instructions, and if you make an error you may have to re-copy the translation file from the main PEBL
battery
directory (i.e., in Program Files(x86)
PEBL).

In this dialog, each critical piece of text has a name that is referred to within the testing script. The next column indicates the original text, and the third column is the translated text (which will probably be in English if no translations have been made previously). Select the name on the left, and edit the text on the right. If you want, you can right-click on the window to clear the text or copy in text created elsewhere.

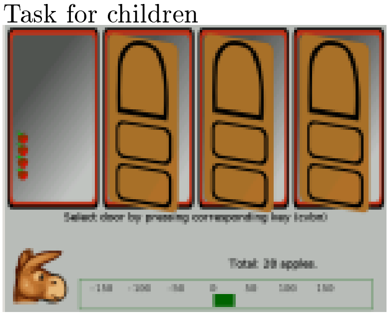
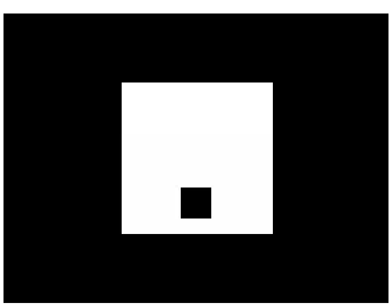
For some languages, this translation dialog may not work–we are still working on improving international keyboard input. In reality, this just edits a .csv file that is stored within the test
translations
directory. For a test called test.pbl, the English file will be called test
translations
test.pbl-en.csv. You can also edit this with a normal text editor or spreadsheet. To edit by hand, copy the English file to one with a name associated with your chosen language, replacing -en with your language code. Then, edit using either a text editor like notepad++, or a spreadsheet program. Edit only the words within the second column. If you want to add a line break, use `\n`.

8.4 The Tests

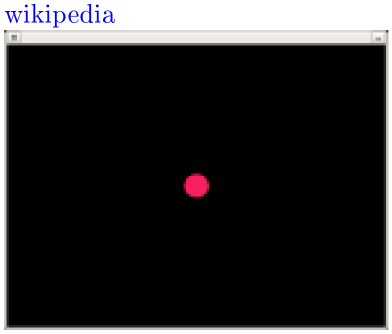
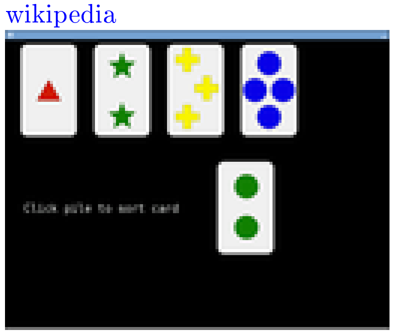
The following table describes the basic tests currently implemented in the PEBL Test Battery. Many of them represent the only Free version of proprietory tests

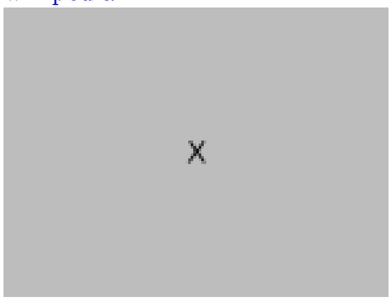
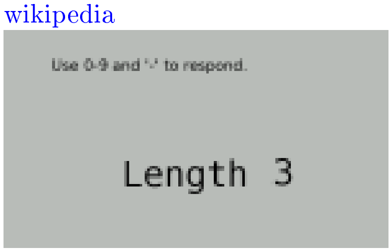
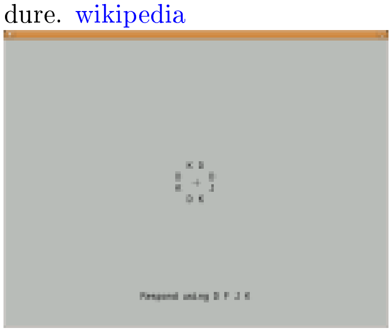
available anywhere. They include a free Iowa Gambling Task, a free version of the TOVA®, a free Wisconsin Card Sort Test®, a free version of Conners Continuous Performance task, and a number of other useful tasks, with more to come. All screenshots found on this page are released into the public domain, and can be used for whatever purpose without copyright assignment, including in academic papers. More information on tests is found in the
PEBL WIKI

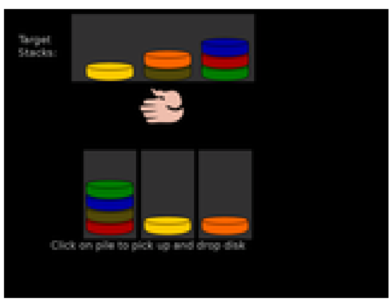
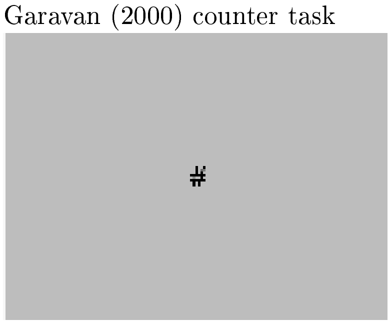
Table 8.1: Test Battery

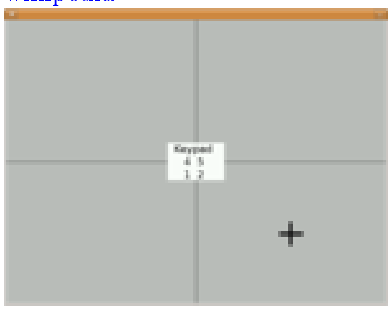
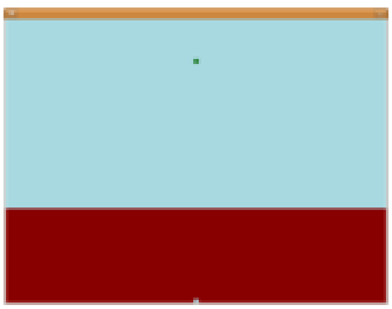
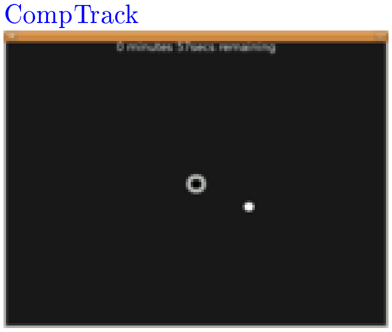
<table>
<tr><th>PEBL Test/Version of:</th><th>Description</th></tr>
<tr><td>Bechera's Gambling Task
(version of Bechara's Iowa Gambling Task ®
wikipedia)
</td><td>Choose from four decks, each choice with a cost and each providing reward. Used for tests of executive control.
Key Skills used: Decision Making, Strategy and Problem Solving, Risk Assessment.
Note: the task requires individuals to decide on which deck to choose from, with the chance of loosing in the process. Test can be modified to ask individual to achieve a certain amount of money.</td></tr>
<tr><td>The "Hungry Donkey" Task
A version of Bechera's Gambling Task for children
</td><td>The donkey chooses from four doors, each door has a cost and reward in apples. Used for tests of executive control.
Key Skills used: Fine-motor skills, Visual processing.
Note: Test can be modified to ask individual to reach a certain number of apples (i.e. 10 apples) in a certain amount of time.</td></tr>
<tr><td>TOAV: Test of Attentional Vigilance
A Version of TOVA®: Test of Variables of Attention
wikipedia
</td><td>22-minute test requiring subject to detect a rare visual stimulus (top or bottom). Used to diagnose ADD, ADHD, etc.

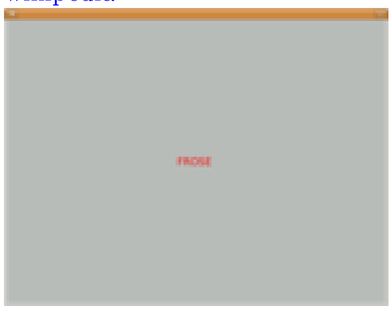
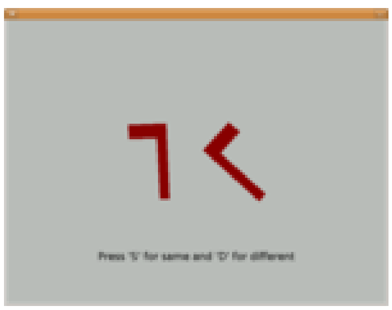
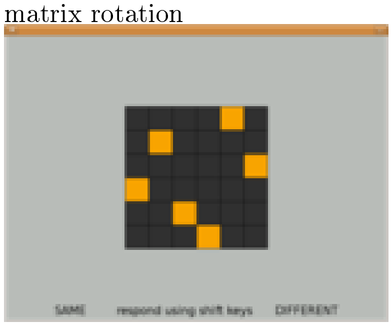
Key Skills used: Concentration, Reaction Time, Attention
Note: This task requires the individual to concentrate for an extended period of time. Thus, the extent to which their reaction time scores alter through the duration of this test can be indicative of how their attention levels have been affected.</td></tr>
</table>

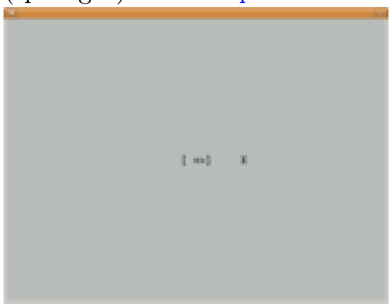
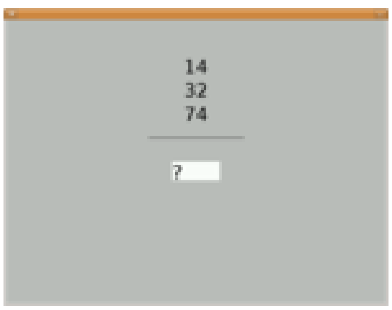
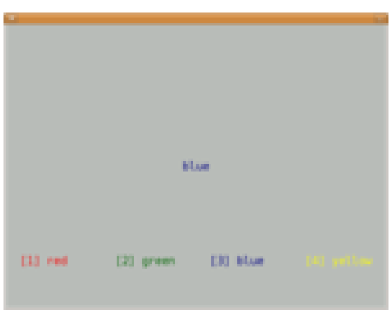
PEBL Test/Version of:	**Description**
PEBL Continuous Performance Test Version of Conners CPT wikipedia 	14-minute vigilance test requiring subject respond to non-matches. Used to diagnose ADD, ADHD, etc. **Key Skills Used:** Reaction Time, Attention, Concentration. **Note:** The test length allows for observation of how their results change overtime (i.e. attention levels altering).
PEBL Perceptual Vigilance Task (PPVT) Wilkinson & Houghton's Psychomotor Vigilance Task wikipedia 	A vigilance task used to detect vigilance and sleep lapses. **Key Skills Used:** Reaction Time, Attention, Concentration. **Note:** The individual's results can be viewed in data section, and we can observe how their performance declines or improves throughout test duration.
Berg's Card Sorting Test version of Berg's (1948) Wisconsin Card Sorting Test wikipedia 	Sort multi-attribute cards into piles according to an unknown and changing rule. **Key Skills used:** Strategy and Problem Solving, Decision Making, Inhibition, Working Memory. **Note:** The results from the data section provide an indication of which rule (shape, color or number) is easiest for the individual via reaction time. We are able to see how the individual's working memory is operating by their ability to recall which rule is active (via correct responses).

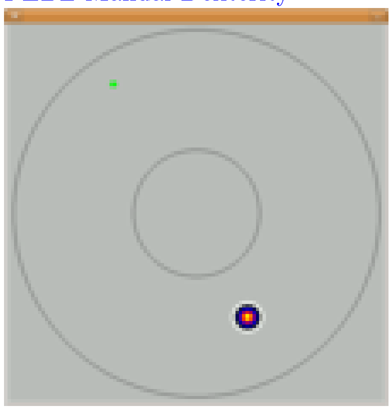
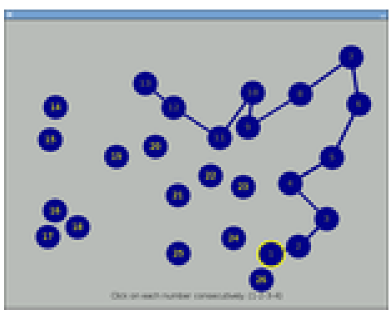
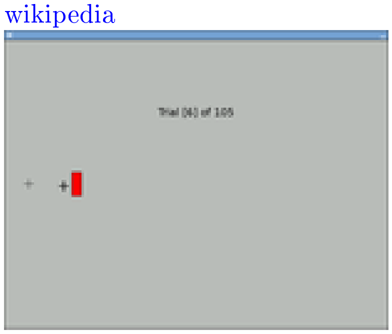
PEBL Test/Version of:	**Description**
Simple Response Time wikipedia  	Detect the presence of a visual stimulus, as quickly and accurately as possible. **Key Skills Used:** Reaction Time, Attention, Fine Motor Skills. **Note:** The task allows for observation of how their attention and reactivity alter throughout the test's duration. The individual can also work on their executive control and fine motor ability.
Digit Span A component of many intelligence tests wikipedia  	Remember a sequence of digits. **Key Skills Used:** Working Memory, Numerical Processing, Short Term Memory. **Note:** Primacy, Recency effects can be observed in this task (i.e. which numbers in the set are being remembered, first numbers or last numbers).
Partial Report Procedure Lu et al.'s (2005) update of Sperling's iconic memory procedure. wikipedia 	May provide an early-warning sign for Alzheimer's. **Key Skills used:** Reaction Time, Decision Making, Working Memory. **Note:** Individuals are required to make quick decision based on a brief stimulus shown. Not recommended for people with slow reaction times.

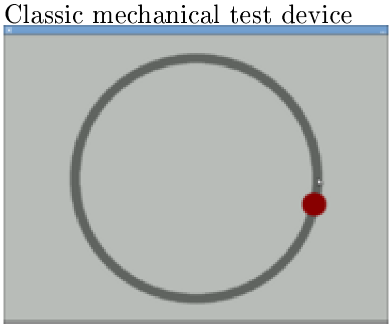
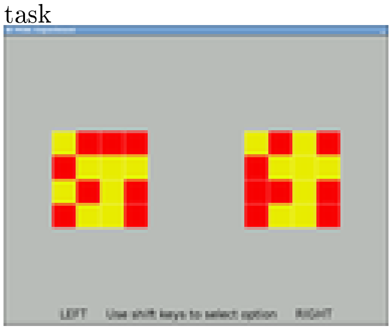
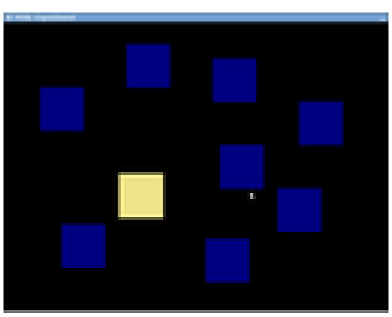
PEBL Test/Version of:	Description
Implicit Association Test A test of automatic associations between memory representations. wikipedia 	Tests association between two sets of binary classifications.
Tower of London Traditional problem solving/planning task wikipedia 	Tests ability to make and follow plans in problem solving task. **Key Skills Used:** Strategy and Problem Solving, Color Processing, Hand-eye coordination, Fine Motor Skills. **Note:** Test cannot be completed successfully for color-blind individuals. Task is great for individuals trying to improve on executive control, and requires both strategy and problem solving skills to complete successfully.
Symbol Counter Task Garavan (2000) counter task 	Useful indicator of executive control. **Key Skills used:** Reaction Time, Working Memory, Selective Attention. **Note:** We can view if the individual will be able to recall which symbols are associated with which shift tab (i.e. a measure of working memory via correct responses).

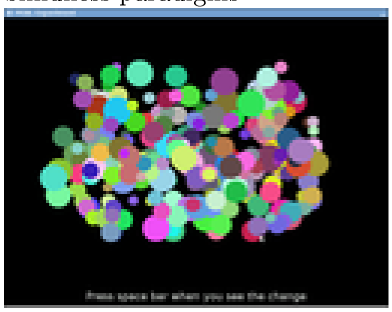
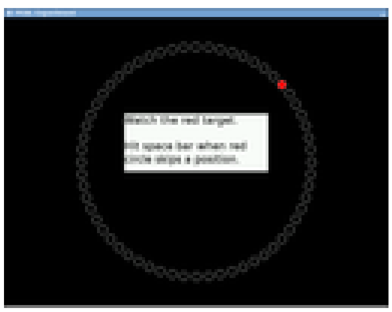
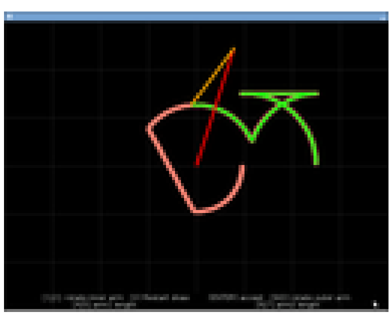
PEBL Test/Version of:	**Description**
Four choice response time Wilkinson & Houghton's 4-choice response time wikipedia 	Respond to a plus sign that appears in one of four corners of the screen. **Key Skills used:** Reaction Time, Selective Attention, Visual Processing. **Note:** the task measures how quickly the individual's attention leads them to the correct location, combining visual processing abilities with reaction time.
Time Wall UTCPAB's Time wall 	Estimate the time when a moving target will reach a location behind a wall. **Key Skills Used:** Reasoning, Calculating, Reaction Time, Strategy and Problem Solving. **Note:** this task requires tracking of an object after its disappearance. It requires the individual to in a sense to imagine the location of this object using precise calculating (of object's speed).
PEBL Compensatory Tracker Similar to Makeig & Jolley's CompTrack 	Use mouse/trackball to keep a randomly moving target inside a bullseye. **Key Skills used:** Fine Motor Skills, Strategy and Problem Solving, Hand Eye Coordination. **Note:** this task can be helpful for individuals wanting to get better with using a mouse for the computer.

PEBL Test/Version of:	**Description**
Lexical Decision Meyer & Schvaneveldt's LDT wikipedia 	Determine whether a stimulus is a word or nonword. **Key skills used:** Linguistic Processing, Language Processing. **Note:** the words are able to be changed for the test. They can be changed to fit closely to an individual's expertise (ex. If individual is aphasic but has an interest in bands, the words can be altered to include words of bands they listen to frequently).
Mental Rotation Shepard's mental rotation task wikipedia 	Determine whether two figures are identical, subject to rotation. **Key Skills used:** Reasoning, Visual Processing, Decision Making. **Note:** while observing both objects, the individual is required to make a decision of whether the objects are similar, and requires precise reasoning due to their similarities (i.e. be able to reason that object on left looks identical to the object on the right, only inverted from the object on the right)
Matrix Rotation Version of UTC test battery matrix rotation 	Determine whether a 6x6 matrix is the same (with rotation) as another. **Key skills used:** Selective Attention, Working Memory, Visual Processing. **Note:** Working Memory is being tested, we can see how individual's object manipulation or 'visuo-spatial sketchpad' is operating (I.e. correct responses being a measure of working memory, and the 'sketchpad' the specific component being measured).

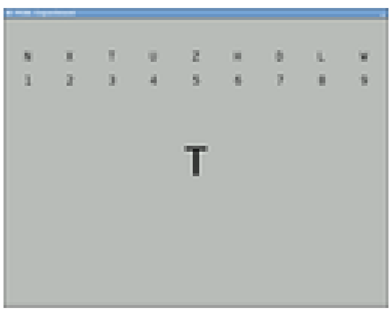
PEBL Test/Version of:	**Description**
Spatial Cueing Posner's attentional cueing (spotlight) task.wikipedia 	Given a probabilistic cue of where a stimulus will appear, respond as fast as possible. **Key Skills used:** Selective Attention, Inhibition. **Note:** this task tests the individual's ability to make the correct response regardless of the correct cue or the distracter cue. We can view how the distracter cue affects the individual via correct responses and reaction time.
Two column addition UTC test battery's 2-column addition. 	Add three two-digit numbers and respond quickly and accurately. **Key Skills Used:** Mathematical Processing, Numerical Processing, Working Memory. **Note:** it is important to distinguish between Mathematical and Numerical, as mathematical processing in this test refers to the manipulation of numerical information, whereas numerical processing refers to the knowledge of numerical information (i.e. the understanding that the number 'one' means '1'.)
Stroop task Stroop's attention task wikipedia 	Respond to either the color or name of stimuli. **Key Skills Used:** Inhibition, Selective Attention. **Note:** Reaction Time is recorded in the data section, allowing for analysis of which trails are easiest, and which are most challenging.

PEBL Test/Version of:	Description
PEBL Manual Dexterity 	Move a noisy cursor to the target. **Key Skills used:** Fine Motor Skills, Strategy and Problem Solving, Hand-eye Coordination. **Note:** This task is helpful for individuals trying to improve their mouse ability with the computer.
PEBL Trail-making test Version of Reitan's (1958) Trail-making A and B tests. wikipedia 	Connect the dots task. **Key Skills used:** Language Processing, Numerical Processing, Hand-eye coordination. **Note:**this task tests both linguistic and numerical processing, and tests the individual's ability to navigate to the correct location (i.e. visual processing).
Aimed Movement (Fitts's Law) test wikipedia 	Mouse-driven implementation of classic perceptual-motor task. **Key Skills used:** Hand-eye coordination, Fine Motor Skills, Concentration. **Note:** The number of trails (105) requires continuous concentration on the participants' behalf.

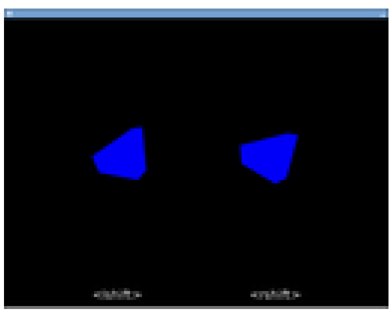
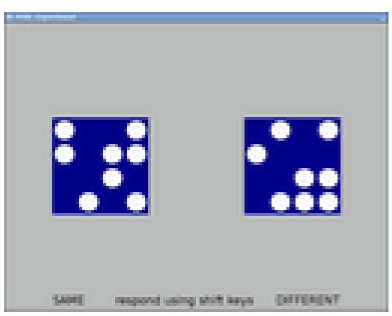
PEBL Test/Version of:	Description
Pursuit Rotor task Classic mechanical test device 	Mouse-driven motor pursuit. **Key Skills used:** Hand –eye coordination, Fine Motor Skills, Strategy and Problem Solving. **Note:** The task requires the individual to adapt to the rate at which the circle is moving, thus requiring incorporation of a calculating strategy to complete successfully.
Match to sample task Classic non-visual short-memory task 	Match a matrix pattern to one presented after a delay. **Key Skills used:** Reasoning, Calculating, Color-processing. **Note:** color-blind individuals will not be as successful in this task.
Corsi block test Version of physical "Corsi block-tapping test" 	Measure of visual-spatial working memory. **Key Skills used:** Working Memory, Visual Processing. **Note:** reaction time can be measured in the trails varying in length.

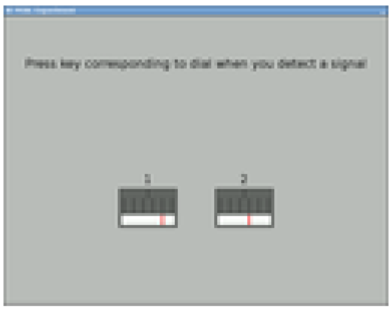
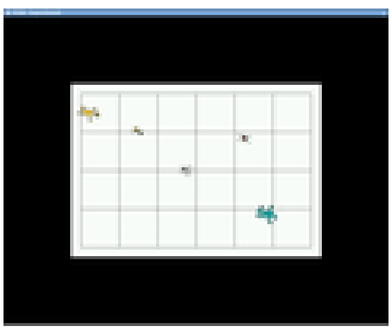
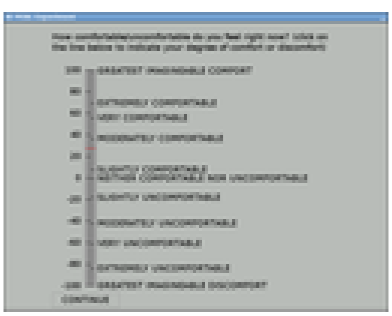
PEBL Test/Version of:	**Description**
Change Detection test Version of numerous change blindness paradigms 	Assess whether participant sees change in a display of colored circles. **Key Skills used:** Selective attention, Visual processing, Concentration. **Note:** the changing object may not be so obvious at first, so additional concentration may be required.
Clock Test Mackworth's Sustained attention test 	Watch a clock, and respond whenever it skips a beat. **Key Skills used:** Selective attention. **Note:** Reaction Time is revealed in the data section, indicating the individual's attention levels as the task progresses.
Device Mimicry Test 	Operate a 4-df etch-a-sketch to recreate paths produced by the computer. **Key Skills used:** Calculating, Hand-eye coordination, concentration, Fine Motor Skills, Strategy and Problem Solving. **Note:** This task requires precision to complete successfully. Test can be very helpful for individual's trying to improve their computer skills, or in cognitive rehabilitation sessions.

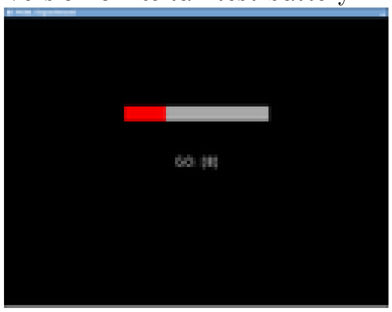
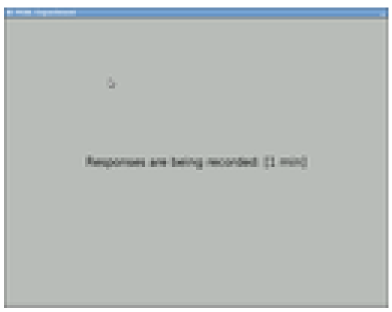
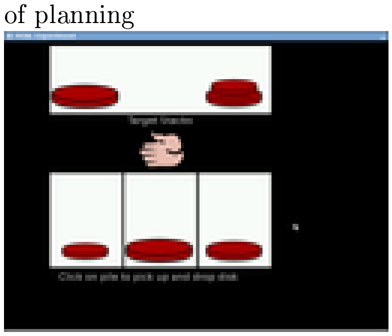
<table>
<tr><th>PEBL Test/Version of:</th><th>Description</th></tr>
<tr><td>Item-Order Test

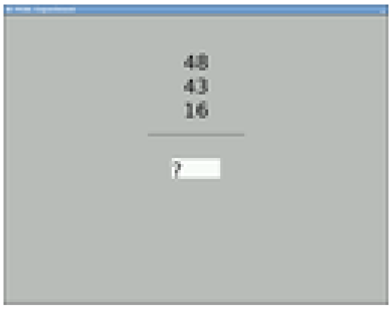
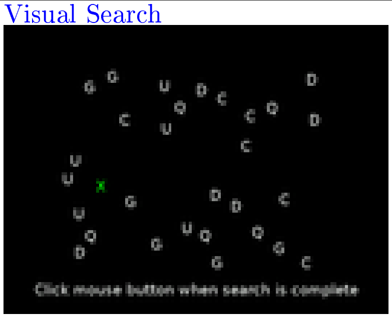
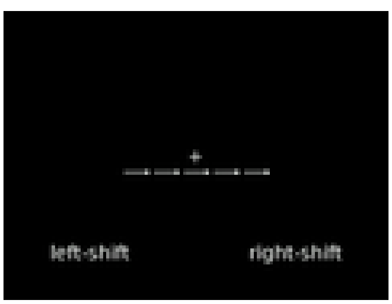
</td><td>Assess two consecutive letter strings, and determine whether they are the same or different. Different trials are creating either by changing identity of a letter or the order of two adjacent letters.
Key Skills used: Language Processing, Working Memory.
Note: Does the duration of the test result in better or poorer performance? This can be measured in the data section.</td></tr>
<tr><td>Letter-Digit substitution
Version of UTCPAB and Wechsler tests

</td><td>Recode stimuli according to a letter-digit code chart.
Key Skills used: Language Processing, Numerical Processing.
Note: great test to use with Aphasiac patients to see how they map language information with mathematical information. Reaction time revealed in data section.</td></tr>
<tr><td>Math Processing

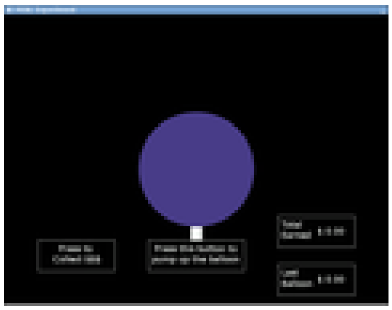
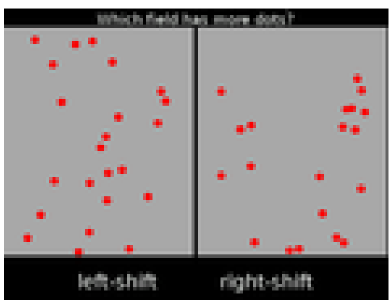
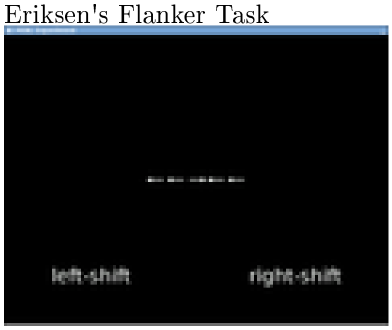
</td><td>Do simple arithmetic problems.
Key Skills used: Mathematical processing, Numerical processing, Reaction Time.
Note: Important to distinguish between mathematical and numerical processes, as the former refers to the manipulation of numerical information, and the latter refers to basic processing of numerical information (i.e. that ‘1’ means ‘one’).</td></tr>
</table>

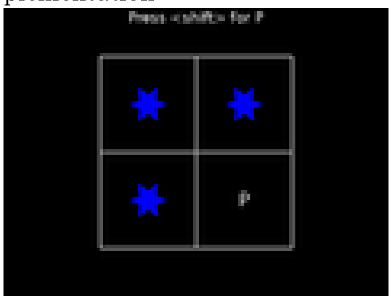
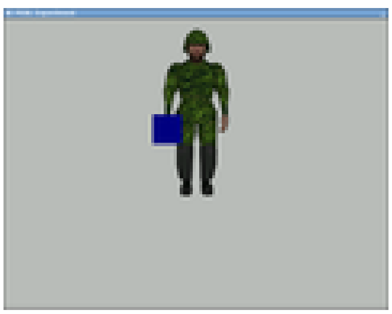
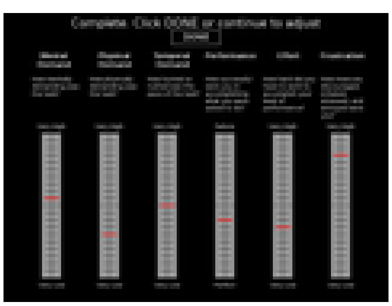
PEBL Test/Version of:	**Description**
Memory Span (Visual) Classic experimental paradigm 	See a sequence of items, then respond using mouse or touchscreen. **Key Skills used:** Working Memory, Short Term Memory, Visual Processing. **Note:** Individuals familiarity with certain objects may result in better recall for those objects (i.e. animal lovers).
Object Judgment 	Determine whether two polygons are identical, while manipulating shape, orientation, size. **Key Skills used:** Calculating, Reasoning, Visual Processing. **Note:** may require concentration due to the duration of task. Task requires visual manipulation of the stimuli presented.
Pattern Comparison Test 	Examine two grid patterns and determine whether they are the same. **Key Skills used:** Calculating, Visual Processing. **Note:** pattern-samediff.pbl requires reaction time (found in data section), while pattern-sequential.pbl requires working memory to function (via correct responses).

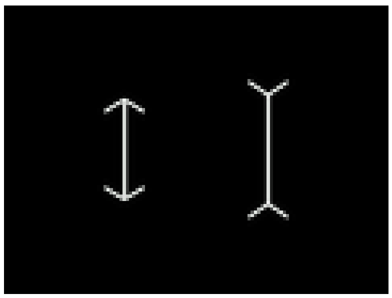
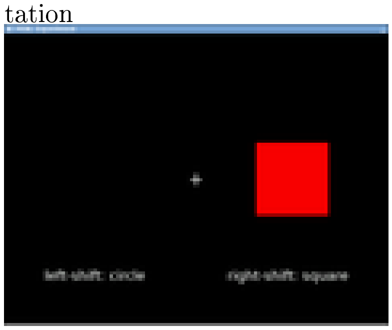
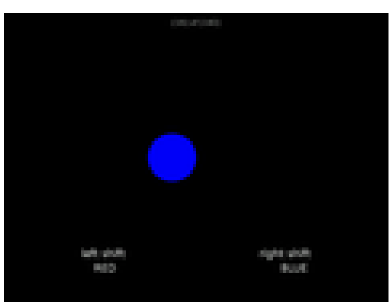
PEBL Test/Version of:	**Description**
Probability Monitor 	Watch a set of gauges to determine when one gets a hit. **Key Skills used:** Calculating, Inhibition, Visual Processing, Reasoning. **Note:** while trying to detect a pattern (calculating and reasoning), the individual is required to inhibit other random dials on later trails (trails 2 and 3). Reaction time is measured in data section.
Situation Awareness Test 	Watch a set of moving targets and respond to probes about their locations and identities. **Key Skills used:** Selective Attention, Working Memory, Visual Processing. **Notes:** Test great for combining visual awareness with working memory.
Comfort scales 	Respond to four visual-analytic scales about different dimensions of comfort. **Key Skills used:** Linguistic Processing, Calculating. **Note:** Allows for extensive self reflection, and requires linguistic ability for responses (to indicate how they feel).

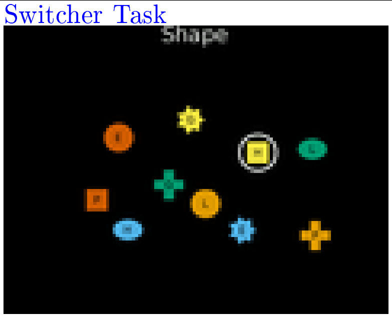
PEBL Test/Version of:	**Description**
Speed tapping test Version of Reitan test battery 	Tap a key as quickly as possible. **Key Skills used:** Fine Motor Skills. **Note:** can be used for individuals in rehabilitation sessions.
Time tapping test 	Tap for a production period at a prespecified pace. **Key Skills used:** Calculating, Working Memory. **Note:** requires individual to recall and implement the pace at which they are required to tap.
Tower of Hanoi test Classic puzzle and cognitive test of planning 	Solve game with disks. **Key Skills used:** Calculating, Reasoning, Hand-eye coordination, Fine Motor Skills, Working Memory, Visual Processing, Strategy and Problem Solving. **Note:** Able to track the individual's number of moves. Task is very great for a multitude of cognitive abilities, and is helpful for patients with cognitive disorders.

PEBL Test/Version of:	Description
Two-column addition 	Do mental arithmetic of at least three two-digit summands. **Key Skills used:** Mathematical Processing, Working Memory, Calculating. **Note:** Individual can be asked how they decided to solve the problems (i.e. with what strategy: first column then the next two columns, or adding all the numbers at once etc.)
Visual Search 	Find the target amidst clutter. **Key Skills used:** Language Processing, Visual Processing, Selective Attention, Colour Processing, Inhibition, Concentration. **Note:** X's and O's are quite distinguishable letters. **O's** look more similar to the other letters than X does, and therefore the trials with X's and O's can be compared to see which ones are easier (via correct response or not) and found quicker (via reaction time).
Attentional Network Task Version of Fan et al.'s ANT 	Assess three types of attention. **Key Skills used:** Selective Attention, Reaction Time, Inhibition. **Note:** The data section reveals trial and the corresponding reaction times. Can be viewed is how their attention processes alter through the test's duration.

PEBL Test/Version of:	Description
PEBL Balloon Analog Risk Task Version of LeJuez et al's BART 	Assess three types of attention. **Key Skills used:** Risk Assessment and risk aversion. **Note:** Test can be modified to ask the participant to reach a certain money value in a set amount of time.
Dot Judgment Task Determine which field has more dots. 	**Key Skills used:** Calculating, Decision Making **Note:** Threshold provides an opportunity to observe how the individual performs (with correct judgment) when dot amounts are similar.
Flanker Task Eriksen's Flanker Task 	Make direction response with distraction. **Key Skills used:** Selective Attention, Reaction Time, Inhibition. **Note:** The data section reveals trial and the corresponding reaction times. Can be viewed is how their attention processes progress through the test's duration.

PEBL Test/Version of:	**Description**
Go/No-go Task Version of Bezdjian's 2009 Implementation 	Classic continuous performance task. **Key Skills used:** Inhibition, Reaction Time, Language Processing, Selective attention. **Note:** The data section allows for observation of their scores, and to view if their inhibition skills are increasing or decreasing with time.
Manikin Task 	Assess mental rotation.
TLX Workload Assessment An implementation of NASA's TLX workload assessment wikipedia 	Assess workload of task on multiple dimensions. **Key Skills used:** Concentration, Linguistic Processing, Calculating. **Note:** requires the individual to self reflect, read the information, and calculate their levels according to the scale provided.

PEBL Test/Version of:	**Description**
Muller-Lyer Illusion Classic perceptual illusion wikipedia 	Psychometric study of Illusion. **Key Skills used:** Calculating, Reaction Time. **Note:** the task requires a quick response, thus attention abilities can be hard to measure in this task.
Oddball Task Version of Huettel's implementation 	Respond to a stimulus dimension overshadowed by irrelevant dimension. **Key Skills used:** Inhibition, Selective Attention, Visual Processing, Reaction Time. **Note:** Inhibition skills require the individual to ignore the location and instead focus on the shape differences.
Simon Task Simon's S-R compatibility test 	Respond to a stimulus dimension, overshadowed by spatial location. **Key Skills used:**Color Processing, Inhibition, Visual Processing, Selective Attention, Reaction Time. **Note:** those who are color blind will have difficulty in completing this task. Individual's inhibition abilities can be measured (via correct responses) to see how well they can focus on the point of the task (color) and not be distracted by its location.

PEBL Test/Version of:	Description
Switcher Task 	Respond to a matched and changing stimulus dimension. **Key Skills used:** Visual Processing, Selective Attention. **Note:** reaction time is measured in the data section, along with trail type. Thus, times associated with color, shape and letter can be measured to see which is easiest and most challenging for the individual.

Norms and Other Uses
Many of the original versions of the tasks we implement here have been normed on a large population. Such norms are available in published articles. Because these implementations are not identical (many of them use slightly different stimuli, response methods, timing, etc.) one must be careful when applying the results to the normed data. If you use PEBL or the PEBL Psychological Test Battery, please reference us! If you are interested in helping develop norms for PEBL tests, have access to subject populations and testing facilities, join the pebl-norms@lists.sourceforge.net mailing list and tell us what norms you are most interested in.

Support and Contact info
If you have any general questions about PEBL or the PEBL Psychological Test Battery, you can contact us at: pebl-list@lists.sourceforge.net. Email support is available free-of-charge. You can sign up for this email list or browse the archives here. More information about the main author is available here. Enquire on the list if you are interested in paying someone to write new experiments or modify existing ones for your needs.

Obtaining the Battery The PEBL Test Battery is installed with the main PEBL installation. The first time you run PEBL, it will be copied into a folder in your Documents directory called pebl-exp.2.0 (or similar depending on the version of PEBL you are running). On Linux, running `> pebl -install` will copy the battery directory there. The PEBL launcher will start in that directory, and let you explore and navigate the different tests in the battery.

http://pebl.sourceforge.net/battery.html

Chapter 9

Detailed Function and Keyword Reference

9.1 Symbols

Name/Symbol: +

Description: Adds two expressions together. Also, concatenates strings together.

Usage:

```
<num1> + <num2>
<string1> + <string2>
<string1> + <num1>
```

Using other types of variables will cause errors.

Example:

```
33 + 322                    --> 355
"Hello" + " " + "World"     --> "Hello World"
"Hello" + 33 + 322.5        --> "Hello355.5"
33 + 322.5 + "Hello"        --> "33322.5Hello"
```

See Also: -, `ToString()`

Name/Symbol: -

Description: Subtracts one expression from another

Usage:

```
<num1> - <num2>
```

Example:

See Also:

Name/Symbol: `/`

Description: Divides one expression by another

Usage: `<expression> / <expression>`

Example: `333 / 10    # == 33.3`

See Also:

Name/Symbol: `*`

Description: Multiplies two expressions together

Usage: `<expression> * <expression>`

Example: `32 * 2 # == 64`

See Also:

Name/Symbol: `^`

Description: Raises one expression to the power of another expression

Usage: `<expression> ^ <expression>`

Example: `25 ^ 2  # == 625`

See Also: `Exp`, `NthRoot`

Name/Symbol: `;`

Description: Finishes a statement, can start new statement on the same line (not needed at end of line)

Usage:

Example:

See Also:

Name/Symbol: `#`

Description: Comment indicator; anything until the next CR following this character is ignored

Usage:

Example:

See Also:

Name/Symbol: `<-`

Description: The assignment operator. Assigns a value to a variable
N.B.: This two-character sequence takes the place of the '=' operator found in many programming languages.

Usage:

Example:

See Also:

Name/Symbol: `( )`

Description: Groups mathematical operations

Usage: `(expression)`

Example: `(3 + 22) * 4  # == 100`

See Also:

Name/Symbol: `{ }`

Description: Groups a series of statements

Usage:
```
{ statement1
  statement2
  statement3
}
```

Example:

See Also:

Name/Symbol: `[ ]`

Description: Creates a list. Closing `]` must be on same line as last element of list, even for nested lists.

Usage:

```
[<item1>, <item2>, ....]
```

Example:

```
[]                      #Creates an empty list
[1,2,3]                 #Simple list
[[3,3,3],[2,2],0]       #creates a nested list structure
```

See Also: `List()`

Name/Symbol: <

Description: Less than. Used to compare two numeric quantities.

Usage:

```
3 < 5
3 < value
```

Example:

```
if(j < 33)
{
  Print ("j is less than 33.")
}
```

See Also: >, >=, <=, ==, ~=, !=, <>

Name/Symbol: >

Description: Greater than. Used to compare two numeric quantities.

Usage:

```
5 > 3
5 > value
```

Example:

```
if(j > 55)
{
 Print ("j is greater than 55.")
}
```

See Also: <, >=, <=, ==, ~=, !=, <>

Name/Symbol: <=

Description: Less than or equal to.

Usage:

```
3<=5
3<=value
```

Example:
```
if(j <= 33)
{
 Print ("j is less than or equal to 33.")
}
```

See Also: `<, >, >=, ==, ~=, !=, <>`

Name/Symbol: `>=`

Description: Greater than or equal to.

Usage:
```
5>=3
5>=value
```

Example:
```
if(j >= 55)
{
 Print ("j is greater than or equal to 55.")
}
```

See Also: `<`, `>`, `<=`, `==`, `~=`, `!=`, `<>`

Name/Symbol: `==`

Description: Equal to.

Usage: `4 == 4`

Example: `2 + 2 == 4`

See Also: `<`, `>`, `>=`, `<=`, `~=`, `!=`, `<>`

Name/Symbol: `<>`, `!=`, `~=`

Description: Not equal to.

Usage:

Example:

See Also: `<`, `>`, `>=`, `<=`, `==`

9.2 A

Name/Symbol: Abs()

Description: Returns the absolute value of the number.

Usage: Abs(<num>)

Example:

```
Abs(-300)   # ==300
Abs(23)     # ==23
```

See Also: Round(), Floor(), AbsFloor(), Sign(), Ceiling()

Name/Symbol: AbsFloor()

Description: Rounds <num> toward 0 to an integer.

Usage: AbsFloor(<num>)

Example:

```
AbsFloor(-332.7)    # == -332
AbsFloor(32.88)     # == 32
```

See Also: Round(), Floor(), Abs(), Sign(), Ceiling()

Name/Symbol: ACos()

Description: Inverse cosine of <num>, in degrees.

Usage: ACos(<num>)

Example:

See Also: Cos(), Sin(), Tan(), ATan(), ATan()

Name/Symbol: AddObject()

Description: Adds a widget to a parent window, at the top of the object stack. Once added, the object will be drawn onto the parent last, meaning it will be on top of anything previously added.

In general, objects can be added to other objects as well as windows. For example, you can add drawing objects (circles, etc.) to an image to annotate the image and maintain its proper x,y coordinates.

Also, if you 're-add' an object that is already on a widget, it will get automatically removed from the window first. This is an easy way to reorder elements on a screen.

```
AddObject(<obj>, <window>)
AddObject(<obj>, <canvas>)
AddObject(<obj>, <widget>)
```

Example:

```
define Start(p)
{
 win <- MakeWindow()
 img <- MakeImage("pebl.png")
 circ <- Circle(20,20,10,MakeColor("red"),1)
 AddObject(circ,img)
 AddObject(img,win)
 Move(img,100,100)
 Draw()
 WaitForAnyKeyPress()
}
```

See Also: `RemoveObject()`

Name/Symbol: `and`

Description: Logical and operator.

Usage: `<expression> and <expression>`

Example:

See Also: `or`, `not`

Name/Symbol: `Append`

Description: Appends an item to a list. Useful for constructing lists in conjunction with the loop statement.

Note: `Append()` is useful, but inefficent for large data structures, because it requires making a copy of the entire data list and then overwriting it, if you use `list <- Append(list, item)`. The overhead will be hardly noticeable unless you are building lists hundreds of elements long. In that case you shuold either create the list upfront and use `SetElement`, or you `PushOnEnd` to modify the list directly.

Usage: `Append(<list>, <item>)`

Example:

```
list <- Sequence(1,5,1)
double  <- []
loop(i, list)
{
 double <- Append(double, [i,i])
}
Print(double)
# Produces [[1,1],[2,2],[3,3],[4,4],[5,5]]
```

See Also: `SetElement()` `List()`, `[ ]`, `Merge()`, `PushOnEnd`

Name/Symbol: `AppendFile`

Description: Appends onto the end of `<file1>` the contents of `<file2>`. Useful for compiling pooled data at the end of an experiment.

Usage: `AppendFile(<file1>, <file2>)`

Example: :

The following open ten consecutive files, writes 50 random numbers to each, then appends each to a master file:

```
 loop(j, Sequence(1,10,1))
   {
    file <- FileOpenWrite(j+".txt")
   loop(i,Sequence(1,50,1))
    {
       FilePrint(file,j+","+i+","+Random())
    }
    AppendFile("master.txt",j+".txt")
  }
```

See Also: `FileOpenWrite()`

Name/Symbol: ASin()

Description: Inverse Sine of <num>, in degrees.

Usage: ASin(<num>)

Example:

See Also: Cos(), Sin(), Tan(), ATan(), ACos(), ATan()

Name/Symbol: ATan

Description: Inverse Tan of <num>, in degrees.

Usage:

Example:

See Also: Cos(), Sin(), Tan(), ATan(), ACos(), ATan()

9.3 B

Name/Symbol: `Bezier`

Description: Creates a smoothed line through the points specified by `<xpoints>`, `<ypoints>`. The lists `<xpoints>` and `<ypoints>` are adjusted by `<x>` and `<y>`, so they should be relative to 0, not the location you want the points to be at.

Like other drawn objects, the bezier must then be added to the window to appear. <steps> denotes how smooth the approximation will be.

Usage:

```
Bezier(<x>,<y>,<xpoints>,<ypoints>,
       <steps>,<color>)
```

Example:

```
win <- MakeWindow()
 #This makes a T
 xpoints <- [-10,10,10,20,20,-20,-20,-10]
 ypoints <- [-20,-20,40,40,50,50,40,40]
p1 <-    Bezier(100,100,xpoints, ypoints,
         5, MakeColor("black"))
AddObject(p1,win)
Draw()
```

See Also: `BlockE()`, `Polygon()`, `MakeStarPoints()`, `MakeNGonPoints()`

Name/Symbol: `BlockE`

Description: Creates a polygon in the shape of a block E, pointing in one of four directions. Arguments include position in window.

- `<x>` and `<y>` is the position of the center
- `<h>` and `<w>` or the size of the E in pixels
- `<thickness>` thickness of the E
- `<direction>` specifies which way the E points: 1=right, 2=down, 3=left, 4=up.
- `<color>` is a color object (not just the name)

Like other drawn objects, the Block E must then be added to the window to appear.

Usage:

```
BlockE(x,y,h,w,thickness,direction,color)
```

Example:

```
win <- MakeWindow()
e1 <- BlockE(100,100,40,80,10,1,MakeColor("black"))
AddObject(e1,win)
Draw()
```

See Also: `Plus()`, `Polygon()`, `MakeStarPoints()`, `MakeNGonPoints()`

Name/Symbol: `break`

Description: Breaks out of a loop immediately.

Usage: break

Example:

```
loop(i ,[1,3,5,9,2,7])
{
 Print(i)
 if(i == 3)
        {
         break
        }
}
```

See Also: `loop`, `return`

9.4 C

Name/Symbol: `Ceiling()`

Description: Rounds `<num>` up to the next integer.

Usage: `Ceiling(<num>)`

Example:
```
Ceiling(33.23)   # == 34
Ceiling(-33.02)  # == -33
```

See Also: `Round()`, `Floor()`, `AbsFloor()`, `Ceiling()`

Name/Symbol: `ChooseN()`

Description: Samples `<number>` items from list, returning a list in the original order. Items are sampled without replacement, so once an item is chosen it will not be chosen again. If `<number>` is larger than the length of the list, the entire list is returned in order. It differs from `SampleN` in that `ChooseN` returns items in the order they appeared in the originial list, but `SampleN` is shuffled.

Usage: `ChooseN(<list>, <n>)`

Example:
```
# Returns 5 numbers
ChooseN([1,1,1,2,2], 5)

# Returns 3 numbers from 1 and 7:
ChooseN([1,2,3,4,5,6,7], 3)
```

See Also: `SampleN()`, `SampleNWithReplacement()`, `Subset()`

Name/Symbol: `Circle()`

Description: Creates a circle for graphing at x,y with radius r. Circles must be added to a parent widget before it can be drawn; it may be added to widgets other than a base window. The properties of circles may be changed by accessing their properties directly, including the FILLED property which makes the object an outline versus a filled shape.

Usage: `Circle(<x>, <y>, <r>,<color>)`

Example:

```
c <- Circle(30,30,20, MakeColor(green))
AddObject(c, win)
Draw()
```

See Also: `Square()`, `Ellipse()`, `Rectangle()`, `Line()`

Name/Symbol: `CheckForNetworkConnection()`

Description: Checks to see if there is an incoming TCP/IP connection on a network that is opened using `OpenNetworkListener`. This is an alternative to the `WaitForNetworkConnection` function that allows more flexibility (and allows updating the during waiting for the connection).

Usage: `net <- CheckForNetwokConnection(network)`

Example:

```
network <-      OpenNetworkListener(4444)
time <- GetTime()
while(not connected and (GetTime() < time + 5000))
 {
    connected <- CheckForNetwokConnection(network)
 }
```

See Also: `OpenNetworkListener()`, `Getdata()`, `WaitForNetworkConnection()`, `CloseNetwork()`

Name/Symbol: `ClearEventLoop()`

Description: Clears the event loop. This function is currently experimental, and its usage may change in future versions of PEBL.

Usage: `USAGE CURRENTLY UNDOCUMENTED`

Example:

See Also: `RegisterEvent()`, `StartEventLoop()`

Name/Symbol: `ClickCheckbox()`

Description: This 'clicks' a checkbox, changing its status (both the visual display and its .status property). Its state can also be set using the `SetCheckBox()` function. The text "ClickCheckBox" is by default bound to the .clickon property of any checkbox, enabling you to handle on a number of graphical object the same (see callfunction example). The [x,y] coordinates are ignored, and so anything can be fed to them, but the standard approach is to use give gClick, which is a global bound to the last click coordinates when WaitForClickOnTarget is used.

Usage:

```
ClickCheckBox(obj, [x,y])
```

Example: The following creates a button, waits for you to click on it, and animates a button press

```
ok <- MakeCheckbox("OK?",400,250,gWin,150)
resp <- WaitForClickOnTarget([ok],[1])
ClickCheckBox(done,gClick)
Draw()
```

You can handle a bunch of objects together using an idiom like this:

```
ok <- MakeCheckbox("OK?",400,250,gWin,150)
ok2 <- MakeCheckbox("Otherwise?",400,280,gWin,150)

checks  <- [ok,ok2]
resp <- WaitForClickOnTarget(checks,[1,2])
 check <- Nth(checks,resp)
CallFunction(check.clickon,[check,gClick])
Draw()
```

Examples of its use can be found in demo
ui.pbl

See Also: `MakeCheckBox()`, `SetCheckBox()`

Name/Symbol: `Clickon()`

Description: Calls the function named by the .clickon property of a custom object. Useful for handling click events of a bunch of different objects. This is essentially the same as CallFunction(obj.clickon, [obj,gClick]).

Usage: `Clickon(obj,[x,y])`

Example:

```
##This overrides buttons placement at the center:
done <- MakeButton("QUIT",400,250,gWin,150)
WaitForClickOnTarget([done],[1])
Clickon(done,gClick)
```

See Also: `Inside()`, `ClickCheckbox` `MoveObject`, `DrawObject`

Name/Symbol: `ClickOnMenu()`

Description: Handles clicking on a menu item. It will call the .clickon property of that item, and then hide the menu.

Usage: `ClickOnMenu(obj,[x,y])`

This function is typically not used directly, but rather it is called via `MakeMenu`. However, it can be used as a quick-and-dirty button.

Example: This creates a menu and awaits clicking on. More complete examples are available in ui.pbl. It requires that MyMessage is created somewhere

```
menu1 <- MakeMenuItem("File",0,0,gWin,14,10,"MYMESSAGE")


menu2<- MakeMenu("Edit",70,0,gWin,14,10, "MYMESSAGE")

menus <- [menu1,menu2]
opt <- WaitForClickOntarget(menu,[1,2])
ClickOnMenu(Nth(menus,opt),gClick)
```

See Also: `MakeMenu()`, `OpenSubMenus()`, `MakeMenuItem`

Name/Symbol: `ClickOnScrollbox()`

Description: Handles a click event on the a `ScrollBox`. This should be called after one checks (e.g., via InsideTB) whether the scrollbox was actually clicked on. It will handle scrolling, moving via the thumb, up/down arrows, and reselection. It is also used to interact with `ScrollingTextBox` objects. This function name is bound to the .clickon property of scrollboxes, so it can be called using CallFunction (see example below).

Usage:

```
ClickOnScrollbox(sb,[x,y])
```

Here, `sb` is the scrollbox object. `[x,y]` is a list of xy coordinates, which can also be the global variable `gClick`

Example: See ui.pbl in the demo directory for examples of the use of a scrolling text box. A brief example follows:

```
sb <- MakeScrollBox(Sequence(1,50,1),"The numbers",40,40,gWin,12,150,5
Draw()

resp <- WaitForClickOntarget([sb],[1])
 ClickOnScrollbox(sb,gClick)

 #Alternately:   CallFunction(sb.clickon,[sb,gClick])


##change the selected items
sb.list <- Sequence(sb.selected,sb.selected+50,1)
UpdateScrollbox(sb)
DrawScrollbox(sb)
Draw()
```

See Also: `MakeScrollingTextBox` `MakeScrollBox` `UpdateScrollBox` `DrawScrollBox`

Name/Symbol: `CloseNetworkConnection()`

Description: Closes network connection

Usage:

```
CloseNetwork(<network>)
```

Example:

```
net <- WaitForNetworkConnection("localhost",1234)
SendData(net,"Watson, come here. I need you.")
CloseNetworkConnection(net)
```

Also see nim.pbl for example of two-way network connection.

See Also: `ConnectToIP`, `ConnectToHost`, `WaitForNetworkConnection`, `GetData`, `SendData`, `ConvertIPString`

Name/Symbol: `ConcatenateList()`

Description: Combines a list together to form a single string. Like ListToString but defaults to a separator of " " (space).

Usage:

```
ConcatenateList(<list>)
ConcatenateList(<list>,"|")
```

Example:

```
ConcatenateList([1,2,3,444])
# == "1 2 3 444"
ConcatenateList(["a","b","c","d","e"],",")
# == "a,b,c,d,e"
```

See Also: SubString, StringLength, FoldList, ModList

Name/Symbol: ConnectToHost()

Description: Connects to a host computer waiting for a connection on <port>, returning a network object that can be used to communicate. Host is a text hostname, like "myname.indiana.edu", or use "localhost" to specify your current computer.

Usage:

```
ConnectToHost(<hostname>,<port>)
```

Example: See nim.pbl for example of two-way network connection.

```
net <- ConnectToHost("localhost",1234)
dat <- GetData(net,20)
Print(dat)
CloseNetworkConnection(net)
```

See Also: ConnectToIP, GetData, WaitForNetworkConnection, SendData, ConvertIPString, CloseNetworkConnection

---

Name/Symbol: ConnectToIP()

Description: Connects to a host computer waiting for a connection on <port>, returning a network object that can be used to communicate. <ip> is a numeric ip address, which must be created with the ConvertIPString(ip) function.

Usage:

```
ConnectToIP(<ip>,<port>)
```

Example: See nim.pbl for example of two-way network connection.

```
ip <- ConvertIPString("192.168.0.1")
net <- ConnectToHost(ip,1234)
dat <- GetData(net,20)
Print(dat)
CloseNetworkConnection(net)
```

See Also: `ConnectToHost`, `GetData`, `WaitForNetworkConnection`, `SendData`, `ConvertIPString`, `CloseNetworkConnection`

Name/Symbol: `ConvertIPString()`

Description: Converts an IP address specified as a string into an integer that can be used by ConnectToIP.

Usage:

```
ConvertIPString(<ip-as-string>)
```

Example: See nim.pbl for example of two-way network connection.

```
ip <- ConvertIPString("192.168.0.1")
net <- ConnectToHost(ip,1234)
dat <- GetData(net,20)
Print(dat)
CloseNetworkConnection(net)
```

See Also: `ConnectToHost`, `ConnectToIP`, `GetData`, `WaitForNetworkConnection`, `SendData`, `CloseNetworkConnection`

Name/Symbol: `ConvexHull()`

Description: Computes the convex hull of a set of [x,y] points. It returns a set of points that forms the convex hull, with the first and last point identical. A convex hull is the set of outermost points, such that a polygon connecting just those points will encompass all other points, and such that no angle is acute. It is used in MakeAttneave.

Usage:

```
ConvexHull(<list-of-x-y-points>)
```

Example:

```
pts <- [[0.579081, 0.0327737],
        [0.0536094, 0.378258],
        [0.239628, 0.187751],
        [0.940625, 0.26526],
        [0.508748, 0.840846],
        [0.352604, 0.200193],
```

```
        [0.38684, 0.212413],
        [0.00114761, 0.768165],
        [0.432963, 0.629412]]
  Print(ConvexHull(pts))
```

output:

```
[[0.940625, 0.26526]
, [0.508748, 0.840846]
, [0.00114761, 0.768165]
, [0.0536094, 0.378258]
, [0.239628, 0.187751]
, [0.579081, 0.0327737]
, [0.940625, 0.26526]
```

See Also: `MakeAttneave`,

Name/Symbol: `CopyFile()`

Description: This makes a copy of a specified file, by Copying the contents of one file to another. This makes the copy byte-by-byte (so should work for binary data). It is probably better to use a systemcall function to make a copy of an entire file at once. This is likely to be slower and possibly error-prone (i.e., permissions and other file properties may not copy.), but it is a useful cross-platform solution to creating a new file based on others. It copies by name from the current working directory.

Usage: `CopyFile(<sourcefilename>,<destfilename>)`

Example:

```
base <- "template.txt"
CopyFile(base,"newfile.txt")
```

See Also: `Format()`, `Tab()`

Name/Symbol: `CopyFromClipboard`

Description: This copies text currently living in the system clipboard. Note that (depending on platform), text copied into the clipboard may not remain there after PEBL exits.

Usage: `CopyFromClipboard()`

Example:
```
text <- CopyFromClipboard()
textbox.text <- text
```

See Also: `CopyToClipboard()`

Name/Symbol: `CopyToClipboard`

Description: Puts text into the the system clipboard, so that it can be accessed either by another program or by the `Copyfromclipboard` function. Note that, possibly depending on platform, text copied into the clipboard by PEBL may not stay there after PEBL exits.

Usage: `CopyToClipboard(<text>)`

Example:
```
text <- GetInput(textbox,"<enter>")
CopyToClipboard(text)
    MessageBox("Text : " + text + " copied to clipboard",gWin)
```

See Also: `CopyFromClipboard()`

Name/Symbol: `Cos()`

Description: Cosine of `<deg>` degrees.

Usage:

Example:
```
Cos(33.5)
Cos(-32)
```

See Also: `Sin()`, `Tan()`, `ATan()`, `ACos()`, `ATan()`

Name/Symbol: `Countdown()`

Description: Displays a 3-2-1 countdown on the screen in with 500 ms ISI. `CountDown` temporarily hides whatever is on the screen. It is useful in orienting participants to the first trial of a task.

The second argument (useBackground) is true (1) by default. In this case, the entire screen will be hidden with a black overlay. If set to 0, this overlay will not be made.

Usage:
```
CountDown(win)
CountDown(win,(optional)useBackground)
```

Example:

```
  win <- MakeWindow()
  MessageBox("Press any key to begin",win)
  CountDown(win)
  Trial()

  CountDown(win,0)
  Trial
```

See Also: `MessageBox`

Name/Symbol: `CR()`

Description: Produces `<number>` linefeeds which can be added to a string and printed or saved to a file. CR is an abbreviation for "Carriage Return".

Usage: `CR(<number>)`

Example:

```
        Print("Number: "  Tab(1) + number  + CR(2))
        Print("We needed space before this line.")
```

See Also: `Format()`, `Tab()`

Name/Symbol: `CrossFactorWithoutDuplicates()`

Description: This function takes a single list, and returns a list of all pairs, excluding the pairs that have two of the same item. To achieve the same effect but include the duplicates, use: `DesignFullCounterBalance(x,x)`.

Usage: `CrossFactorWithoutDuplicates(<list>)`

Example:

```
CrossFactorWithoutDuplicates([a,b,c])
# == [[a,b],[a,c],[b,a],[b,c],[c,a],[c,b]]
```

See Also: `DesignFullCounterBalance()`, `Repeat()`, `DesignBalancedSampling()`, `DesignGrecoLatinSquare()`, `DesignLatinSquare()`, `RepeatList()`, `LatinSquare()`, `Shuffle()`

Name/Symbol: `CumNormInv()`

Description: This function takes a probability and returns the corresponding z-score for the cumulative standard normal distribution. It uses an accurate numerical approximation from: `http://home.online.no/ pjacklam/notes/invnorm`

Usage: `CumNormInv(<p>)`

Example:

```
 Print(CumNormInv(0))    #= NA
  Print(CumNormInv(.01)) #= -2.32634
  Print(CumNormInv(.5))  #= 0
  Print(CumNormInv(.9))  #= 1.28
  Print(CumNormInv(1))   #= NA
```

See Also: `NormalDensity()`, `RandomNormal()`

Name/Symbol: `CumSum()`

Description: Returns the cumulative sum of `<list>`.

Usage: `CumSum(<list>)`

Example:

```
sum <- CumSum([1,2,3,3,4,7])
# == [1,3,6,9,13,20]
```

See Also: `Min()`, `Max()`, `Mean()`, `Median()`, `Quantile()`, `StDev()`

9.5 D

Name/Symbol: `define`

Description: Defines a user-specified function.

Usage:

```
define functionname (parameters)
{
 statement1
 statement2
 statement3
       #Return statement is optional:
 return <value>
}
```

Example: See above.

See Also:

Name/Symbol: `DegToRad()`

Description: Converts degrees to radians.

Usage:

```
DegToRad(<deg>)
```

Example:

```
DegToRad(180) # == 3.14159...
```

See Also: `Cos()`, `Sin()`, `Tan()`, `ATan()`, `ACos()`, `ATan()`

Name/Symbol: `DeleteFile()`

Description: Deletes a file from the file system.

Usage:

```
DeleteFile( <filename>)
```

Example:

```
tmpfile <- FileOpenWrite("tmp.txt")
FilePrint(tmpfile,Random())
FileClose(tmpfile)
text <- FileReadText("tmp.txt")
DeleteFile("tmp.txt")
```

See Also: `GetDirectoryListing()`, `FileExists()`, `IsDirectory()`, `MakeDirectory()`

Name/Symbol: `DesignBalancedSampling()`

Description: Samples elements "roughly" equally. This function returns a list of repeated samples from `<treatment_list>`, such that each element in `<treatment_list>` appears approximately equally. Each element from `<treatment_list>` is sampled once without replacement before all elements are returned to the mix and sampling is repeated. If there are no repeated items in `<list>`, there will be no consecutive repeats in the output. The last repeat-sampling will be truncated so that a `<length>`-size list is returned. If you don't want the repeated epochs this function provides, Shuffle() the results.

Usage: `DesignBalancedSampling(<list>, <length>)`

Example:

```
DesignBalancedSampling([1,2,3,4,5],12)
## e.g., produces something like:
##    [5,3,1,4,2, 3,1,5,2,4, 3,1 ]
```

See Also: `CrossFactorWithoutDuplicates()`, `Shuffle()`, `DesignFullCounterBalance()`, `DesignGrecoLatinSquare()`, `DesignLatinSquare()`, `Repeat()`, `RepeatList()`, `LatinSquare()`

Name/Symbol: `DesignFullCounterbalance()`

Description: This takes two lists as parameters, and returns a nested list of lists that includes the full counterbalancing of both parameter lists. Use cautiously; this gets very large.

Usage: `DesignFullCounterbalance(<lista>, <listb>)`

Example:

```
a <- [1,2,3]
b <- [9,8,7]
DesignFullCounterbalance(a,b)
# == [[1,9],[1,8],[1,7],
#     [2,9],[2,8],[2,7],
#     [3,9],[3,8],[3,7]]
```

See Also: `CrossFactorWithoutDuplicates()`, `LatinSquare()`, `Shuffle()`, `DesignBalancedSampling()`, `DesignGrecoLatinSquare()`, `DesignLatinSquare()`, `Repeat()`, `RepeatList()`,

Name/Symbol: `DesignGrecoLatinSquare()`

Description: This will return a list of lists formed by rotating through each element of the `<treatment_list>`s, making a list containing all element of the list, according to a greco-latin square. All lists must be of the same length.

Usage:
```
DesignGrecoLatinSquare(<factor_list>,
                       <treatment_list>,
                       <treatment_list>)
```

Example:
```
x <- ["a","b","c"]
y <- ["p","q","r"]
z <- ["x","y","z"]
Print(DesignGrecoLatinSquare(x,y,z))
# produces:    [[[a, p, x], [b, q, y], [c, r, z]],
#               [[a, q, z], [b, r, x], [c, p, y]],
#               [[a, r, y], [b, p, z], [c, q, x]]]
```

See Also: `CrossFactorWithoutDuplicates()`, `LatinSquare()`, `DesignFullCounterBalance()`, `DesignBalancedSampling()`, `DesignLatinSquare()`, `Repeat()`, `RepeatList()`, `Shuffle()`

Name/Symbol: `DesignLatinSquare()`

Description: This returns return a list of lists formed by rotating through each element of `<treatment_list>`, making a list containing all element of the list. Has no side effect on input lists.

Usage:
```
DesignLatinSquare(<treatment1_list>,
                  <treatment2_list>)
```

Example:
```
order <- [1,2,3]
treatment <- ["A","B","C"]
design <- DesignLatinSquare(order,treatment)
# produces: [[[1, A], [2, B], [3, C]],
#            [[1, B], [2, C], [3, A]],
#            [[1, C], [2, A], [3, B]]]
```

See Also: `CrossFactorWithoutDuplicates()`, `DesignFullCounterBalance()`, `DesignBalancedSampling()`, `DesignGrecoLatinSquare()`, `Repeat()`, `LatinSquare()` `RepeatList()`, `Shuffle()`, `Rotate()`

Name/Symbol: `Dist()`

Description: Returns Euclidean distance between two points. Each point should be [x,y], and any additional items in the list are ignored.

Usage: `Dist(<xylist1>, <xylist2>)`

Example:
```
p1 <- [0,0]
p2 <- [3,4]
d <- Dist(p1,p2)  #d is 5
```

See Also:

Name/Symbol: `Div()`

Description: Returns round(`<num>/<mod>`)

Usage: `Div(<num>, <mod>)`

Example:

See Also: `Mod()`

Name/Symbol: `Draw()`

Description: Redraws the screen or a specific widget.

Usage:
```
Draw()
Draw(<object>)
```

Example:

See Also: `DrawFor()`, `Show()`, `Hide()`

Name/Symbol: `DrawFor()`

Description: Draws a screen or widget, returning after `<cycles>` refreshes. This function currently does not work as intended in the SDL implementation, because of a lack of control over the refresh blank. It may work in the future.

Usage: `DrawFor( <object>, <cycles>)`

Example:

See Also: `Draw()`, `Show()`, `Hide()`

Name/Symbol: `DrawObject()`

Description: Calls the function named by the .draw property of a custom object. Useful for handling drawing of a bunch of different objects. This is essentially the same as CallFunction(obj.draw, [obj]), but falls back to a normal Draw() command so it handles built-in objects as well.

Usage: `DrawObject(obj)`

Example:

```
##This overrides buttons placement at the center:
done <- MakeButton("QUIT",400,250,gWin,150)
WaitForClickOnTarget([done],[1])
Clickon(done,gClick)
DrawObject(done)
```

See Also: `Inside()`, `ClickOnCheckbox` `MoveObject`, `Draw`

Name/Symbol: `DrawPulldown()`

Description: This handles layout/drawing of a pulldown box. This does not actually call Draw() on the window, and so an additional draw command is needed before the output is displayed. The main use case for this function is if you need to manually change the selected object (by changing .selected). This will redraw the pulldown with the new selection.

Usage: `DrawPullDown(object)`

Example:

```
options  <- MakePulldownButton(["A",B","C"],400,250,gWin,14,100,1)
Draw()
WaitForAnyKeyPress()
options.selected <- 2
DrawPulldown(options)
Draw()
WaitForAnyKeyPress()
```

See Also: `MakePullDown()`, `Pulldown()`, `UpdatePulldown`

Name/Symbol: `DrawScrollbox()`

Description: Redraws a `ScrollBox`. This is called by various internal functions, but should be used to handle redrawing if `UpdateScrollbox` is used. When things like the scrollbar, offset, and selected item change, this can be called directly. If the actual list is changed, `UpdateScrollBox` should be called first. Note that the redrawn scrollbox won't be changed on the screen until a `Draw()` command is issued.

Usage:

```
DrawScrollBox(sb)
```

Here, `sb` is the scrollbox object.

Example: See ui.pbl in the demo directory for examples of the use of a scrolling text box. A brief example follows:

```
sb <- MakeScrollBox(Sequence(1,50,1),"The numbers",40,40,gWin,12,150,5
Draw()

resp <- WaitForClickOntarget([sb],[1])
CallFunction(sb.clickon,[sb,gClick])
#Alternately: ClickOnScrollbox(sb,gClick)

##change the selected items
sb.list <- Sequence(sb.selected,sb.selected+50,1)
UpdateScrollbox(sb)
DrawScrollbox(sb)
Draw()
```

See Also: `MakeScrollingTextBox` `MakeScrollBox` `UpdateScrollBox` `ClickOnScrollBox`

9.6 E

Name/Symbol: `EasyLabel()`

Description: Creates and adds to the window location a label at specified location. Uses standard vera font with grey background. (May in the future get background color from window). Easy-to-use replacement for the `MakeFont`, `MakeLabel`, `AddObject`, `Move`, steps you typically have to go through.

The optional argument fontsize defaults to 16-point. The optional argument fg specifies a color name (e.g., `"red"`) to use, and style specifies the font style, where 0,1,2,3 = normal, italic, bold, bolditalic.

Usage:
```
EasyLabel( <text>,<x>, <y>, <win>, (opt):<fontsize>,
                          (opt):<fg>,(opt):<style>)
```

Example:
```
win <- MakeWindow()
lab <- EasyLabel("What?",200,100,win)
Draw()
lab <- EasyLabel("What?",200,100,win,12)
```

See Also: `EasyTextBox()`, `MakeLabel()`

Name/Symbol: `EasyTextBox()`

Description: Creates and adds to the window location a textbox at specified location. Uses standard vera font with white background. Easy-to-use replacement for the MakeFont,MakeTextBox, AddObject, Move, steps.

The optional arguments fgcolor and bgcolor should specify color names (like white and black). By default, the textbox is created with a foreground of `"black"` and a background of `"white"`.

Usage:
```
EasyTextBox( <text>,<x>, <y>, <win>,
             <fontsize>,<width>,<height>,
             (opt):fgcolor, (opt):bgcolor)
```

Example:

```
win <- MakeWindow()
entry <- EasyTextBox("1 2 3 4 5",200,100,
                     win,12,200,50)
Draw()
entry <- EasyTextBox("1 2 3 4 5",200,100,
                     win,12,200,50,"red","blue")
Draw()
```

See Also: `EasyLabel()`, `MakeTextBox()`

Name/Symbol: `Ellipse()`

Description: Creates a ellipse for graphing at x,y with radii rx and ry. Ellipses are only currently definable oriented in horizontal/vertical directions. Ellipses must be added to a parent widget before it can be drawn; it may be added to widgets other than a base window. The properties of ellipses may be changed by accessing their properties directly, including the FILLED property which makes the object an outline versus a filled shape.

Usage: `Ellipse(<x>, <y>, <rx>, <ry>,<color>)`

Example:

```
e <- Ellipse(30,30,20,10, MakeColor(green))
AddObject(e, win)
Draw()
```

See Also: `Square()`, `Circle()`, `Rectangle()`, `Line()`

Name/Symbol: `EndOfFile()`

Description: Returns true if at the end of a file.

Usage: `EndOfFile(<filestream>)`

Example:

```
while(not EndOfFile(fstream))
{
 Print(FileReadLine(fstream))
}
```

See Also:

Name/Symbol: `EndOfLine()`

Description: Returns true if at end of line.

Usage: `EndOfLine(<filestream>)`

Example:

See Also:

Name/Symbol: `Enquote()`

Description: Surrounds the argument with quotes.

Usage: `Enquote("one two three")`

Example:

```
##use to add quoted text to instructions.
instructions <- "Respond whenever you see an "+
                 Enquote("X")

 ##Use it for saving data that may have spaces:
 resp <-  GetInput(tb, "<enter>")
 FilePrint(fileout, Enquote(resp))
```

See Also: gQuote

Name/Symbol: `ExitQuietly()`

Description: Stops PEBL and prints `<message>` to stderr. Unlike SignalFatalError, it will NOT pop-up a window with the error message. Useful exiting a study or application without causing a popup error message.

Usage: `ExitQuietly(<message>)`

Example:

```
If(response == "exit")
{
       ExitQuietly("Exiting study.")
}
##Prints out error message and
##line/filename of function
```

See Also: `MessageBox`, `Print()`, `SignalFatalError()`

Name/Symbol: `Exp()`

Description: e to the power of <pow>.

Usage: Exp(<pow>)

Example:

```
Exp(0)  # == 1
Exp(3) # == 20.0855
```

See Also: Log()

Name/Symbol: ExtractListItems()

Description: Extracts items from a list, forming a new list. The list <items> are the integers representing the indices that should be extracted.

Usage: ExtractListItems(<list>,<items>)

Example:

```
myList <- Sequence(101, 110, 1)
ExtractListItems(myList, [2,4,5,1,4])
# produces [102, 104, 105, 101, 104]
```

See Also: Subset(), SubList(), SampleN(), Filter()

9.7 F

Name/Symbol: `FileClose()`

Description: Closes a filestream variable. Be sure to pass the variable name, not the filename.

Usage: `FileClose(<filestream>)`

Example:

```
x <- FileOpenRead("file.txt")
# Do relevant stuff here.
FileClose(x)
```

See Also: `FileOpenAppend()`, `FileOpenRead()`, `FileOpenWrite()`

Name/Symbol: `FileExists()`

Description: Checks whether a file exists. Returns 1 if it exists, 0 otherwise.

Usage: `FileExists(<path>)`

Example:

```
filename <- "data-"+gSubNum+".csv"
exists <-  FileExists(filename)
 if(exists)
  {
   MessageBox("Subject file already exists. "+
   " Please try a new one.",gWin)
   SignalFatalError("filename already used")
  }
```

See Also: `GetDirectoryListing()`, `FileExists()`, `IsDirectory()`, `MakeDirectory()`

Name/Symbol: `FileOpenAppend()`

Description: Opens a filename, returning a stream that can be used for writing information. Appends if the file already exists.

Usage: `FileOpenAppend(<filename>)`

Example:

See Also: `FileClose()`, `FileOpenRead()`, `FileOpenWrite()`, `FileOpenOverWrite()`

Name/Symbol: `FileOpenOverwrite()`

Description: Opens a filename, returning a stream that can be used for writing information. Overwrites if file already exists. This function should not be used for opening data files; instead, use FileOpenWrite, which saves to a backup file if the specified file already exists.

Usage: `FileOpenOverWrite(<filename>)`

Example:

See Also: `FileClose()`, `FileOpenAppend()`, `FileOpenRead()` `FileOpenWrite()`

Name/Symbol: `FileOpenRead()`

Description: Opens a filename, returning a stream to be used for reading information.

Usage: `FileOpenRead(<filename>)`

Example:

See Also: `FileClose()`, `FileOpenAppend()`, `FileOpenWrite()`, `FileOpenOverWrite()`

Name/Symbol: `FileOpenWrite()`

Description: Opens a filename, returning a stream that can be used for writing information. If the specified filename exists, it won't overwrite that file. Instead, it will create a related filename, appending a -integer before the filename extension.

Usage: `FileOpenWrite(<filename>)`

Example: In the following example, test.txt gets created with the text "testing 1", and then a second file test-1.txt gets created with the text "testing 2".

```
f1 <- FileOpenWrite("test.txt")
FilePrint(f1,"testing 1")
FileClose(f1)
f2 <- FileOpenWrite("test.txt")
FilePrint(f2,"testing 2")
FileClose(f2)
```

See Also: FileClose(), FileOpenAppend(), FileOpenRead(), FileOpenOverWrite()

Name/Symbol: FilePrint()

Description: Like Print, but to a file. Prints a string to a file, with a carriage return at the end. Returns a copy of the string it prints.

Usage: FilePrint(<filestream>, <value>)

Example: FilePrint(fstream, "Another Line.")

See Also: Print(), FilePrint_()

Name/Symbol: FilePrint_()

Description: Like Print_, but to a file. Prints a string to a file, without appending a newline character. Returns a copy of the string it prints.

Usage: FilePrint_(<filestream>, <value>)

Example: FilePrint_(fstream, "This line doesn't end.")

See Also: Print_(), FilePrint()

Name/Symbol: FilePrintList()

Description: Prints a list to a file, without the ','s or [] characters. Puts a carriage return at the end. Returns a string that was printed. If a list contains other lists, the printing will wrap multiple lines and the internal lists will be printed as normal. To avoid this, try FilePrintList(file,Flatten(list)).

Usage: FilePrintList(<filestream>, <list>)

Example:

```
FilePrintList(fstream, [1,2,3,4,5,5,5])
##
##  Produces:
##1 2 3 4 5 5 5
FilePrintList(fstream,[[1,2],[3,4],[5,6]])
#Produces:
# [1,2]
#,[3,4]
```

```
#,[5,6]

FilePrintList(fstream,Flatten([[1,2],[3,4],[5,6]]))
#Produces:
# 1 2 3 4 5 6
```

See Also: Print(), Print_(), FilePrint(), FilePrint_(), PrintList(),

---

Name/Symbol: FileReadCharacter()

Description: Reads and returns a single character from a filestream.

Usage: FileReadCharacter(<filestream>)

Example:

See Also: FileReadList(), FileReadTable() FileReadLine(), FileReadText(), FileReadWord(),

---

Name/Symbol: FileReadLine()

Description: Reads and returns a line from a file; all characters up until the next newline or the end of the file.

Usage: FileReadLine(<filestream>)

Example:

See Also: FileReadCharacter(),FileReadList(), FileReadTable() FileReadText(), FileReadWord(),

---

Name/Symbol: FileReadList()

Description: Given a filename, will open it, read in all the items into a list (one item per line), and close the file afterward. Ignores blank lines or lines starting with #. Useful with a number of pre-defined data files stored in media/text/. See Section section4.27: Provided Media Files.

Usage: FileReadList(<filename>)

Example: FileReadList("data.txt")

See Also: `FileReadCharacter()`, `FileReadTable()` `FileReadLine()`, `FileReadText()`, `FileReadWord()`,

Name/Symbol: `FileReadTable()`

Description: Reads a table directly from a file. Data in file should separated by spaces. Reads each line onto a sublist, with space-separated tokens as items in sublist. Ignores blank lines or lines beginning with `#`. Optionally, specify a token separator other than space.

Usage: `FileReadTable(<filename>, <optional-separator>)`

Example: `a <- FileReadTable("data.txt")`

See Also: `FileReadCharacter()`,`FileReadList()`, `FileReadLine()`, `FileReadText()`, `FileReadWord()`,

Name/Symbol: `FileReadText()`

Description: Returns all of the text from a file, ignoring any lines beginning with `#`. Opens and closes the file transparently.

Usage: `FileReadText(<filename>)`

Example: `instructions <- FileReadText("instructions.txt")`

See Also: `FileReadCharacter()`,`FileReadList()`, `FileReadTable()` `FileReadLine()`, `FileReadWord()`,

Name/Symbol: `FileReadWord()`

Description: Reads and returns a 'word' from a file; the next connected stream of characters not including a `' '` or a newline. Will not read newline characters.

Usage: `FileReadWord(<filestream>)`

Example:

See Also: `FileReadLine()`, `FileReadTable()`, `FileReadList()` `FileReadCharacter()`,`FileReadList()`, `FileReadTable()` `FileReadLine()`, `FileReadText()`, `FileReadWord()`,

Name/Symbol: `Filter()`

Description: Returns a subset of <list>, depending on whether the <filter> list is zero or nonzero. Both arguments must be lists of the same length.

Usage: Filter(<list>,<filter>)

Example:

```
  x <- [1,2,3,3,2,2,1]
  Print(Filter(x,[1,1,1,0,0,0,0])) ##==[1,2,3]
  Print(Filter(x,Match(x,1)))      ##== [1,1]
```

See Also: Match(), Subset(), Lookup()

Name/Symbol: FindInString()

Description: Finds a token in a string, returning the position (starting at a particular position).

Usage: FindInString(<basestring>,<searchstring>,<startingpos>)

If the string is not found, the value 0 is returned.

Example:

```
FindInString("about","bo",1)  # == 2
FindInString("banana","na",1)  # == 3
FindInString("banana","na",4)  # == 5
```

See Also: SplitString()

Name/Symbol: First()

Description: Returns the first item of a list.

Usage: First(<list>)

Example:

```
First([3,33,132]) # == 3
```

See Also: Nth(), Last()

Name/Symbol: Flatten()

Description: Flattens nested list <list> to a single flat list.

Usage: Flatten(<list>)

Example:

```
Flatten([1,2,[3,4],[5,[6,7],8],[9]])
# == [1,2,3,4,5,6,7,8,9]
Flatten([1,2,[3,4],[5,[6,7],8],[9]])
# == [1,2,3,4,5,6,7,8,9]
```

See Also: FlattenN(), FoldList()

Name/Symbol: FlattenN()

Description: Flattens <n> levels of nested list <list>.

Usage:
```
Flatten(<list>, <n>)
```

Example:
```
Flatten([1,2,[3,4],[5,[6,7],8],[9]],1)
# == [1,2,3,4,5,[6,7],8,9]
```

See Also: Flatten(), FoldList()

Name/Symbol: Floor()

Description: Rounds <num> down to the next integer.

Usage:
```
Floor(<num>)
```

Example:
```
Floor(33.23) # == 33
Floor(3.999)   # ==3
Floor(-32.23)  # == -33
```

See Also: AbsFloor(), Round(), Ceiling()

Name/Symbol: FoldList()

Description: Folds a list into equal-length sublists.

Usage:
```
FoldList(<list>, <size>)
```

Example:
```
FoldList([1,2,3,4,5,6,7,8],2)
# == [[1,2],[3,4],[5,6],[7,8]]
```

See Also: FlattenN(), Flatten()

Name/Symbol: Format()

Description: Formats the printing of values to ensure the proper spacing. It will either truncate or pad <value> with spaces so that it ends up exactly <length> characters long. Character padding is at the end.

Usage:
```
Format(<value>, <length>)
```

Example:

```
x <- 33.23425225
y <- 23.3
Print("["+Format(x,5)+"]")
Print("["+Format(y,5)+"]")
## Output:
## [33.23 ]
## [23.3  ]
```

See Also: `CR()` `Tab()`

9.8 G

Name/Symbol: `GetAngle()`

Description: Gets an angle (in degrees) from (0,0) of an x,y coordinate

Usage: `GetAngle(<x>,<y>)`

Example:

```
##point sprite in the direction of a click
sprite <- LoadImage("car.png")
AddObject(sprite,gWin)
Move(sprite,300,300)
xy <- WaitForDownClick()
newangle <- GetAngle(First(xy)-300,Second(xy)-300)
sprite.rotation <- newangle
Draw()
```

See Also: `DegtoRad`, `RadToDeg`

Name/Symbol: `GetAngle3()`

Description: Gets an angle (in radians) of abc.

Usage: `GetAngle3(<a>,<b>,<c>)`

Example:

```
 a <- [0.579081, 0.0327737]
 b <- [0.0536094, 0.378258]
 c <- [0.239628, 0.187751]

Print(GetAngle3(a,b,c)) ## .2157
```

See Also: `DegtoRad`, `RadToDeg`, `GetAngle`, `ToRight`

Name/Symbol: `GetCurrentScreenResolution()`

Description: Returns an list of [width,height] specifying what the current computer screen resolution is. This is used within the pebl launcher in order to use the current resolution to run the experiment.

Usage: `res <- GetCurrentScreenResolution()`

Example:

```
define Start(p)
{
   ## For testing, let's make the screen resolution a bit smaller than th
   ## current one so that it doesn't get hidden by the bottom task bar
   ##
   res <- GetCurrentScreenResolution()
   gVideoWidth <- First(res)-100
   gVideoHeight <- Second(res)-100
   gWin <- MakeWindow()
   MessageBox("Window slightly smaller than screen",gWin)
}
```

See Also: `GetVideoModes()`

Name/Symbol: `GetCursorPosition()`

Description: Returns an integer specifying where in a textbox the edit cursor is. The value indicates which character it is on.

Usage:

```
GetCursorPosition(<textbox>)
```

Example:

See Also: `SetCursorPosition()`, `MakeTextBox()`, `SetText()`

Name/Symbol: `GetData()`

Description: Gets Data from network connection. Example of usage in demo/nim.pbl.

Usage:

```
val <- GetData(<network>,<size>)
```

Example: On 'server':

```
  net <- WaitForNetworkConnection("localhost",1234)
  SendData(net,"Watson, come here. I need you.")
  value <-  GetData(net,10)
  Print(value)
```

On Client:

```
  net <- ConnectToHost("localhost",1234)
  value <-  GetData(net,20)
  Print(value)
##should print out "Watson, come here. I need you."
```

See Also: `ConnectToIP`, `ConnectToHost`, `WaitForNetworkConnection`, `SendData`, `ConvertIPString`, `CloseNetworkConnection`

Name/Symbol: `GetDirectoryListing()`

Description: Returns a list of files and directories in a particular directory/folder.

Usage: `list <- GetDirectoryListing(<path>)`

Example:

```
files <-  GetDirectoryListing("./")
```

See Also: `GetDirectoryListing()`, `FileExists()`, `IsDirectory()`, `MakeDirectory()`

Name/Symbol: `GetDrivers()`

Description: Gets a list of video drivers on the current platform. This is usually one of opengl, opengles, software, and directx, different ones of which are available on different platforms. This is most useful for building launchers, although it could be used within a script *before* MakeWindow is called to choose the best available driver.

Usage:

```
drivers <- GetDrivers()
```

See Also: `GetCurrentScreenResolution`, `gVideoWidth`, `gVideoHeight`, `GetVideoModes`

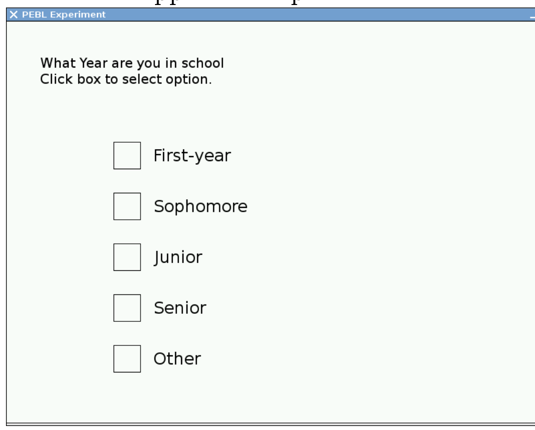
Name/Symbol: `GetEasyChoice()`

Description: Hides what is on the screen and presents a textbox with specified message, and a series of options to select from. Returns element from corresponding position of the `<output>` list.

Usage:

```
GetEasyChoice(<message>,<list-of-choices>,
              <output>,<window>)
```

Example: The code snippet below produces the following screen:

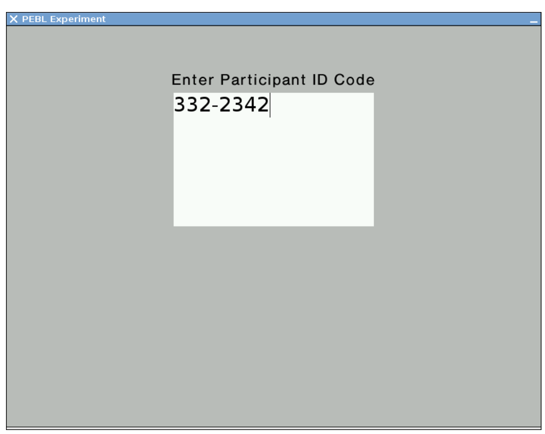



```
gWin <- MakeWindow("white")
inp <-  GetEasyChoice("What Year are you in school",
                      ["First-year","Sophomore",
                      "Junior","Senior","Other"],
                      [1,2,3,4,5],  gWin)
```

See Also: `MessageBox`,`GetEasyChoice`, `EasyTextBox`

Name/Symbol: `GetEasyInput()`

Description: Hides what is on the screen and presents a textbox with specified message, and a second text box to enter input. Continues when 'enter' it hit at the end of text entry.



Usage:

GetEasyInput(<message>,<window>)

Example:

```
gWin <- MakeWindow()
inp <-  GetEasyInput("Enter Participant ID Code",gWin)
```

See Also: MessageBox() GetEasyChoice(), EasyTextBox()

Name/Symbol: GetInput()

Description: Allows user to type input into a textbox.

Usage: GetInput(<textbox>,<escape-key>)

Example:

See Also: SetEditable(), GetCursorPosition(), MakeTextBox(), SetText()

Name/Symbol: GetJoystickAxisState

Description: This gets the state of a particular joystick axis. You need to specify a joystick object, which is created with OpenJoystick(). You also need to specify the axis. You can determine how many axes a joystick has with the GetNumJoystickAxes() function. The function returns a value between 1 and 32768.

Usage: GetJoystickAxisState(js,1)

Example: See joysticktest.pbl in the demo directory

See Also: GetNumJoysticks(), OpenJoystick(), GetNumJoystickAxes() GetNumJoystickBalls(), GetNumJoystickButtons(), GetNumJoystickHats() GetJoystickAxisState(), GetJoystickHatState(), GetJoystickButtonState()

Name/Symbol: GetJoystickButtonState

Description: This gets the state of a particular joystick button. You need to specify a joystick object, which is created with OpenJoystick(). You also need to specify the button. You can determine how many buttons a joystick has with the GetNumJoystickButtons() function. The function returns either 0 (for unpressed) or 1 (for pressed).

Usage: GetJoystickButtonState(js,1)

Example: See joysticktest.pbl in the demo directory

See Also: GetNumJoysticks(), OpenJoystick(), GetNumJoystickAxes() GetNumJoystickBalls(), GetNumJoystickButtons(), GetNumJoystickHats() GetJoystickAxisState(), GetJoystickHatState(), GetJoystickButtonState()

Name/Symbol: `GetJoystickBallState`

Description: Not implemented.

Usage: `GetJoystickBallState(js,1)`

Example: See joysticktest.pbl in the demo directory

See Also: GetNumJoysticks(), OpenJoystick(), GetNumJoystickAxes() GetNumJoystickBalls(), GetNumJoystickButtons(), GetNumJoystickHats() GetJoystickAxisState(), GetJoystickHatState(), GetJoystickButtonState()

Name/Symbol: `GetJoystickHatState`

Description:

Usage: `GetJoystickHatState(js,1)` This gets the state of a particular joystick hat. You need to specify a joystick object, which is created with OpenJoystick(). You also need to specify the hat id. You can determine how many hats a joystick has with the GetNumJoystickHats() function. The function returns a value between 0 and 15, which is the sum of values specifying whether each primary NSEW direction is pressed. The coding is: 0=no buttons; 1=N, 2=E, 4=S, 8=W. Thus, if 1 is returned, the north hat button is pressed. If 3 is returned, NorthEast. If 12 is returned, SW, and so on.

Example: See joysticktest.pbl in the demo directory

See Also: GetNumJoysticks(), OpenJoystick(), GetNumJoystickAxes() GetNumJoystickBalls(), GetNumJoystickButtons(), GetNumJoystickHats() GetJoystickAxisState(), GetJoystickHatState(), GetJoystickButtonState()

Name/Symbol: `GetMouseCursorPosition()`

Description: Gets the current x,y coordinates of the mouse pointer.

Usage: `GetMouseCursorPosition()`

Example:

```
pos <- GetMouseCursorPosition()
```

See Also: `ShowCursor`, `WaitForMouseButton`, `SetMouseCursorPosition`, `GetMouseCursorPosition`

Name/Symbol: `GetMouseState()`

Description: Gets the current x,y coordinates of the mouse pointer, plus the current state of the buttons. Returns a 5-element list, with the first two indicating x,y position, the third is either 0 or 1 depending on if the left mouse is clicked, the fourth 0 or 2 depending on whether the middle mouse is clicked, and the fifth either 0 or 4 depending on whether the right mouse is clicked.

Usage: `GetMouseState()`

Example:

```
define Start(p)
{

  win <- MakeWindow()
  i <- 1
  while(i < 100)
  {
    Draw()
    Print(GetMouseState())

    Wait(100)
    i <- i + 1

  }
##Returns look like:
[417, 276, 0, 0, 0]
[495, 286, 0, 0, 0]
[460, 299, 0, 0, 0]
[428, 217, 0, 0, 0]
[446, 202, 0, 0, 4]
[446, 202, 1, 0, 0]
[446, 202, 1, 0, 0]
[446, 202, 0, 2, 0]
```

See Also: `ShowCursor` `WaitForMouseButton`, `SetMouseCursorPosition`, `GetMouseCursorPosition`

Name/Symbol: `GetNewDataFile()`

Description: Creates a data file for output, asking for either append or renumbering the subject code if the specified file is already in use.

Usage: `GetNewDataFile(subnum,win,basename,extension,header)`

Here, subnum should be a subject code you want to use. win should refer to the window a prompt will be displayed on if the subject code is already in use. basename should be the base filename of the file, and extension should be the . extension (without the dot) at the end of the file. Finally, header is what will be printed on the first row of a file.

When this file is used, a 'data' subdirectory will first be created in the current directory (i.e., the directory where the experiment is). Then, a subdirectory will be created inside data based on the subnum. Spaces and some other characters will be removed to ensure easy and uniform access to this directory. Then, a filename will be created composed of:

```
data\subnum\basename-subnum.extension
```

If this file does not exist, one will be created and the header will be printed to the first line. If it does exist, you will be prompted that the file exists, and at that point you can choose to either append to the existing file (in which case no header will be added), or choose a new subject code (in which case, a new directory will be made). The process can repeat until you either append or choose an unused file.

Multiple files can be made, and they will all appear in the subnum directory. If you get a filename collision, you decision on the first file will carry forward on future files, controlled by a special global variable called gResetNumber.

Note that nearly all of the test battery tests use this function. This can make pooling subject data more difficult, but use the combine data dialog in the launcher to easily combine data from multiple files in multiple subdirectories.

In all situations, the global variable `gSubNum` is set to the resulting subject code (whether or not `gSubNum` is passed to this function). This should only be called at the beginning of an experiment, when the experimenter still has control of the computer, in case a subject code is reused and a decision needs to be made. Finally, the extension chosen has essentially nothing to do with how the internals are formatted; it is up to you

Example:
```
  file1 <- GetNewDataFile("1",gWin,"memorytest","csv",
                   "sub,trial,word,answer,rt,corr")
##above creates a file data\1\memorytest-1.csv

 file2 <- GetNewDataFile("1",gWin,"memorytest","csv",
                   "sub,trial,word,answer,rt,corr")
# above will prompt you for new subject code

 file3 <- GetNewDataFile("1",gWin,"memorytest-report","txt",
                   "")
##No header is needed on a text-based report file.
```

See Also: `FileOpenWrite`, `FileOpenAppend`, `FileOpenOverwrite`

Name/Symbol: `GetNIMHDemographics()`

Description: Gets demographic information that are normally required for NIMH-related research. Currently are gender (M/F/prefer not to say), ethnicity (Hispanic or not), and race (A.I./Alaskan, Asian/A.A., Hawaiian, black/A.A., white/Caucasian, other). It then prints their responses in a single line in the demographics file, along with any special code you supply and a time/date stamp. This code might include a subject number, experiment number, or something else, but many informed consent forms assure the subject that this information cannot be tied back to them or their data, so be careful about what you record. The file output will look something like:

```
----
31,Thu May 12 17:00:35 2011,F,hisp,asian,3331
32,Thu May 12 22:49:10 2011,M,nothisp,amind,3332
----
```

The first column is the user-specified code (in this case, indicating the experiment number). The middle columns indicate date/time, and the last three columns indicate gender (M, F, other), Hispanic (Y/N), and race.

Usage:
```
GetNIMHDemographics(<code-to-print-out>,
                     <window>, <filename>)
```

Example:
```
GetNIMHDemographics("x0413", gwindow,
                    "x0413-demographics.txt")
```

See Also:

Name/Symbol: `GetNumJoystickAxes`

Description: This gets the number of axes on a joystick. You need to specify a joystick object, which is created with OpenJoystick().

Usage: `GetNumJoystickAxes(js,1)`

Example: See joysticktest.pbl in the demo directory

See Also: GetNumJoysticks(), OpenJoystick(), GetNumJoystickAxes() GetNumJoystickBalls(), GetNumJoystickButtons(), GetNumJoystickHats() GetJoystickAxisState(), GetJoystickHatState(), GetJoystickButtonState()

Name/Symbol: `GetNumJoystickBalls`

Description: This gets the number of joystick balls available on a particular joystick. You need to specify a joystick object, which is created with OpenJoystick().

Usage: `GetNumJoystickBalls(js)`

Example: See joysticktest.pbl in the demo directory

See Also: GetNumJoysticks(), OpenJoystick(), GetNumJoystickAxes() GetNumJoystickBalls(), GetNumJoystickButtons(), GetNumJoystickHats() GetJoystickAxisState(), GetJoystickHatState(), GetJoystickButtonState()

Name/Symbol: `GetNumJoystickButtons`

Description: This gets the number of joystick buttons available on a particular joystick. You need to specify a joystick object, which is created with OpenJoystick().

Usage: `GetNumJoystickButtons(js,1)`

Example: See joysticktest.pbl in the demo directory

See Also: GetNumJoysticks(), OpenJoystick(), GetNumJoystickAxes() GetNumJoystickBalls(), GetNumJoystickButtons(), GetNumJoystickHats() GetJoystickAxisState(), GetJoystickHatState(), GetJoystickButtonState()

Name/Symbol: `GetNumJoystickHats`

Description: This gets the number of hats available on a particular joystick. You need to specify a joystick object, which is created with OpenJoystick().

Usage: `GetNumJoystickHats(js,1)`

Example: See joysticktest.pbl in the demo directory

See Also: GetNumJoysticks(), OpenJoystick(), GetNumJoystickAxes() GetNumJoystickBalls(), GetNumJoystickButtons(), GetNumJoystickHats() GetJoystickAxisState(), GetJoystickHatState(), GetJoystickButtonState()

Name/Symbol: `GetNumJoysticks`

Description: This gets the number of joysticks available on a system. It returns an integer, which if greater than you can open a joystick using the OpenJoystick() function..

Usage: `GetNumJoysticks()`

Example: See joysticktest.pbl in the demo directory

See Also: GetNumJoysticks(), OpenJoystick(), GetNumJoystickAxes() GetNumJoystickBalls(), GetNumJoystickButtons(), GetNumJoystickHats() GetJoystickAxisState(), GetJoystickHatState(), GetJoystickButtonState()

Name/Symbol: `GetLineBreaks`

Description: This gets linebreaks for a textbox. It is mainly used internally for text rendering/layout, but could be useful in other contexts.

Usage: `GetLineBreaks(<obj>)`

This will return a list of character positions indicating the actual line breaks, either from wrapping in the textbox, or from explicit newline characters.

Example:

```
gWin <- MakeWindow()
obj <- EasyTextbox("test a b c
 d e f
 g h i j k
 l m n o p q r
 s t u v",30,30,gWin,22, 40,200)
```

```
breaks <- GetLinBreaks(obj)
Print("Number of lines:" + Length(breaks))
```

See Also:

Name/Symbol: `GetParent`

Description: This gets parent of a widget.

Usage: `GetParent(<obj>)`

Example:

```
gWin <- MakeWindow()
obj <- EasyLabel("test",30,30,gWin,22)

## later

win <- GetParent(obj) ##should be gWin
```

See Also:

Name/Symbol: `GetPEBLVersion()`

Description: Returns a string describing which version of PEBL you are running.

Usage: `GetPEBLVersion()`

Example: `Print(GetPEBLVersion())`

See Also: `TimeStamp()`

Name/Symbol: `GetPixelColor()`

Description: Gets a color object specifying the color of a particular pixel on a widget.

Usage: `color <- GetPixelColor(widget,x,y)`

Example:

```
##Judge brightness of a pixel
img <- MakeImage("test.png")
col <- GetPixelColor(img,20,20)
hsv <- RGBtoHSV(col)
Print(Third(hsv))
```

See Also: `SetPixel()`

Name/Symbol: `GetPPortState`

Description: Gets the parallel port state, as a list of 8 'bits' (1s or 0s).

Usage: `out <- SetPPortState(pport)`

Example:

See Also: `COMPortGetByte`, `COMPortSendByte`, `OpenPPort` `OpenCOMPort`, `SetPPortMode`, `GetPPortState`

Name/Symbol: `GetProperty`

Description: Gets a particular named property of an object. This works for custom or built-in objects. If the property does not exist, a fatal error will be signaled, and so you should check using PropertyExists() if there is any chance the property does not exist.

Usage: `out <- GetProperty(obj,property)`

Example:

```
obj <- MakeCustomObject("myobject")
obj.taste <- "buttery"
obj.texture <- "creamy"
SetProperty(obj,"flavor","tasty")

list <- GetPropertyList(obj)
loop(i,list)
 {
   if(PropertyExists(obj,i)
    {
      Print(i  + ":  " + GetProperty(obj,i))
    }
 }
```

See Also: `GetPropertyList`, `PropertyExists`, `SetProperty` `MakeCustomObject`, `PrintProperties`

Name/Symbol: `GetPropertyList`

Description: Gets a list of all of the properties an object has. This works for custom or built-in objects.

Usage: `out <- GetPropertyList(obj)`

Example:

```
  obj <- MakeCustomObject("myobject")
  obj.taste <- "buttery"
  obj.texture <- "creamy"
  SetProperty(obj,"flavor","tasty")

  list <- GetPropertyList(obj)
  loop(i,list)
   {
     if(PropertyExists(obj,i)
      {
        Print(i  + ":  " + GetProperty(obj,i))
      }
   }
```

See Also: `GetProperty`, `PropertyExists`, `SetProperty` `MakeCustomObject`, `PrintProperties`

Name/Symbol: `GetSize()`

Description: Returns a list of `[height, width]`, specifying the size of the widget. The .width and .height properties can also be used instead of this function

Usage: `GetSize(<widget>)`

Example:

```
image <- MakeImage("stim1.bmp")
xy <- GetSize(image)
x <- Nth(xy, 1)
y <- Nth(xy, 2)
```

See Also:

Name/Symbol: `GetSubNum()`

Description: Creates dialog to ask user to input a subject code

Usage: `GetSubNum(<win>)`

Example:

```
## Put this at the beginning of an experiment,
## after a window gWin has been defined.
##
 if(gSubNum == 0)
  {
```

```
    gSubNum <- GetSubNum(gWin)
  }
```

Note: gSubNum can also be set from the command line.

See Also:

Name/Symbol: `GetSystemType()`

Description: Returns a string identify what type of computer system you are using. It will return either: OSX, LINUX, or WINDOWS.

Usage: `GetSystemType()`

Example:

```
## Put this at the beginning of an experiment,
## after a window gWin has been defined.
   if(GetSystemType() == "WINDOWS")
    {
      SignalFatalError("Experiment untested on windows")
    }
```

See Also: `SystemCall()`

Name/Symbol: `GetText()`

Description: Returns the text stored in a text object (either a textbox or a label). The .text properties can also be used instead of this function.

Usage: `GetText(<widget>)`

Example:

See Also: `SetCursorPosition()`, `GetCursorPosition()`, `SetEditable()`, `MakeTextBox()`

Name/Symbol: `GetTextBoxCursorFromClick()`

Description: Returns the position (in characters) corresponding to a x,y click on a text box. The X,Y position must be relative to the x,y position of the box, not absolute. Once obtained, the cursor position can be set with SetCursorPosition().

Usage: `GetTextBoxCursorFromClick(<widget>,<x>,<y>)`

Example:
```
win <- MakeWindow()
tb <- EasyTextBox("Click here to set cursor position"
        ,100,100,win,200,200)
Draw()
WaitForClickOnTarget([tb],[1])
 #get the x and y cursor positions
relx <- First(gClick) - (tb.x )
rely <- Second(gClick) - (tb.y )
tb.cursorpos <- GetTextBoxCursorFromClick(tb,
                                          relx,rely))
Draw()
WaitForAnyKeyPress()
```

See Also: `SetCursorPosition()`, `GetCursorPosition()`, `SetEditable()`, `MakeTextBox()`

Name/Symbol: `GetTime()`

Description: Gets time, in milliseconds, from when PEBL was initialized. Do not use as a seed for the RNG, because it will tend to be about the same on each run. Instead, use `RandomizeTimer()`.

Usage: `GetTime()`

Example:
```
a <- GetTime()
WaitForKeyDown("A")
b <- GetTime()
Print("Response time is: " + (b - a))
```

See Also: `TimeStamp()`

Name/Symbol: `GetVideoModes()`

Description: Gets a list of useable video modes (in width/height pixel pairs), as supplied by the video driver, for a specified screen. Screen is specified as an integer, with 0 being the default screen. If no screen is specified, screen 0 is used.

Usage: `modes <- GetVideoModes()`

Example:
```
Print(GetVideoModes)
##Might return:
[[1440, 900]
, [1360, 768]
, [1152, 864]
, [1024, 768]
```

```
, [960, 600]
, [960, 540]
, [840, 525]
, [832, 624]
, [800, 600]
, [800, 512]
, [720, 450]
, [720, 400]
, [700, 525]
]
```

See Also: `GetCurrentScreenResolution`, `gVideoWidth`, `gVideoHeight`, `GetDrivers`

Name/Symbol: `GetVocalResponseTime`

Description: This is a simple audio amplitude voice key controlled by two parameters *ONLY AVAILABLE ON WINDOWS AND LINUX*.

Usage:

```
GetVocalResponseTime(buffer,
                     timethreshold,
                     energythreshold)
```

This is a simple function that fairly reliably gets an audio response time. It works by recording audio to a buffer, and computing energy for 1-ms bins. When enough bins (whose number/duration is set by timethreshold) in a row surpass an energy threshold (scaled from 0 to 1, set by energythreshold), recording will stop, and the voice key will return. Reasonable values depend on the amount of noise in your microphone, and the types of vocal responses being made. The return time will lag the detection time a bit, and so using the time it takes for the function to return is an unreliable measure of vocal response time.

It returns a list of three elements:

- Response time (in ms),
- End time (using ms counter),
- Responded flag: either 0 or 1, depending on whether the key was tripped,

If the responded flag is 0, the other two numbers will be as well.

See number-stroop.pbl in the stroop directory of the test battery and testaudioin.pbl in demo/ for examples.

Example:

```
buffer <- MakeAudioInputBuffer(5000)
resp0 <-  GetVocalResponseTime(buffer,.35, 200)
SaveAudioToWaveFile("output.wav",buffer)
```

See Also: `MakeAudioInputBuffer()`, `SaveAudioToWaveFile()`,

9.9 H

Name/Symbol: `Hide()`

Description: Makes an object invisible, so it will not be drawn.

Usage: `Hide(<object>)`

Example:

```
window <- MakeWindow()
image1  <- MakeImage("pebl.bmp")
image2  <- MakeImage("pebl.bmp")
AddObject(image1, window)
AddObject(image2, window)
Hide(image1)
Hide(image2)
Draw() # empty screen will be drawn.

Wait(3000)
Show(image2)
Draw() # image2 will appear.

Hide(image2)
Draw() # image2 will disappear.

Wait(1000)
Show(image1)
Draw() # image1 will appear.
```

See Also: `Show()`

9.10 I

Name/Symbol: `if`

Description: Simple conditional test.

Usage:
```
if(test)
{
 statements
 to
 be
 executed
}
```

Example:

See Also:

Name/Symbol: `if...elseif...else`

Description: Complex conditional test. Be careful of spacing the else—if you put carriage returns on either side of it, you will get a syntax error. The `elseif` is optional, but multiple `elseif` statements can be strung together. The `else` is also optional, although only one can appear.

Usage:
```
if(test)
{
 statements if true
} elseif (newtest) {
 statements if newtest true; test false
} else {
 other statements
}
```

Example:
```
 if(3 == 1) {
             Print("ONE")
  }elseif(3==4){
             Print("TWO")
  }elseif(4==4){
             Print("THREE")
  }elseif(4==4){
             Print("FOUR")
  }else{Print("FIVE")}
```

See Also: if

Name/Symbol: `Insert()`

Description: Inserts an element into a list at a specified position, returning the new list. The original list in unchanged.

Usage: `Insert(<[list]>,<item>,<position>)`

Example:

```
x <- [1,2,3,5]
y <- Insert(x,1,4)
##y== [1,2,3,1,5]
```

See Also: `List()`, `Merge`, `Append`

Name/Symbol: `Inside()`

Description: Determines whether an `[x,y]` point is inside another object. Will operate correctly for rectangles, squares, circles, textboxes, images, and labels. For custom objects having a function name bound to their .inside property, it will use that function to test for insideness. `[xylist]` can be a list containing [x,y], and if it is longer the other points will be ignored (such as the list returned by `WaitForMouseButton()`. Returns 1 if inside, 0 if not inside.

Usage: `Inside(<[xylist]>,<object>)`

Example:

```
button <- EasyLabel("Click me to continue", 100,100,gWin,12)

continue <- 1
while(continue)
{
   xy <- WaitForMouseButton()
   continue <- Inside(xy,button)
}
```

See Also: `WaitForMouseButton()`, `GetMouseCursorPosition`, `InsideTB`

Name/Symbol: `InsideTB()`

Description: Determines whether an `[x,y]` point is inside an object having .x, .y, .width, and .height properties, with .x and .y representing the upper left corner of the object. This is bound to the .inside property of many custom ui objects. The `Inside` function will use the function bound to the .inside property for any custom object having that property, and so this function's use is mainly hidden from users.

Usage: `InsideTB([x,y],<obj>)`

Example:

```
pulldown <- MakePulldown(["one","two","three","four"],400-75,300,gWin,

if(InsideTB([300,300],pulldown))
 {
   Print("INSIDE")
  }
```

See Also: `Inside()`, `MoveObject` `ClickOn`, `DrawObject`

Name/Symbol: `IsAnyKeyDown()`

Description:

Usage: `IsAnyKeyDown()`

Example:

See Also:

Name/Symbol: `IsAudioOut()`

Description: Tests whether `<variant>` is a AudioOut stream.

Usage: `IsAudioOut(<variant>)`

Example:

```
if(IsAudioOut(x))
{
 Play(x)
}
```

See Also: `IsColor()`, `IsImage()`, `IsInteger()`, `IsFileStream()`, `IsFloat()`, `IsFont()`, `IsLabel()`, `IsList()`, `IsNumber()`, `IsString()`, `IsTextBox()`, `IsWidget()`

Name/Symbol: `IsCanvas()`

Description: Tests whether `<variant>` is a Canvas widget.

Usage: `IsCanvas(<variant>)`

Example:

```
if(IsCanvas(x)
{
   SetPixel(x,10,10,MakeColor("red"))
}
```

See Also: IsAudioOut(), IsImage(), IsInteger(), IsFileStream(), IsFloat(), IsFont(), IsLabel(), IsList(), IsNumber(), IsString(), IsTextBox(), IsText() IsWidget(), IsWindow()

Name/Symbol: IsColor()

Description: Tests whether <variant> is a Color.

Usage: IsColor(<variant>)

Example:

```
if(IsColor(x)
{
 gWin <- MakeWindow(x)
}
```

See Also: IsAudioOut(), IsImage(), IsInteger(), IsFileStream(), IsFloat(), IsFont(), IsLabel(), IsList(), IsNumber(), IsString(), IsTextBox(), IsWidget(), IsWindow()

Name/Symbol: IsCustomObject()

Description: Tests whether <variant> is a Custom object (created with MakeCustomObject.) Return 1 if so, 0 if not.

Usage: IsCustomObject(<obj>)

Example:

```
if(IsCustomObject(obj)
{
   MoveObject(obj,x,y)
} else {
   Move(obj,x,y)
}
```

See Also: IsAudioOut(), IsImage(), IsInteger(), IsFileStream(), IsFloat(), IsFont(), IsLabel(), IsList(), IsNumber(), IsString(), IsTextBox(), IsText() IsWidget(), IsWindow()

Name/Symbol: IsDirectory()

Description: Determines whether a named path is a directory. Returns 1 if it exists and is a directory, and 0 otherwise.

Usage: IsDirectory(<path>)

Example:
```
filename <- "data-"+gSubNum+".csv"
exists <-  FileExists(filename)
 if(exists)
  {
   out <-    IsDirectory(filename)
   Print(out)
  }
```

See Also: `GetDirectoryListing()`, `FileExists()`, `IsDirectory()`, `MakeDirectory()`

Name/Symbol: `IsImage()`

Description: Tests whether `<variant>` is an Image.

Usage: `IsImage(<variant>)`

Example:
```
if(IsImage(x))
{
 AddObject(gWin, x)
}
```

See Also: `IsAudioOut()`, `IsColor()`, `IsInteger()`, `IsFileStream()`, `IsFloat()`, `IsFont()`, `IsLabel()`, `IsList()`, `IsNumber()`, `IsString()`, `IsTextBox()`, `IsWidget()`

Name/Symbol: `IsInteger()`

Description: Tests whether `<variant>` is an integer type. Note: a number represented internally as a floating-point type whose is an integer will return false. Floating-point numbers can be converted to internally- represented integers with the `ToInteger()` or `Round()` commands.

Usage: `IsInteger(<variant>)`

Example:
```
x <- 44
y <- 23.5
z <- 6.5
test <- x + y + z

IsInteger(x) # true
IsInteger(y) # false
IsInteger(z) # false
IsInteger(test) # false
```

See Also: `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsFileStream()`, `IsFloat()`, `IsFont()`, `IsLabel()`, `IsList()`, `IsNumber()`, `IsString()`, `IsTextBox()`, `IsWidget()`

Name/Symbol: `IsFileStream()`

Description: Tests whether `<variant>` is a FileStream object.

Usage: `IsFileStream(<variant>)`

Example:

```
if(IsFileStream(x))
{
 Print(FileReadWord(x)
}
```

See Also: `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsInteger()`, `IsFloat()`, `IsFont()`, `IsLabel()`, `IsList()`, `IsNumber()`, `IsString()`, `IsTextBox()`, `IsWidget()`

Name/Symbol: `IsFloat()`

Description: Tests whether `<variant>` is a floating-point value. Note that floating-point can represent integers with great precision, so that a number appearing as an integer can still be a float.

Usage: `IsFloat(<variant>)`

Example:

```
x <- 44
y <- 23.5
z <- 6.5
test <- x + y + z

IsFloat(x)      # false
IsFloat(y)      # true
IsFloat(z)      # true
IsFloat(test)   # true
```

See Also: `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsInteger()`, `IsFileStream()`, `IsFont()`, `IsLabel()`, `IsList()`, `IsNumber()`, `IsString()`, `IsTextBox()`, `IsWidget()`

Name/Symbol: `IsFont()`

Description: Tests whether `<variant>` is a Font object.

Usage: `IsFont(<variant>)`

Example:
```
if(IsFont(x))
{
 y <- MakeLabel("stimulus", x)
}
```

See Also: `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsInteger()`, `IsFileStream()`, `IsFloat()`, `IsLabel()`, `IsList()`, `IsNumber()`, `IsString()`, `IsTextBox()`, `IsWidget()`

Name/Symbol: `IsKeyDown()`

Description:

Usage:

Example:

See Also: `IsKeyUp()`

Name/Symbol: `IsKeyUp()`

Description:

Usage:

Example:

See Also: `IsKeyDown()`

Name/Symbol: `IsLabel()`

Description: Tests whether `<variant>` is a text Label object.

Usage: `IsLabel(<variant>)`

Example:
```
if(IsLabel(x)
{
 text <- GetText(x)
}
```

See Also: `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsInteger()`, `IsFileStream()`, `IsFloat()`, `IsFont()`, `IsList()`, `IsNumber()`, `IsString()`, `IsTextBox()`, `IsWidget()`

Name/Symbol: `IsList()`

Description: Tests whether `<variant>` is a PEBL list.

Usage: `IsList(<variant>)`

Example:

```
if(IsList(x))
{
 loop(item, x)
 {
  Print(item)
 }
}
```

See Also: `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsInteger()`, `IsFileStream()`, `IsFloat()`, `IsFont()`, `IsLabel()`, `IsNumber()`, `IsString()`, `IsTextBox()`, `IsWidget()`

Name/Symbol: `IsMember()`

Description: Returns true if `<element>` is a member of `<list>`.

Usage: `IsMember(<element>,<list>)`

Example:

```
IsMember(2,[1,4,6,7,7,7,7]) # false
IsMember(2,[1,4,6,7,2,7,7,7])  # true
```

See Also:

Name/Symbol: `IsNumber()`

Description: Tests whether `<variant>` is a number, either a floating-point or an integer.

Usage: `IsNumber(<variant>)`

Example:

```
if(IsNumber(x))
{
 Print(Sequence(x, x+10, 1))
}
```

See Also: `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsInteger()`, `IsFileStream()`, `IsFloat()`, `IsFont()`, `IsLabel()`, `IsList()`, `IsString()`, `IsTextBox()`, `IsWidget()`

Name/Symbol: `IsShape`

Description: Tests whether `<variant>` is a drawable shape, such as a circle, square rectangle, line, bezier curve, or polygon.

Usage: `IsShape(<variant>)`

Example:

```
if(IsShape(x))
{
  Move(x,300,300)
}
```

See Also: `Square()`, `Circle()`, `Rectangle()`, `Line()`, `Bezier()`, `Polygon()` `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsInteger()`, `IsFileStream()`, `IsFloat()`, `IsFont()`, `IsLabel()`, `IsList()`, `IsNumber()`, `IsString()`, `IsTextBox()`, `IsWindow()`

Name/Symbol: `IsString()`

Description: Tests whether `<variant>` is a text string.

Usage: `IsString(<variant>)`

Example:

```
if(IsString(x))
{
 tb <- MakeTextBox(x, 100, 100)
}
```

See Also: `IsText()` `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsInteger()`, `IsFileStream()`, `IsFloat()`, `IsFont()`, `IsLabel()`, `IsList()`, `IsNumber()`, `IsTextBox()`, `IsWidget()`

Name/Symbol: `IsText()`

Description: Tests whether `<variant>` is a text string. Same as IsString().

Usage: `IsString(<variant>)`

Example:

```
if(IsText(x))
{
 tb <- MakeTextBox(x, 100, 100)
}
```

See Also: `IsString()` `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsInteger()`, `IsFileStream()`, `IsFloat()`, `IsFont()`, `IsLabel()`, `IsList()`, `IsNumber()`, `IsTextBox()`, `IsWidget()`

Name/Symbol: `IsTextBox()`

Description: Tests whether `<variant>` is a TextBox Object

Usage: `IsTextBox(<variant>)`

Example:
```
if(IsTextBox(x))
{
 Print(GetText(x))
}
```

See Also: `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsInteger()`, `IsFileStream()`, `IsFloat()`, `IsFont()`, `IsLabel()`, `IsList()`, `IsNumber()`, `IsString()`, `IsWidget()`

Name/Symbol: `IsWidget`

Description: Tests whether `<variant>` is any kind of a widget object (image, label, or textbox).

Usage: `IsWidget(<variant>)`

Example:
```
if(IsWidget(x))
{
 Move(x, 200,300)
}
```

See Also: `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsInteger()`, `IsFileStream()`, `IsFloat()`, `IsFont()`, `IsLabel()`, `IsList()`, `IsNumber()`, `IsString()`, `IsTextBox()`

Name/Symbol: `IsWindow`

Description: Tests whether `<variant>` is a window.

Usage: `IsWindow(<variant>)`

Example:
```
if(IsWindow(x))
{
  AddObject(y,x)
}
```

See Also: `IsAudioOut()`, `IsColor()`, `IsImage()`, `IsInteger()`, `IsFileStream()`, `IsFloat()`, `IsFont()`, `IsLabel()`, `IsList()`, `IsNumber()`, `IsString()`, `IsTextBox()`

9.11 K

Name/Symbol: `KaniszaPolygon`

Description: Creates generic polygon, defined only by with “pac-man” circles at specified vertices.

Usage:

```
KaniszaPolygon(<xypoints>, <vertices-to-show>,
               <circle-size>, <fgcol>, <bgcol>,
               <show-edge>)
```

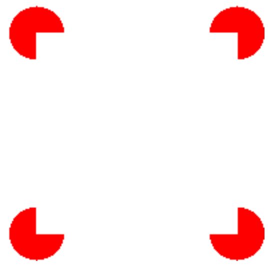
Example: For detailed usage example, see:
`http://peblblog.blogspot.com/2010/11/kanizsa-shapes.html`
Part of a script using KaniszaPolygon:

```
#Specify the xy points
xys <- [[10,10],[10,50],[130,60],[100,100],[150,100],
        [150,20],[80,-10],[45,10]]

 #Specify which vertices to show (do all)
 show <- [1,1,1,1,1,1,1,1]

 #Make one, showing the line
 x <-  KaniszaPolygon(xys,show,10,fg,bg,1)
 AddObject(x,gWin);   Move(x,200,200)

 #Make a second, not showing the line
 x2 <-  KaniszaPolygon(xys,show,10,fg,bg,0)
 AddObject(x2,gWin);   Move(x2,400,200)

 #Make a third, only showing some vertices:
 x3 <-  KaniszaPolygon(xys,[1,1,1,1,1,0,0,1],10,fg,bg,0)
 AddObject(x3,gWin);  Move(x3,600,200)
```

See Also: `Polygon()`, `KaneszaSquare()`

Name/Symbol: `KaniszaSquare`

Description: Creates generic Kanesza Square, one defined only by with "pac-man" circles at its vertices:



Usage:

```
KaniszaSquare(<size>, <circ-rad>,<fgcol>, <bgcol>)
```

KaniszaSquare creates a graphical object that can be added to a window, moved to the proper location, etc. Parameters specify the size of the square, the size of the vertex circles, and the foreground and background colors.

Example: For detailed usage example, see `http://peblblog.blogspot.com/2010/11/kanizsa-shapes.html`

```
gWin <- MakeWindow()
square <- KaniszaSquare(150,20,MakeColor("red"),
                               MakeColor("green"))
AddObject(square,gWin)
Move(square,200,200)
Draw()
WaitForAnyKeyPress()
```

See Also: `Polygon()`, `KaneszaPolygon()`

9.12 L

Name/Symbol: `Last()`

Description: Returns the last item in a list. Provides faster access to the last item of a list than does Nth().

Usage: `Last(<list>)`

Example: `Last([1,2,3,444]) # == 444`

See Also: `Nth()`, `First()`

Name/Symbol: `LatinSquare()`

Description: Quick and dirty latin square, taking on just one list argument.

Usage: `LatinSquare(<list>)`

Example:

```
Print(LatinSquare([11,12,13,14,15,16]))
# Output:
#[[11, 12, 13, 14, 15, 16]
#, [12, 13, 14, 15, 16, 11]
#, [13, 14, 15, 16, 11, 12]
#, [14, 15, 16, 11, 12, 13]
#, [15, 16, 11, 12, 13, 14]
#, [16, 11, 12, 13, 14, 15]
#]
```

See Also: `DesignFullCounterBalance()`, `DesignBalancedSampling()`, `DesignGrecoLatinSquare()`, `DesignLatinSquare()`, `Repeat()`, `RepeatList()`, `Shuffle()`

Name/Symbol: `LaunchFile()`

Description: Launch a specified file or URI with a platform-specific handler.

Usage: `LaunchFile("filename")`

Example: Example uses:

```
#open google:
LaunchFile("http://google.com")
#Open a .pbl file with text editor:
LaunchFile("test.pbl")
#Open a data directory in file manager:
LaunchFile("data\")
```

See Also: `SystemCall()`

Name/Symbol: `LayoutGrid`

Description: Creates a grid of x,y points in a range, that are spaced in a specified number of rows and columns. Furthermore, you can specify whether they are vertical or horizontally laid out.

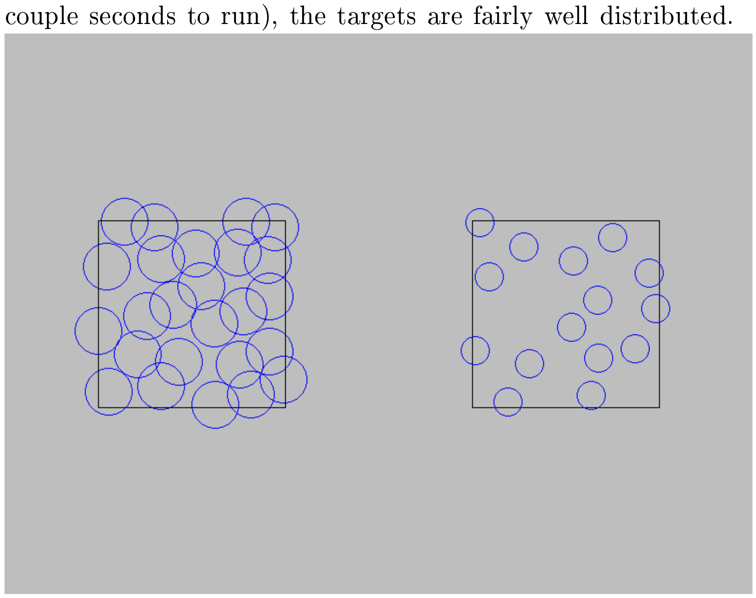
Usage: `LayoutGrid(<xmin>,<xmax>,<ymin>,<ymax>,<culumns>,<rows>,<vertical>)`

Example: Example PEBL Program using NonoverlapLayout:

```
define Start(p)
{
   gWin <- MakeWindow()
   gVideoWidth <- 800
   gVideoHeight <- 300

   lab1 <- EasyLabel("LayoutGrid, horizontal",
                     200,25,gWin,24)
   lab2 <- EasyLabel("LayoutGrid, vertical",
                     600,25,gWin,24)
   nums <- Sequence(1,20,1)
   stim1 <- []
   stim2 <- []

   font <- MakeFont(gPeblBaseFont,0,25,
              MakeColor("black"),MakeColor("white"),0)
   loop(i,nums)
   {
     stim1 <- Append(stim1,MakeLabel(i+"",font))
     stim2 <- Append(stim2,MakeLabel(i+"",font))
    }

  layout1 <- LayoutGrid(50,gVideoWidth/2-50,
                        50,gVideoHeight-50,5,4,0)
  layout2 <- LayoutGrid(gVideoWidth/2+50,gVideoWidth-50,
```

```
                          50,gVideoHeight-50,5,4,1)


  ##Now, layout the stuff.

  loop(i,Transpose([stim1,layout1]))
   {
      obj <- First(i)
      xy <- Second(i)
      AddObject(obj,gWin)
      Move(obj, First(xy),Second(xy))
   }

  loop(i,Transpose([stim2,layout2]))
   {
      obj <- First(i)
      xy <- Second(i)
      AddObject(obj,gWin)
      Move(obj, First(xy),Second(xy))
   }

  Draw()
  WaitForAnyKeyPress()
}
```

The output of the above program is shown below. Even for the left configuration, which is too compact (and which takes a couple seconds to run), the targets are fairly well distributed.



See Also: `NonOverlapLayout()`

Name/Symbol: `Line()`

Description: Creates a line for graphing at x,y ending at x+dx, y+dy. dx and dy describe the size of the line. Lines must be added to a parent widget before it can be drawn; it may be added to widgets other than a base window. Properties of lines may be accessed and set later.

Usage: `Line(<x>, <y>, <dx>, <dy>, <color>)`

Example:

```
l <- Line(30,30,20,20, MakeColor("green")
AddObject(l, win)
Draw()
```

See Also: `Square()`, `Ellipse()`, `Rectangle()`, `Circle()`

Name/Symbol: `List()`

Description: Creates a list of items. Functional version of `[]`.

Usage: `List(<item1>, <item2>, ....)`

Example: `List(1,2,3,444) # == [1,2,3,444]`

See Also: `[ ]`, `Merge()`, `Append()`

Name/Symbol: `ListBy()`

Description: organizes a list into sublists, based on the elements of a second list. It returns a list of two entities: (1) a condition list, describing what values were aggregated across; (2) the nested list elements. The length of each element should be the same.

Together with Match and Filter, ListBy is useful for aggregating data across blocks and conditions for immediate feedback.

Usage: `ListBy(<list>, <conds>)`

Example:

```
a <- Sequence(1,10,1)
    b <- RepeatList([1,2],5)
    x <- ListBy(a,b)
    Print(x)
```

```
#[[1, 2],
#  [[1, 3, 5, 7, 9],
#   [2, 4, 6, 8, 10]]
#]

    Print(ListBy(b,a))
#[[1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
# [[1], [2], [1], [2], [1], [2], [1], [2], [1], [2]]]
```

See Also: `List()`, `[ ]`, `Merge()`, `Append()`

Name/Symbol: `ListToHumanText()`

Description: Converts a list of a text listing of options

Usage:

```
,
  ListToHumanText(<list>,<connector>:"or")
  ListToHumanText(<list>,<connector>)
```

Example:

```
ListToHumanText([1,2,3,444])

"1, 2, 3, or 444"

ListToHumanText(["a","b","c","d","e"],"and")
"a, b, c, d, and e"
```

See Also: `ConcatenateList`, `PrintList`, `ListToString`

Name/Symbol: `ListToString()`

Description: Converts a list of things to a single string

Usage:

```
  ListToString(<list>)
```

Example:

```
ListToString([1,2,3,444]) # == "123444"
ListToString(["a","b","c","d","e"]) # == "abcde"
```

See Also: `SubString`, `StringLength`, `ConcatenateList`

Name/Symbol: `Length()`

Description: Returns the number of items in a list.

Usage: Length(<list>)

Example: Length([1,3,55,1515]) # == 4

See Also: StringLength()

Name/Symbol: Levels()

Description: Returns sorted list of unique elements of a list.

Usage: Levels(<list>)

Example: Levels([1,3,55,1,5,1,5]) # == [1,3,5,55]

See Also: Match(), Filter(), Sort()

Name/Symbol: LoadAudioFile()

Description: Loads an audio file supported by the ffmpeg library. It is nearly identical to LoadMovie(), but only works for audio files (.ogg, .mp3, .wav, .aiff, .wma, et.). It creates a movie object, which can then be played using PlayMovie() or StartPlayback() functions. Currently, only supported on Windows and Linux.

The ffmpeg (http://ffmpeg.org) library supports a wide range of audio formats, including most .wav, .mp3, .ogg, .flac, .aiff, .wma, and others. Currently, there appears to sometimes be playback problems if the audio stream is not stereo, so be sure to convert your audio to stereo. Also, there appears to be some problems with .flac data formats.

If you have problems with playback, you should verify that your media file loads with another ffmpeg media player.

Usage: LoadAudioFile(audiofile)

Example:

```
movie <- LoadAudioFile("instuctions.mp3")
PrintProperties(inst)
PlayMovie(inst)
PausePlayback(insnt)
```

See Also: LoadMovie(), PlayMovie(),StartPlayback() PausePlayback()

Name/Symbol: LoadMovie()

Description: DOES NOT WORK IN PEBL 2.0+

Loads a movie file using the ffmpeg library. It creates a movie object, which can then be played using PlayMovie() or StartPlayback() functions. Currently, only supported on Windows and Linux.

The ffmpeg (`http://ffmpeg.org`) library supports a wide range of video and audio formats, including most .mpg, .avi, .ogg and .mp3 type formats. Audio-only formats should load and play with LoadMovie, but another function, LoadAudioFile(), has been created for these, as they do not need to be added to a window to work.

If you have problems with playback, you should verify that your media file loads with another ffmpeg media player.

For technical reasons, a movie MUST be loaded directly onto a window, and not another widget.

Usage: `LoadMovie(movie,window, width, height)`

Example:

```
movie <- LoadMovie("movie.avi",gWin,640,480)
PrintProperties(movie)
Move(movie,20,20)
Draw()
StartPlayback(movie)
Wait(500) #Play 500 ms of the movie.
PausePlayback(movie)
```

See Also: `LoadAudioFile()`, `LoadMovie()`, `PlayMovie()`,`StartPlayback()` `PausePlayback()`

Name/Symbol: `LoadSound()`

Description: Loads a soundfile from `<filename>`, returning a variable that can be played using the PlayForeground or PlayBackground functions.

`LoadSound` As of PEBL version 2.1, LoadSound will load raw and compressed audio files of various sorts. This includes uncompressed .wav files, .mp3, .ogg, .flac, and .midi files. This is based on the sdl2_mixer library, and so more details about the file formats accepted can be found by examining that library.

Examples of using LoadSound are found in `demo`
`tests`
`testaudio.pbl`

When the file gets loaded, it gets automatically transcoded into a stereo 44100-sampling rate audio stream, regardless of its original playback rate. We have reports that in some cases, this can cause some problems, especially if a mono file gets loaded multiple times in an experiment. If you experience playback problems, try converting your audio to stereo 44100 hz and see if it helps.

Usage: `LoadSound(<filename>)`

Example:

```
woof   <- LoadSound("dog.wav")
PlayBackground(woof)
Wait(200)
Stop(woof)
PlayForeground(woof)
```

See Also: `PlayForeground`, `PlayBackground`, `LoadAudioFile`, `LoadMovie`

Name/Symbol: `Log10()`

Description: Log base 10 of `<num>`.

Usage: `Log10(<num>)`

Example:

See Also: `Log2()`, `LogN()`, `Ln()`, `Exp()`

Name/Symbol: `Log2()`

Description: Log base 2 of `<num>`.

Usage: `Log2(<num>)`

Example:

See Also: `Log()`, `LogN()`, `Ln()`, `Exp()`

Name/Symbol: `LogN()`

Description: Log base `<base>` of `<num>`.

Usage: `LogN(<num>, <base>)`

Example:
```
LogN(100,10) # == 2
LogN(256,2) # == 8
```

See Also: `Log()`, `Log2()`, `Ln()`, `Exp()`

Name/Symbol: `Lowercase()`

Description: Changes a string to lowercase. Useful for testing user input against a stored value, to ensure case differences are not detected.

Usage: `Lowercase(<string>)`

Example: `Lowercase("POtaTo") # == "potato"`

See Also: `Uppercase()`

Name/Symbol: `Ln()`

Description: Natural log of `<num>`.

Usage: `Ln(<num>)`

Example:

See Also: `Log()`, `Log2()`, `LogN()`, `Exp()`

Name/Symbol: `Lookup()`

Description: Returns element in `<database>` corresponding to element of `<keylist>` that matches `<key>`.

If no match exists, Match returns an empty list.

Usage: `Lookup(<key>,<keylist>,<database>)`

Example:
```
 keys     <- [1,2,3,4,5]
 database <- ["market","home","roast beef",
             "none","wee wee wee"]
 Print(Lookup(3,keys,database)))

## Or, do something like this:

data  <- [["punky","brewster"],
          ["arnold","jackson"],
          ["richie","cunningham"],
```

```
          ["alex","keaton"]]

d2 <- Transpose(data)
key <- First(data)

Print(Lookup("alex", key, data))
##Returns ["alex","keaton"]
```

See Also: Match

Name/Symbol: loop()

Description: Loops over elements in a list. During each iteration, <counter> is bound to each consecutive member of <list>. If instead of a list, an integer is given as the second argument, loop will create a list of integers from 1 to that number and loop over them.

Usage:

```
loop(<counter>, <list>)
{
 statements
 to
 be
 executed
}
```

or

```
  loop(<counter>, <number>)
  {
   to-be-executed.
  }
```

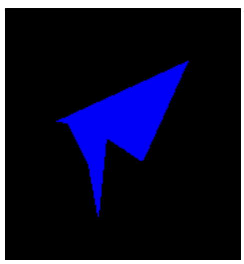
Example:

See Also: while(), { }

9.13 M

Name/Symbol: `MakeAttneave()`

Description: Makes a random 'Attneave' figure[1]. An Attneave figure is a complex polygon that can be used as a stimulus in a number of situations. It returns a sequence of points for use in Polygon().



MakeAttneave uses ConvexHull, InsertAttneavePointRandom() and ValidateAttneaveShape(), found in Graphics.pbl. Override these to change constraints such as minimum/maximum side lengths, angles, complexity, etc.

MakeAttneave uses a sampling-and-rejection scheme to create in-bounds shapes. Thus, if you specify impossible or nearly-impossible constraints, the time necessary to create shapes may be very long or infinite.

The arguments to MakeAttneave are:

- size: size, in pixels, of a circle from which points are sampled in a uniform distribution.
- numpoints: number of points in the polygon.
- minangle: smallest angle acceptable (in degrees).
- maxangle: largest angle acceptable (in degrees).

Usage: `MakeAttneave(size,numpoints,minangle,maxangle)`

[1](Collin, C. A., & Mcmullen, P. A. (2002). Using Matlab to generate families of similar Attneave shapes. Behavior Research Methods Instruments and Computers, 34(1), 55-68.).

Example:

```
gWin <- MakeWindow()
shape <- MakeAttneave(100,5+RandomDiscrete(5),5,170)
pts <- Transpose(shape)
poly <- Polygon(200,200,First(pts),Second(pts),
                MakeColor("blue"),1)
AddObject(poly,gWin)
Draw()
WaitForAnyKeyPress()
```

See Also: `MakeImage()`, `Polygon()`, `Square()`

Name/Symbol: `MakeAudioInputBuffer(<time-in-ms>)`

Description: Creates a sound buffer to use for audio recording or voicekey sound input. It is currently very simple, allowing only to set the duration. By default, it record mono at 44100 hz.

Usage: `MakeAudioInputBuffer(<time-in-ms>)`

See number-stroop.pbl in the stroop directory of the test battery for examples.

Note: Version 0.12 seems to have some trouble specifying buffers of different lengths. 5000 seems to work, but others (3500?) may not.

Example:

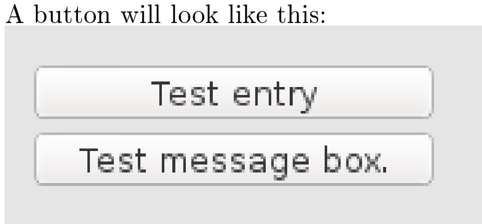
```
buffer <- MakeAudioInputBuffer(5000)
resp0 <-  GetVocalResponseTime(buffer,.35, 200)
SaveAudioToWaveFile("output.wav",buffer)
```

See Also: `GetVocalResponseTime()`, `SaveAudioToWaveFile()`,

Name/Symbol: `MakeButton()`

Description: Creates a button on a window that can be clicked and launches actions. The button is always 20 pixels high (using images in media
images), with a rounded grey background. The label text will be shrunk to fit the width, although this should be avoided as it can look strange. A button is a custom object made from images and text. It has a property 'clickon' that is bound to 'PushButton'

A button will look like this:



Usage:

```
MakeButton(label,x,y,window,width)
```

Example: The following creates a button, waits for you to click on it, and animates a button press

```
done <- MakeButton("QUIT",400,250,gWin,150)
resp <- WaitForClickOntarget([done],[1])
CallFunction(done.clickon,[done,gClick])
```

See Also: `PushButton()`, `MakeCheckBox()`

Name/Symbol: `MakeCanvas()`

Description: Makes a canvas object `<x>` pixels by `y` pixels, in color `<color>`.

A canvas is an object that other objects can be attached to, and imprinted upon. When the canvas gets moved, the attached objects move as well. The background of a canvas can be made invisible by using a color with alpha channel == 0. The Setpixel and SetPoint functions let you change individual pixels on a canvas, to enable adding noise, drawing functional images, etc. A canvas gets 'cleared' by calling ResetCanvas(canvas). Any object added to a canvas creates an 'imprint' on the canvas that remains if the object is moved. This allows you to use another image as a paintbrush on the canvas, and lets you to add noise to text. Because a text label gets re-rendered when its drawn, if you want to add pixel noise to a stimulus, you can create a label, add it to a canvas, then add pixel noise to the canvas.

Usage:

```
MakeCanvas(<x>, <y>, <color>)
```

Example:

```
gWin <- MakeWindow()
clear <- MakeColor("white")
clear.alpha <- 0
#make a transparent canvas:
```

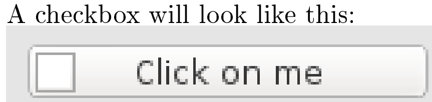
```
x <- MakeCanvas(300,300,clear)
AddObject(x,gWin)
Move(x,300,300)
img <- MakeImage("pebl.png")
AddObject(img,x)
Move(img,100,100)
Draw(x)          #imprint the image on the canvas
Move(img,100,200)
Draw(x)          #imprint the image on the canvas
Hide(img)

#draw a line on the canvas
 i <- 10
 red <- MakeColor("red")
while(i < 200)
 {
   SetPixel(x,20,i,red)
   i <- i + 1
 }
Draw()
WaitForAnyKeyPress()
```

See Also: `MakeImage()`, `SetPixel()`, `MakeGabor()`, `ResetCanvas()`

Name/Symbol: `MakeCheckbox()`

Description: Creates a checkbox on a window that can be clicked and keeps track of its status. The checkbox uses a MakeButton object as its base. The checkbox button is always 20 pixels high (using images in media
images), with a rounded grey background. The label text will be shrunk to fit the width, although this should be avoided as it can look strange. It has a property 'clickon' that is bound to `ClickCheckBox`, which flips its state and updates the graphics. It has a property state which is either 0 or 1, depending on the state of the checkbox. Its initial state is 0. Its state can be set using the `SetCheckBox()` function.

A checkbox will look like this:



Usage: `MakeCheckBox(label,x,y,window,width)`

Example: The following creates a button, waits for you to click on it, and animates a button press

```
ok <- MakeCheckbox("OK?",400,250,gWin,150)
resp <- WaitForClickOnTarget([ok],[1])
CallFunction(done.clickon,[done,gClick])
Draw()
```

Alternately:

```
ok <- MakeCheckbox("OK?",400,250,gWin,150)
resp <- WaitForClickOnTarget([ok],[1])
ClickCheckBox(done,gClick)
Draw()
```

Examples of its use can be found in demo
ui.pbl

See Also: `ClickCheckBox()`, `SetCheckBox()`

Name/Symbol: `MakeColor()`

Description: Makes a color from `<colorname>` such as "red", "green", and nearly 800 others. Color names and corresponding RGB values can be found in `doc/colors.txt`.

Usage: `MakeColor(<colorname>)`

Example:

```
green <- MakeColor("green")
black <- MakeColor("black")
```

See Also: `MakeColorRGB()`, `RGBtoHSV()`

Name/Symbol: `MakeColorRGB()`

Description: Makes an RGB color by specifying `<red>`, `<green>`, and `<blue>` values (between 0 and 255).

Usage: `MakeColorRGB(<red>, <green>, <blue>)`

Example:

See Also: `MakeColor()`, `RGBtoHSV()`

Name/Symbol: `MakeCustomObject`

Description: Creates a 'custom' object that can encapsulate multiple properties. It takes a name as an argument, but this is currently not accessible.

Usage: `obj <- MakeCustomObject("mybutton")`

Example:

```
obj <- MakeCustomObject("myobject")
obj.taste <- "buttery"
obj.texture <- "creamy"
SetProperty(obj,"flavor","tasty")

list <- GetPropertyList(obj)
loop(i,list)
 {
   if(PropertyExists(obj,i)
    {
      Print(i  + ":  " + GetProperty(obj,i))
    }
 }
```

See Also: `GetPropertyList`, `PropertyExists`, `SetProperty` `IsCustomObject`, `PrintProperties` ,`GetProperty`

Name/Symbol: `MakeDirectory()`

Description: Creates a directory with a particular name. It will have no effect of the directory already exists.

Usage: `FileExists(<path>)`

Example:

```
#create data subdirectory + subject-specific directory
MakeDirectory("data")
MakeDirectory("data/"+gsubnum)
filename <- "data/"+gsubnum+"/output.csv"
```

See Also: `GetDirectoryListing()`, `FileExists()`, `IsDirectory()`, `MakeDirectory()`

Name/Symbol: `MakeFont()`

Description: Makes a font. The first argument must be a text name of a font. The font can reside anywhere in PEBL's search path, which would primarily include the media/fonts directory, and the working directory (where the script is saved).

- style changes from normal to bold/underline, italic. 0=normal, 1=underline, 2=italic,3=bolditalic
- fgcolor and bgcolor need to be colors, not just names of colors
- if show-backing is 0, the font gets rendered with an invisible
- background; otherwise with a bgcolor background. (Note: previous to PEBL 0.11, the final argument = 0 rendered the font with non anti-aliased background, which I can see almost no use for.)

Usage:

```
MakeFont(<ttf_filename>, <style>, <size>,
         <fgcolor>, <bgcolor>, <show-backing>)
```

Example:

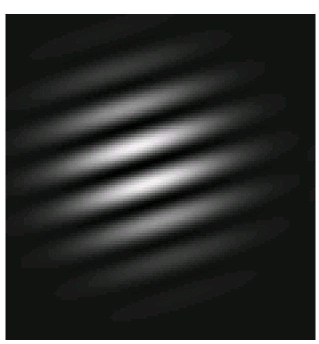
```
font <- MakeFont("Vera.ttf",0,22,MakeColor("black"),
                 MakeColor("white"),1)
```

See Also:

Name/Symbol: `MakeGabor()`

Description: Creates a greyscale gabor patch, with seven variables:

- size (in pixels) of square the patch is drawn on
- freq: frequency of grating (number of wavelengths in size)
- sd: standard deviation, in pixels, of gaussian window
- angle: angle of rotation of grating, in radians
- phase: phase offset of grating (in radians)
- bglev: number between 0 and 255 indicating background color in greyscale.



Usage: `MakeGabor(<size>,<freq>,<sd>, <angle>,<phase>,<bglev>)`

MakeGabor creates a canvas that can be used like any image. It must be added to the window, placed, and drawn to appear. Typically, it can take several seconds to create a patch of any large size, so it is usually best to create the gabor patches when the test is initiatialized, or save and load images using WritePNG().

Typically, a sd roughly 1/4 to 1/10 the size of size is necessary to avoid vignetting.

Example:

```
win <- MakeWindow()
patch <- MakeGabor(80, 0,10,0,0,100)
AddObject(patch,win)
Move(patch,200,200)
Draw()
```

See Also: `MakeAttneave()`, `SetPixel()>`, `MakeCanvas()`

Name/Symbol: `MakeGraph()`

Description: Creates a simple bargraph that can be added to/moved on a window..

Usage:

```
MakeGraph(data,xsize,ysize,x,y)
```

Here, data should be a set of number you want to graph. xsize/ysize is the size of the graph in pixels, and x,y is the x,y coordinate of the center of the graph on the screen.

This creates a custom object that gets returned. In addition, its Move() Draw(), and Add() methods are overridden with the functions MoveGraph(), DrawGraph(), and AddGraph().

See Also:

Name/Symbol: `MakeImage()`

Description: Makes an image widget from an image file. `.bmp` formats should be supported; others may be as well.

Usage:

```
MakeImage(<filename>)
```

Example:

See Also:

Name/Symbol: `MakeLabel()`

Description: Makes a text label for display on-screen. Text will be on a single line, and the `Move()` command centers `<text>` on the specified point.

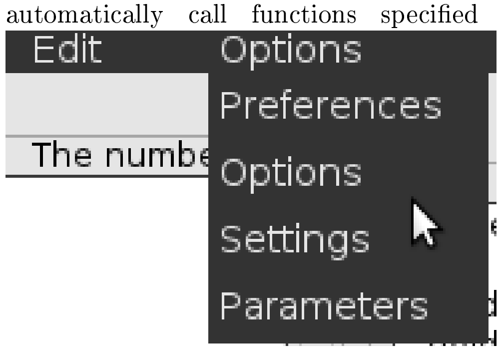
Usage: `MakeLabel(<text>, <font>)`

Example:

See Also:

Name/Symbol: `MakeMenu()`

Description: Creates a menu containing multiple menu items, that automatically call functions specified by the command.



Usage: `MakeMenu(label,x,y,window,fontsize, width, subitems,functions)`

The subitems list should include the names of the menu options. The functions list should be the same length, and contain the function names called when one of those items is used. MakeMenu uses MakeMenuItem to create each on of those items. Menus can only be nested one-deep (no submenus allowed).

Example: This creates a menu and awaits clicking on. More complete examples are available in ui.pbl. It requires that MyMessage is created somewhere

```
menu1 <- MakeMenu("File",0,0,gWin,14,10,
            ["Open","Save","Save as","Quit"],
            ["MYMESSAGE","MYMESSAGE","MYMESSAGE","MYMESSAGE"])
```

```
menu2<- MakeMenu("Edit",70,0,gWin,14,10,
           ["Cut","Copy","Paste","Select"],
           ["MYMESSAGE","MYMESSAGE","MYMESSAGE","MYMESSAGE"])

menu <- [menu1,menu2]
opt <- WaitForClickOntarget(menu,[1,2])
ClickOnMenu(Nth(menu,opt),gClick)
```

See Also: `MakeMenuItem()`, `OpenSubMenus()`, `ClickOnMenu`

Name/Symbol: `MakeMenuItem()`

Description: Creates a single menu containing a label, whose .clickon property is bound to some other function.

Usage: `MakeMenuItem(label,x,y,window,fontsize, width, function)`

This function is typically not used directly, but rather it is called via `MakeMenu`. However, it can be used as a quick-and-dirty button.

Example: This creates a menu and awaits clicking on. More complete examples are available in ui.pbl. It requires that MyMessage is created somewhere

```
menu1 <- MakeMenuItem("File",0,0,gWin,14,10,"MYMESSAGE")


menu2<- MakeMenu("Edit",70,0,gWin,14,10, "MYMESSAGE")

menus <- [menu1,menu2]
opt <- WaitForClickOntarget(menu,[1,2])
ClickOnMenu(Nth(menus,opt),gClick)
```

See Also: `MakeMenu()`, `OpenSubMenus()`, `ClickOnMenu`

Name/Symbol: `MakeNGonPoints()`

Description: Creates a set of points that form a regular n-gon. It can be transformed with functions like `RotatePoints`, or it can be used to create a graphical object with `Polygon`.

Note: `MakeNGonPoints` returns a list like:

```
[[x1, x2, x3,...],[y1,y2,y3,...]],
```

while Polygon() takes the X and Y lists independently.

Usage: `MakeNGonPoints(<radius>, <num_peaks>)`

Example:

```
window <- MakeWindow()
ngonp <- MakeNGonPoints(50,10)
ngon <- Polygon(200,200,First(ngonp),Nth(ngonp,2),
                MakeColor("red"),1)
AddObject(ngon,window)
Draw()
```

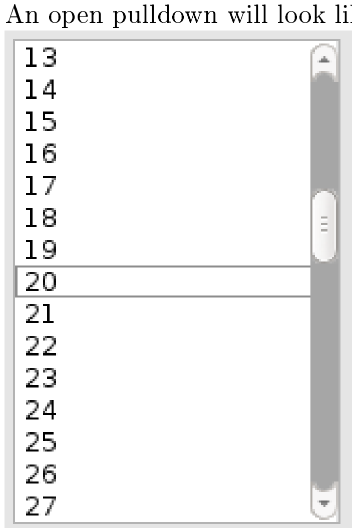
See Also: `MakeStarPoints`, `Polygon`, `RotatePoints`, `ZoomPoints`

Name/Symbol: `MakePulldown()`

Description: Creates a pulldown list that can be used to select an option. The closed version is s always 20 pixels high. When opened, it will be by default 15 rows high, although this is made smaller if the pulldown is close to the bottom of the screen. A button is a custom object made from images and text. It has a property 'clickon' that is bound to 'Pulldown'

A closed pulldown will look like this:

An open pulldown will look like this:



Usage: `MakePulldown(options,x,y,window,fontsize,width,selected)`

The `options` argument is a list of options you want to appear. x and y are the coordinates of the upper left corner, window is the name of the window (or other graphical object) it appears on, fontsize is the size of the font, and width is the width of the pulldown in pixels. The selected argument is the initial selected list item.

Pulldown objects have a property .maxitems, that specify how many elements are displayed. If the list contains more than obj.maxitems, the pulldown will enable scrolling. A pulldown's click-on handler is by default bound to the 'Pulldown' function. When `PullDown(obj,mousexy)` is called, it will pop open the pulldown, allow for a new option to be selected, and return. It returns the index of the selected object, but the selected index can also be accessed using `obj.selected`.

Example: See ui.pbl in the demo directory for examples of the use of pulldowns. Pulldowns are also used within the PEBL launcher for various purposes. A basic example is:

```
options  <- MakePulldownButton(["A",B","C"],
                              400,250,gWin,14,100,1)
resp <- WaitForClickOntarget([options],[1])
CallFunction(options.clickon,[options,gClick])
```

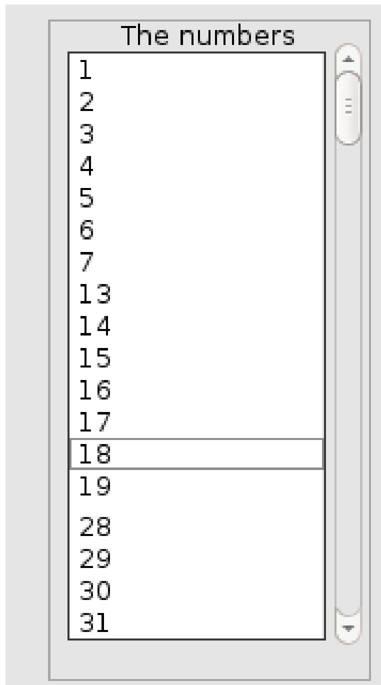
See Also: `PullDown()`, `DrawPulldown()`, `UpdatePulldown`

Name/Symbol: `MakeScrollBox()`

Description: Creates a graphical object that displays and allows selection of a list of items, and scrolls if the text gets too big.

It has a property 'clickon' that is bound to 'ClickOnScrollBox'

A Scrolling textbox looks like this:



Usage: `MakeScrollBox(list,header,x,y,window,fontsize, width,height,selected)`

The `list` argument is a text block you want to display. header is a label. x and y are the coordinates of the upper left corner, window is the name of the window (or other graphical object) it appears on, fontsize is the size of the font, and width and height is the size of the scrollbox in pixels. `selected` indicates which option is selected, and this selection (accessed via .selected) is updated by users using `ClickOnScrollBox`, which is bound to the .clickon property.

Several related function help update and draw a scrollbox. To change the list or selected item, set the .list property to a new list or .selected to new selection and then call `UpdateScrollBox`. The function `DrawScrollbox` to manage redrawing drawing, and `ClickOnScrollBox` to handle interaction (this is bound to the .clickon property). .inside is bound to `InsideTB` A summary of important properties:

- `selected`: which item is selected
- `numitems`: How many items on the list
- `maxoffset`: The most lines that can be displayed

- `list`: the list of options
- `inside`: bound to InsideTB
- `clickon`: bound to ClickOnScrollBox

Example: See ui.pbl in the demo directory for examples of the use of a scrolling text box

```
sb <- MakeScrollBox(Sequence(1,50,1),"The numbers",40,40,gWin,12,150,50

 Draw()
 resp <- WaitForClickOntarget([sb],[1])
 CallFunction(sb.clickon,[sb,gClick])
 #Alternately: ClickOnScrollbox(sb,gClick)
```

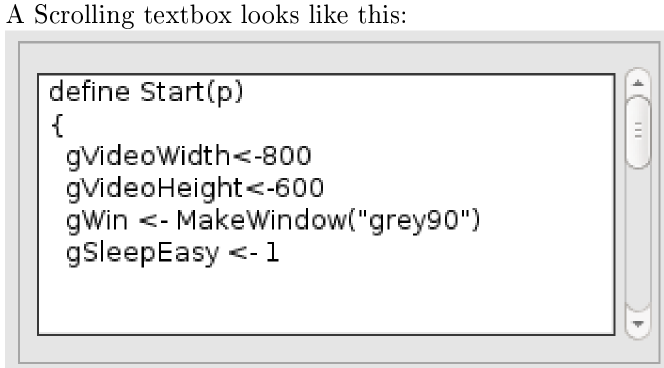
See Also: `SetScrollingText` `MakeScrollingTextBox` `UpdateScrollBox` `DrawScrollBox` `ClickOnScrollBox`

Name/Symbol: `MakeScrollingTextBox()`

Description: Creates a graphical object that displays a block of text, and scrolls if the text gets too big. It uses a `Scrollbox` as its base, but handles parsing the text into lines and hides the selection box. Thus, no 'selection' is displayed (although it actually exists), and a .text property is added to hold the text being displayed.

It has a property 'clickon' that is bound to 'ClickOnScrollBox'

A Scrolling textbox looks like this:



Usage:

```
MakeScrollingTextBox(text,x,y,window,fontsize,
                               width,height,linewrap)
```

The `text` argument is a text block you want to display. x and y are the coordinates of the upper left corner, window is the name of the window (or other graphical object) it appears on, fontsize is the size of the font, and width and height is the size of the scrolling textbox in pixels. linewrap, if non-zero, will parse the text layout so you see everything, breaking when the text gets to the end of the box, and on linebreaks. if 0, it will only break at explicit carriage returns.

Note that parsing text into the scrolling textbox is fairly fast, but you may need workarounds for to display extremely long files if you want high responsiveness.

Several related function help update and draw a scrolling textbox. To change the text, use `SetScrollingText`. Because a scrolling textbox is really just a scrollbox, you also use `DrawScrollbox` to manage drawing, and `ClickOnScrollBox` to handle interaction (this is bound to the .clickon property). .inside is bound to `InsideTB`

Example: See ui.pbl in the demo directory for examples of the use of a scrolling text box

```
textscroll <- MakeScrollingTextBox("",200,50,gWin,12,
                                      300,150,0)

SetScrollingText(textscroll,FileReadText("Uppercase.txt"))
 Draw()
resp <- WaitForClickOntarget([textscroll],[1])
 CallFunction(textscroll.clickon,[textscroll,gClick])
```

See Also: `SetScrollingText` `MakeScrollBox` `UpdateScrollBox` `DrawScrollBox` `ClickOnScrollBox`

Name/Symbol: `MakeSineWave()`

Description: Creates a sine wave that can be played using the Play() or PlayBackground() functions. It will create a single-channel sound at 44100 bitrate, 16 bit precision.

Usage: `MakeSineWave(<duration_in_ms>, <hz>, <amplitude>)`

- The first argument specifies how long (in ms) the tone should be.
- The second argument specifies the frequency. Good values range between 100 and 2000.
- The third argument specifies the volume. It should be less than 1.0.

Example:

```
##Make a sound that is 1000 ms, but just play 300 ms
sound  <- MakeSineWave(200, 220, 1000)
PlayBackground(sound)
Wait(300)
Stop(sound)
```

See Also: `PlayForeground()`, `PlayBackGround()`, `Stop()`

Name/Symbol: `MakeStarPoints()`

Description: Creates a set of points that form a regular star. It can be transformed with functions like `RotatePoints`, or it can be used to create a graphical object with `Polygon`.

Note: `MakeStarPoints` returns a list:

`[[x1, x2, x3,...],[y1,y2,y3,...]],`

while `Polygon()` takes the X and Y lists independently.

Usage:

```
MakeStarPoints(<outer_radius>, <inner_radius>,
                <num_peaks>)
```

Example:

```
window <- MakeWindow()
sp <- MakeStarPoints(50,20,10)
star <- Polygon(200,200,First(sp),Nth(sp,2),
                MakeColor("red"),1)
AddObject(star,window)
Draw()
```

See Also: `MakeNGonPoints`, `Polygon`, `RotatePoints`, `ZoomPoints`

Name/Symbol: `MakeTextBox()`

Description: Creates a textbox in which to display text. Textboxes allow multiple lines of text to be rendered; automatically breaking the text into lines.

Usage:

```
MakeTextbox(<text>,<font>,<width>,<height>)
```

Example:

```
font <-MakeFont("Vera.ttf", 1, 12, MakeColor("red"),
MakeColor("green"), 1)
tb <- MakeTextBox("This is the text in the textbox",
font, 100, 250)
```

See Also: `MakeLabel()`, `GetText()`, `SetText()`, `SetCursorPosition()`, `GetCursorPosition()`, `SetEditable()`

Name/Symbol: `MakeWindow()`

Description: Creates a window to display things in. Background is specified by `<color>`.

Usage: `MakeWindow(opt:<color>, opt:<width>,opt:<height>)`

By default if no arguments are specified, the function will create a window with a black background. To specify the background color, either use a color name or pass in a color object as the first argument. The optional second and third arguments specify window size. If not specified, the window size will be gVideoWidth,gVideoHeight, which are typically set to the current screen resolution.

As of 2.0, multiple windows can be created and used.

Example:

```
win <- MakeWindow()
gWin <- MakeWindow("white")

##make a second window for debugging or experimenter data entry.
gWin2 <- MakeWindow("black",400,200)
```

See Also:

Name/Symbol: `MakeTextList()`

Description: This takes a list and creates a block of text with carriage returns, ensuring each item of the list is on its own line; it also requires an offset, skipping the first lines of the list. It is mostly a helper function used by `Scrollbox` objects to help format. It will make text out of the entire list, so you should be sure to cut off the end for efficiency if you only want to display some of the lines.

Usage: `MakeTextList([<list>], <list-offset>,<prebuffer>)`

Example:

```
letters <- FileReadList("Uppercase.txt")
out <- MakeTextList(letters,20,"--")
```

The above code will create the following:

```
--u
--v
--w
--x
--y
--z
```

See Also: ListToString

Name/Symbol: Match()

Description: Returns a list of 0/1, indicating which elements of <list> match <target>

Usage: Match(<list>,target)

Example:

```
  x <- [1,2,3,3,2,2,1]
  Print(Match(x,1))  ##== [1,0,0,0,0,0,1]
  Print(Match(x,2))  ##== [0,1,0,0,1,1,0]
  Print( Match(x,3)  ##== [0,0,1,1,0,0,0]
```

See Also: Filter(), Subset(), Lookup()

Name/Symbol: Max()

Description: Returns the largest of <list>.

Usage: Max(<list>)

Example:

```
  c <- [3,4,5,6]
  m <- Max(c) # m == 6
```

See Also: Min(), Mean(), StDev()

Name/Symbol: MD5Sum()

Description: Computes MD5 sum of a text string. Returns blank if no string provided<list>.

Usage: MD5Sum(<text>)

Example:

```
Print(MD5Sum(""))
#Return: d41d8cd98f00b204e9800998ecf8427e
 Print(MD5Sum("bananana"))
#returns bb8e9af523e4aeffa88f1807fb2af9ce

text <- FileReadText("test.pbl")
Print(MD5Sum(text))
#returns: 3396a651bd3c96f9799ce02eecb48801; see similar example next

Print(MD5File("test.pbl"))
# returns 3396a651bd3c96f9799ce02eecb48801

Print(MD5File("doesnotexist.txt"))
#returns 0
```

See Also: `MD5File()`

Name/Symbol: `MD5File()`

Description: Computes MD5 sum of a file. Returns blank if no string provided`<list>`.

Usage: `MD5File(<filename>)`

Example:

```
text <- FileReadText("test.pbl")
Print(MD5Sum(text))
#returns: 3396a651bd3c96f9799ce02eecb48801; see similar example next

Print(MD5File("test.pbl"))
# returns 3396a651bd3c96f9799ce02eecb48801

Print(MD5File("doesnotexist.txt"))
#returns 0

Print(MD5Sum(""))
#Return: d41d8cd98f00b204e9800998ecf8427e
 Print(MD5Sum("bananana"))
#returns bb8e9af523e4aeffa88f1807fb2af9ce
```

See Also: `MD5Sum()`

Name/Symbol: `Mean()`

Description: Returns the mean of the numbers in <list>.

Usage: Mean(<list-of-numbers>)

Example:

```
c <- [3,4,5,6]
m <- Mean(c) # m == 4.5
```

See Also: Median(), Quantile(), StDev(), Min(), Max()

Name/Symbol: Median()

Description: Returns the median of the numbers in <list>.

Usage: Median(<list-of-numbers>)

Example:

```
c <- [3,4,5,6,7]
m <- Median(c) # m == 5
```

See Also: Mean(), Quantile(), StDev(), Min(), Max()

Name/Symbol: Merge()

Description: Combines two lists, <lista> and <listb>, into a single list.

Usage: Merge(<lista>,<listb>)

Example:

```
Merge([1,2,3],[8,9])  # == [1,2,3,8,9]
```

See Also: [ ], Append(), List()

Name/Symbol: MessageBox()

Description: Hides what is on the screen and presents a textbox with specified message, with a button to click at the bottom to continue. All arguments after window are optional, but permit changing the size of the text box, (left and right separately), removing the background, and allowing keyboard responses to advance.

By default, if acknowledgement is set to <OK>, the messagebox will continue when the mouse button clicks an on-screen button labeled OK. If set to a key (e.g., 'x'), it will continue when that key is pressed.

Usage:

```
MessageBox(<message>,<window>)

MessageBox(<message>,<window>,<fontsize>:20,
<leftgutter>:100,
<rightgutter>:100,
<bottomgutter>:200,
<usebackground>:1,
acknowledgement:"<OK>")
)
```

Example:

```
 gWin <- MakeWindow()
 MessageBox("Click below to begin.",gWin)

  MessageBox("this makes a messagebox filling the left side, permitting
  graphics you might have put on the right to be displayed.",
             gWin,40,100,gVideoWidth/2,
             300,0,"<OK>")

  MessageBox("This messagebox allows you to continue by hitting the x or z keys",
     gWin,20,100,100,300,1,["X","Z"])
```

See Also: `GetEasyInput`, `EasyTextBox`, `PopUpMessageBox`

Name/Symbol: `Min()`

Description: Returns the ‘smallest’ element of a list.

Usage: `Min(<list>)`

Example:

```
  c <- [3,4,5,6]
  m <-  Min(c) # == 3
```

See Also: `Max()`

Name/Symbol: `Mod()`

Description: Returns `<num>`, `<mod>`, or remainder of `<num>/<mod>`

Usage: `Mod( <num> <mod>)`

Example:

```
Mod(34, 10) # == 4
Mod(3, 10) # == 3
```

See Also: `Div()`

Name/Symbol: `ModList()`

Description: Modifies each element of a list with a pre- and post- string. If the list item is not a string, it will use whatever string it turns into. This creates a new list, so it could be used to make a copy of a string-based list.

Usage:

```
ModList(<list>,<pre>,<post>)
ModList(list,"<",">")  ##encloses each list item in brackets
```

Example:

```
ModList([1,2,3,444]," ","")
ModList(["a","b","c","d","e"],",","-")
```

See Also: `SubString`, `StringLength`, `FoldList`, `ConcatenateList`,

Name/Symbol: `Move()`

Description: Moves an object to a specified location. Images and Labels are moved according to their center; TextBoxes are moved according to their upper left corner.

Usage:

```
Move(<object>, <x>, <y>)
```

Example: `Move(label, 33, 100)`

See Also: `MoveCorner()`, `MoveCenter()`, `.X` and `.Y` properties.

Name/Symbol: `MoveCenter()`

Description: Moves a TextBox to a specified location according to its center, instead of its upper left corner.

Usage:

```
MoveCenter(<object>, <x>, <y>)
```

Example: `MoveCenter(TextBox, 33, 100)`

See Also: `Move()`, `MoveCenter()`, `.X` and `.Y` properties

Name/Symbol: `MoveCorner()`

Description: Moves a label or image to a specified location according to its upper left corner, instead of its center.

Usage: `MoveCorner(<object>, <x>, <y>)`

Example: `MoveCorner(label, 33, 100)`

See Also: `Move()`, `MoveCenter()`, `.X` and `.Y` properties

Name/Symbol: `MoveObject()`

Description: Calls the function named by the .move property of a custom object. Useful if a custom object has complex parts that need to be moved; you can bind .move to a custom move function and then call it (and anything else) using MoveObject. `MoveObject` will fall back on a normal move, so you can handle movement of many built-in objects with it

Usage: `MoveObject(obj,x,y)`

Example:

```
##This overrides buttons placement at the center:
done <- MakeButton("QUIT",400,250,gWin,150)
done.move <- "MoveCorner"
MoveObject(done, 100,100)
```

See Also: `Inside()`, `Move` `ClickOn`, `DrawObject`

9.14 N

Name/Symbol: `NonOverlapLayout`

Description: Creates a set of num points in a xy range, that have a (soft) minimum tolerance of 'tol' between points. That is, to the extent possible, the returned points will have a minumum distance between them of `<tol>`. This may not be possible or be very difficult, and so after a limited number of attempts (by default, 100), the algorithm will return the current configuration, which may have some violations of the minimum tolerance rule, but it will usually be fairly good.

The algorithm works by initializing with a random set of points, then computing a pairwise distance matrix between all points, finding the closest two points, and resampling one of them until its minumum distance is larger than the current. Thus, each internal iteration uniformly improves (or keeps the configuration the same), and the worst points are reconfigured first, so that even if a configuration that does not satisfy the constraints, it will usually be very close.

Internally, the function (located in pebl-lib/Graphics.pbl) has a variable that controls how many steps are taken, called "limit", which is set to 100. For very compacted or very large iterations, this limit can be increased by editing the file or making a copy of the function.

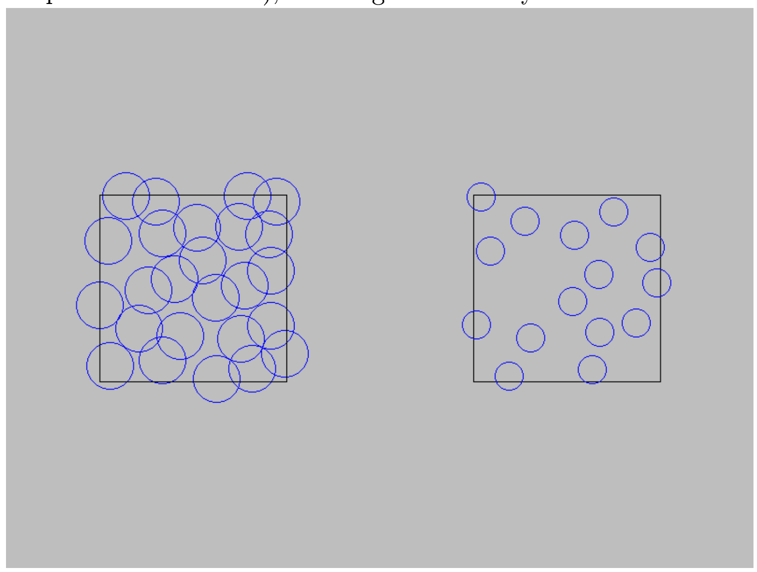
The function usually returns fairly quickly, so it can often be used real-time between trials. However, for complex enough configurations, it can take on the order of seconds; furthermore, more complex configurations might take longer than less complex configurations, which could represent a potential confound (if more complex stimuli have longer ISIs). Users should thus consider creating the configurations when the test is initialized, or created prior to the study and then saved out to a file for later use.

Usage: `NonOverlapLayout(<xmin>,<xmax>,<ymin>,<ymax>,<tol>,<num>)`

Example: Example PEBL Program using NonoverlapLayout:

```
define Start(p)
 {
   win <- MakeWindow()
   ## Make 25 points in a square in the middle
   ## of the screen, a minimum of 50 pixels apart.
   ## This is too compact, but it will be OK.

   points <- NonOverlapLayout(100,300,200,400,50,25)
   circs <- []
   ##This should non-overlapping circles of radius 25
   loop(i,points)
    {
       tmp <- Circle(First(i),Second(i),25,
                     MakeColor("blue"),0)
       AddObject(tmp,win)
       circs <- Append(circs,tmp)
    }


   rect1 <- Square(200,300,200,MakeColor("black"),0)
   rect2 <- Square(600,300,200,MakeColor("black"),0)

   AddObject(rect1,win)
   AddObject(rect2,win)
   ##Reduce the tolerance: this one should be bettter
   points <- NonOverlapLayout(500,700,200,400,50,15)


   ##This should non-overlapping circles of radius 15
   loop(i,points)
    {
       tmp <- Circle(First(i),Second(i),
                     15,MakeColor("blue"),0)
       AddObject(tmp,win)
   circs <- Append(circs,tmp)
    }
   Draw()
   WaitForAnyKeyPress()

}
```

The output of the above program is shown below. Even for the left configuration, which is too compact (and which takes a couple seconds to run), the targets are fairly well distributed.



See Also: `LayoutGrid()`

Name/Symbol: `not`

Description: Logical not

Usage:

Example:

See Also: `and`, `or`

Name/Symbol: `NormalDensity()`

Description: Computes density of normal standard distribution

Usage: `NormalDensity(<x>)`

Example:

```
Print(NormalDensity(-100))      # 1.8391e-2171
Print(NormalDensity(-2.32635)) #5.97
Print(NormalDensity(0))         #0.398942
```

```
Print(NormalDensity(1.28155))  #.90687
Print(NormalDensity(1000))     #inf
```

See Also: `RandomNormal()`, `CumNormInv()`

Name/Symbol: `Nth()`

Description: Extracts the Nth item from a list. Indexes from 1 upwards. `Last()` provides faster access than `Nth()` to the end of a list, which must walk along the list to the desired position.

Usage: `Nth(<list>, <index>)`

Example:

```
a <- ["a","b","c","d"]
Print(Nth(a,3))  # == 'c'
```

See Also: `First()`, `Last()`

Name/Symbol: `NthRoot()`

Description: `<num>` to the power of 1/`<root>`.

Usage: `NthRoot(<num>, <root>)`

Example:

See Also:

9.15 O

Name/Symbol: `OpenCOMPort`

Description: This opens a COM/Serial port, and is used by many usb devices for communication.

The general process is to use OpenComPort to create the port, and then send and receive text strings from that port. These are sent one byte at a time. The mode argument is a 3-character string that specifies aspects of the mode (see Teunis van Beelen's rs232 library at `http://www.teuniz.net/RS-232/`. The first character is the data bits (5,6,7 or 8), parity (N=none, E=even, O=odd), and the third is the stop bit (1 or 2 bits).

Within the demo directory, there is some basic code for communicating with the cedrus response box that uses these functions. In addition, that script provide a NumToASCII() function that can be useful in translating numbers to strings to communicate with a device.

Usage: `OpenCOMPort(<portnum>,<baud>,opt:<mode>)`

Example:

```
port <- OpenCOMPort(16,9600,"8N1")
Print( ComPortGetByte(port))
```

See Also: `COMPortGetByte`, `COMPortSendByte`, `OpenPPort`, `SetPPortMode`, `GetPPortMode`

Name/Symbol: `OpenJoystick`

Description: This opens an available joystick, as specified by its index. The returned object can then be used in to access the state of the joystick. It takes an integer argument, and for the most part, if you have a single joystick attached to your system, you will use OpenJoystick(1). If you want to use a second joystick, use OpenJoystick(2), and so on.

Usage: `OpenJoystick()`

Example: See joysticktest.pbl in the demo directory

See Also: GetNumJoysticks(), OpenJoystick(), GetNumJoystickAxes() GetNumJoystickBalls(), GetNumJoystickButtons(), GetNumJoystickHats() GetJoystickAxisState(), GetJoystickHatState(), GetJoystickButtonState()

Name/Symbol: `OpenNetworkListener()`

Description: Creates a network object that listens on a particular port, and is able to accept incoming connections. You can the nuse `CheckForNetworkConnections` to accept incoming connections. This is an alternative to the `WaitForNetworkConnection` function that allows more flexibility (and allows updating the during waiting for the connection).

Usage: `net <- OpennetworkListener(port)`

Example:

```
network <-      OpenNetworkListener(4444)
time <- GetTime()
while(not connected and (GetTime() < time + 5000))
 {
    connected <- CheckForNetwokConnection(network)
 }
```

See Also: `CheckForNetworkConnection()`, `Getdata()`, `WaitForNetworkConnection()`, `CloseNetwork()`

Name/Symbol: `OpenSubMenus()`

Description: Used by ClickOnMenu to open, display a submenu and get a click.

Usage: `OpenSubMenus(obj,[x,y])`

THis function is bound to the .clickon property of a menu. It will open and display all the submenus, wait for a click, and execute the function called.

Example: This creates a menu and awaits clicking on. More complete examples are available in ui.pbl. It requires that MyMessage is created somewhere

```
menu1 <- MakeMenuItem("File",0,0,gWin,14,10,"MYMESSAGE")


menu2<- MakeMenu("Edit",70,0,gWin,14,10, "MYMESSAGE")

menus <- [menu1,menu2]
opt <- WaitForClickOntarget(menu,[1,2])
ClickOnMenu(Nth(menus,opt),gClick)
```

See Also: `MakeMenu()`, `OpenSubMenus()`, `MakeMenuItem`

Name/Symbol: `or`

Description: Logical or

Usage:

Example:

See Also: `and`, `not`

Name/Symbol: `OpenPPort`

Description: Opens a Parallel port, returning an object that can be used for parallel port communications.

Usage: `OpenPPort(<name>)` The <name> argument can be one of: "LPT1", "LPT2", and "LPTX". Most likely, a parallel port will be configured to LPT1, but other configurations are sometimes possible.

Example:

See Also: `COMPortGetByte`, `COMPortSendByte`, `OpenCOMPort`, `SetPPortMode`, `GetPPortMode`

Name/Symbol: `Order()`

Description: Returns a list of indices describing the order of values by position, from min to max.

Usage: `Order(<list-of-numbers>)`

Example:

```
n <- [33,12,1,5,9]
   o <- Order(n)
    Print(o) #should print [3,4,5,2,1]
```

See Also: `Rank()`

9.16 P

Name/Symbol: `PausePlayback()`

Description: Pauses a playing movie or audio stream. This is used for movies whose playback was initiated using `StartPlayback`, which then ran as background threads during a Wait() function.

Usage: `PausePlayBack(movie)`

Example:

```
movie <- LoadMovie("movie.avi",gWin,640,480)
PrintProperties(movie)
Move(movie,20,20)
Draw()
StartPlayback(movie)
Wait(500) #Play 500 ms of the movie.
PausePlayback(movie)
Wait(500)
```

See Also: `LoadAudioFile()`, `LoadMovie()`, `PlayMovie()`, `StartPlayback()`

Name/Symbol: `PlayForeground()`

Description: Plays the sound ‘in the foreground’; does not return until the sound is complete.

Usage: `PlayForeground(<sound>)`

Example:

```
sound  <- MakeSineWave(200, 220, 1000)
PlayForeground(sound)
```

See Also: `PlayBackground()`, `Stop()`

Name/Symbol: `PlayBackground()`

Description: Plays the sound ‘in the background’, returning immediately.

Usage: `PlayBackground(<sound>)`

Example:

```
sound  <- MakeSineWave(200, 220, 1000)
PlayBackground(sound)
Wait(300)
Stop(sound)
```

See Also: `PlayForeground()`, `Stop()`

Name/Symbol: `PlayMovie()`

Description: Plays the movie (or other multimedia file) loaded via either the LoadMovie or LoadAudioFile function. Note that this functionality uses a different underlying system than the sound playing functions PlayBackground and PlayForeground, and they are not interchangeable.

Usage: `PlayMovie(movie)`

Example:

```
movie <- LoadMovie("movie.avi",gWin,640,480)
PrintProperties(movie)
Move(movie,20,20)
movie.volume <- .1
status <- EasyLabel("Demo Movie Player",300,25,gWin,22)
Draw()
PlayMovie(movie)
```

See Also: `LoadAudioFile()`, `LoadMovie()`, `StartPlayback()`, `PausePlayback()`

Name/Symbol: `Plus`

Description: Creates a polygon in the shape of a plus sign. Arguments include position in window.

- `<x>` and `<y>` is the position of the center
- `<size>` or the size of the plus sign in pixels
- `<width>` thickness of the plus
- `<color>` is a color object (not just the name)

Like other drawn objects, the plus must then be added to the window to appear.

Usage: `Plus(x,y,size,width,color)`

Example:

```
win <- MakeWindow()
p1 <- Plus(100,100,80,15,MakeColor("red"))
AddObject(p1,win)
Draw()
```

See Also: `BlockE()`, `Polygon()`, `MakeStarPoints()`, `MakeNGonPoints()`

Name/Symbol: `Polygon`

Description: Creates a polygon in the shape of the points specified by `<xpoints>`, `<ypoints>`. The lists `<xpoints>` and `<ypoints>` are adjusted by `<x>` and `<y>`, so they should be relative to 0, not the location you want the points to be at.

Like other drawn objects, the polygon must then be added to the window to appear.

Usage:

```
Polygon(<x>,<y>,<xpoints>,<ypoints>,
        <color>,<filled>)
```

Example:

```
win <- MakeWindow()
 #This makes a T
 xpoints <- [-10,10,10,20,20,-20,-20,-10]
 ypoints <- [-20,-20,40,40,50,50,40,40]
p1 <-    Polygon(100,100,xpoints, ypoints,
                 MakeColor("black"),1)
AddObject(p1,win)
Draw()
```

See Also: `BlockE()`, `Bezier()`, `MakeStarPoints()`, `MakeNGonPoints()`

Name/Symbol: `PopUpEntryBox()`

Description: Creates a small text-entry box at a specified location..

Usage:

```
PopuUpEntryBox(<text>,<win>,[x,y])
```

Example:

```
subnum <- PopUpEntryBox("Enter particpant code",gWin,[100,100])
```

See Also: `MessageBox` `GetEasyInput`, `PopUpMessageBox`

Name/Symbol: `PopUpMessageBox()`

Description: Creates a small 300x200 information box at the current cursor location, but also adjusts so it is on the screen. It must be dismissed by clicking the 'OK' button.

Usage:

```
PopuUpMessageBox(<text>,<win>)
```

Note that the function puts the box on the screen at the current mouse position. If you want control over where it goes, you need to use `SetMouseCursorPosition` immediately before the box is made.

Example:
```
subnum <- PopUpMessageBox("There has been an error.",gWin)
```

See Also: MessageBox GetEasyInput, PopUpEntryBox

Name/Symbol: Print()

Description: Prints <value> to stdout (the console [Linux] or the file stdout.txt [Windows]), and then appends a newline afterwards.

Usage: Print(<value>)

Example:
```
Print("hello world")
Print(33 + 43)
x <-Print("Once")
```

See Also: Print_(), FilePrint()

Name/Symbol: Pow()

Description: Raises or lowers <num> to the power of <pow>.

Usage: Pow(<num>, <pow>)

Example:
```
Pow(2,6) # == 64
Pow(5,0) # == 1
```

See Also:

Name/Symbol: Print()

Description: Prints <value> to stdout (the console [Linux] or the file stdout.txt [Windows]), and then appends a newline afterwards.

Usage: Print(<value>)

Example:
```
Print("hello world")
Print(33 + 43)
x <-Print("Once")
```

See Also: Print_(), FilePrint()

Name/Symbol: `PrintProperties()`

Description: Prints .properties/values for any complex object. These include textboxes, fonts, colors, images, shapes, etc. Mostly useful as a debugging tool.

Usage: `PrintProperties(<object>)`

Example:

```
   win <- MakeWindow()
   tb <- EasyTextbox("one",20,20,win,22,400,80)
   PrintProperties(tb)

##Output:
----------
[CURSORPOS]: 0
[EDITABLE]: 0
[HEIGHT]: 80
[ROTATION]: 0
[TEXT]: one
[VISIBLE]: 1
[WIDTH]: 400
[X]: 20
[Y]: 20
[ZOOMX]: 1
[ZOOMY]: 1
----------
```

See Also: `Print()`

Name/Symbol: `Print_()`

Description: Prints `<value>` to stdout; doesn't append a newline afterwards.

Usage: `Print_(<value>)`

Example:

```
Print_("This line")
Print_(" ")
Print_("and")
Print_(" ")
Print("Another line")
# prints out: 'This line and Another line'
```

See Also: `Print()`, `FilePrint()`

Name/Symbol: `PrintList()`

Description: Prints a list, without the ','s or [] characters. Puts a carriage return at the end. Returns a string that was printed. If a list contains other lists, the printing will wrap multiple lines and the internal lists will be printed as normal. To avoid this, try PrintList(Flatten(list)).

Usage: `PrintList( <list>)`

Example:

```
PrintList( [1,2,3,4,5,5,5])
##
##  Produces:
##1 2 3 4 5 5 5
PrintList([[1,2],[3,4],[5,6]])
#Produces:
# [1,2]
#,[3,4]
#,[5,6]

PrintList(Flatten([[1,2],[3,4],[5,6]]))
#Produces:
# 1 2 3 4 5 6
```

See Also: `Print()`, `Print_()`, `FilePrint()`, `FilePrint_()`, `FilePrintList()`,

Name/Symbol: `PropertyExists`

Description: Tests whether a particular named property exists. This works for custom or built-in objects. This is important to check properties that might not exist, because trying to `GetProperty` of a non-existent property will cause a fatal error.

Usage: `out <- PropertyExists(obj,property)`

Example:

```
  obj <- MakeCustomObject("myobject")
  obj.taste <- "buttery"
  obj.texture <- "creamy"
  SetProperty(obj,"flavor","tasty")

  list <- GetPropertyList(obj)
```

```
loop(i,list)
 {
   if(PropertyExists(obj,i)
    {
      Print(i  + ":  " + GetProperty(obj,i))
    }
 }
```

See Also: `GetPropertyList`, `GetProperty`, `SetProperty` `MakeCustomObject`, `PrintProperties`

Name/Symbol: `Pulldown()`

Description: This handles making a new selection on a pulldown box.

Usage: `Pulldown(object, [x,y])`

This function is typically the primary way of interacting with a pulldown box. It will have the effect of opening the pulldown box, waiting for the user to select a new option, and then changing the selected option to whatever they click on.

Example: See demo
ui.pbl for examples of the use of pulldowns. Pulldowns are also used within the PEBL launcher for various purposes. A basic example is:

```
options  <- MakePulldownButton(["A",B","C"],400,250,gWin,14,100,1)
resp <- WaitForClickOntarget([options],[1])
newvalue <- Pulldown(options,gClick)
```

See Also: `MakePullDown()`, `DrawPulldown()`, `UpdatePulldown`

Name/Symbol: `PushButton`

Description: Animates a button-pushing. It takes a button created using the MakeButton function and will animate a downclick when the mouse is down, and release when the mouse is unclicked. To conform with general object handlers, it requires specifying a mouse click position, which could be [0,0], or gclick. This function is bound to the property 'clickon' of any button, allowing you to handle mouse clicks universally for many different objects.

Usage: `PushButton(button, xylist)`

Example: The following creates a button, waits for you to click on it, and animates a button press

```
done <- MakeButton("QUIT",400,250,gWin,150)
resp <- WaitForClickOntarget([done],[1])
PushButton(done,[0,0])
```

To handle multiple buttons, you can do:

```
done <- MakeButton("QUIT",400,250,gWin,150)
ok <-   MakeButton("OK",400,250,gWin,150)

resp <- 2
while (resp != 1)
{
 Draw()
 resp <- WaitForClickOntarget([done,ok],[1,2])
 obj <- Nth([done,ok],resp)
 CallFunction(obj.clickon,[obj,gClick])
}
```

See Also: `MakeCheckBox()`

Name/Symbol: `PushOnEnd`

Description: Pushes an item onto the end of a list, modifying the list itself.

Note: `PushOnEnd` is a more efficient replacement for `Append()`. Unlike `Append`, it will modify the original list as a side effect, so the following works:

```
 PushOnEnd(list, item)
```

There is no need to set the original list to the result of PushOnEnd, like you must do with Append. However, it does in fact work, and incurs only a slight overhead, so that Append can often be replaced with PushOnEnd without worry.

```
list <-  PushOnEnd(list, item)
```

Usage: `PushOnEnd(<list>, <item>)`

Example:

```
list <- Sequence(1,5,1)
double  <- []
loop(i, list)
{
  PushOnEnd(double, [i,i])
}
Print(double)
# Produces [[1,1],[2,2],[3,3],[4,4],[5,5]]
```

See Also: `SetElement()` `List()`, `[ ]`, `Merge()`, `PushOnEnd`

9.17 Q

Name/Symbol: `Quantile()`

Description: Returns the `<num>` quantile of the numbers in `<list>`. `<num>` should be between 0 and 100

Usage: `Quantile(<list>, <num>)`

Example:

```
##Find 75th percentile to use as a threshold.
thresh <- Quantile(rts,75)
```

See Also: `StDev()`, `Median()`, `Mean()`, `Max()`, `Min()`

9.18 R

Name/Symbol: `RadToDeg()`

Description: Converts `<rad>` radians to degrees.

Usage: `RadToDeg( <rad>)`

Example:

See Also: `DegToRad()`, `Tan()`, `Cos()`, `Sin()`, `ATan()`, `ASin()`, `ACos()`

Name/Symbol: `Random()`

Description: Returns a random number between 0 and 1.

Usage: `Random()`

Example: `a <- Random()`

See Also: `Random()`, `RandomBernoulli()`, `RandomBinomial()`, `RandomDiscrete()`, `RandomExponential()`, `RandomLogistic()`, `RandomLogNormal()`, `RandomNormal()`, `RandomUniform()`, `RandomizeTimer()`, `SeedRNG()`

Name/Symbol: `RandomBernoulli()`

Description: Returns 0 with probability `(1-<p>)` and 1 with probability `<p>`.

Usage: `RandomBernoulli(<p>)`

Example: `RandomBernoulli(.3)`

See Also: `Random()`, `RandomBernoulli()`, `RandomBinomial`, `RandomDiscrete()`, `RandomExponential()`, `RandomLogistic()`, `RandomLogNormal()`, `RandomNormal()`, `RandomUniform()`, `RandomizeTimer()`, `SeedRNG()`

Name/Symbol: `RandomBinomial`

Description: Returns a random number according to the Binomial distribution with probability `<p>` and repetitions `<n>`, i.e., the number of `<p>` Bernoulli trials that succeed out of `<n>` attempts.

Usage: `RandomBinomial(<p> <n>)`

Example: `RandomBinomial(.3, 10) # returns number from 0 to 10`

See Also: `Random()`, `RandomBernoulli()`, `RandomBinomial`, `RandomDiscrete()`, `RandomExponential()`, `RandomLogistic()`, `RandomLogNormal()`, `RandomNormal()`, `RandomUniform()`, `RandomizeTimer()`, `SeedRNG()`

Name/Symbol: `RandomDiscrete()`

Description: Returns a random integer between 1 and the argument (inclusive), each with equal probability. If the argument is a floating-point value, it will be truncated down; if it is less than 1, it will return 1, and possibly a warning message.

Usage: `RandomDiscrete(<num>)`

Example:
```
 # Returns a random integer between 1 and 30:
RandomDiscrete(30)
```

See Also: `Random()`, `RandomBernoulli()`, `RandomBinomial`, `RandomDiscrete()`, `RandomExponential()`, `RandomLogistic()`, `RandomLogNormal()`, `RandomNormal()`, `RandomUniform()`, `RandomizeTimer()`, `SeedRNG()`

Name/Symbol: `RandomExponential()`

Description: Returns a random number according to exponential distribution with mean `<mean>` (or decay 1/mean).

Usage: `RandomExponential(<mean>)`

Example: `RandomExponential(100)`

See Also: `Random()`, `RandomBernoulli()`, `RandomBinomial`, `RandomDiscrete()`, `RandomLogistic()`, `RandomLogNormal()`, `RandomNormal()`, `RandomUniform()`, `RandomizeTimer`, `SeedRNG()`

Name/Symbol: `RandomizeTimer()`

Description: Seeds the RNG with the current time.

Usage: `RandomizeTimer()`

Example:
```
RandomizeTimer()
x <- Random()
```

See Also: `Random()`, `RandomBernoulli()`, `RandomBinomial`, `RandomDiscrete()`, `RandomExponential()`, `RandomLogistic()`, `RandomLogNormal()`, `RandomNormal()`, `RandomUniform()`, `SeedRNG()`

Name/Symbol: `RandomLogistic()`

Description: Returns a random number according to the logistic distribution with parameter `<p>`: f(x) = exp(x)/(1+exp(x))

Usage: `RandomLogistic(<p>)`

Example: RandomLogistic(.3)

See Also: `Random()`, `RandomBernoulli()`, `RandomBinomial`, `RandomDiscrete()`, `RandomExponential()`, `RandomLogNormal()`, `RandomNormal()`, `RandomUniform()`, `RandomizeTimer`, `SeedRNG()`

Name/Symbol: `RandomLogNormal()`

Description: Returns a random number according to the log-normal distribution with parameters `<median>` and `<spread>`. Generated by calculating $median*exp(spread*RandomNormal(0,1))$. `<spread>` is a shape parameter, and only affects the variance as a function of the median; similar to the coefficient of variation. A value near 0 is a sharp distribution (.1-.3), larger values are more spread out; values greater than 2 make little difference in the shape.

Usage: `RandomLogNormal(<median>, <spread>)`

Example: `RandomLogNormal(5000, .1)`

See Also: `Random()`, `RandomBernoulli()`, `RandomBinomial`, `RandomDiscrete()`, `RandomExponential()`, `RandomLogistic()`, `RandomNormal()`, `RandomUniform()`, `RandomizeTimer`, `SeedRNG()`

Name/Symbol: `RandomNormal()`

Description: Returns a random number according to the standard normal distribution with `<mean>` and `<stdev>`.

Usage: `RandomNormal(<mean>, <stdev>)`

Example:

See Also: `Random()`, `RandomBernoulli()`, `RandomBinomial`, `RandomDiscrete()`, `RandomExponential()`, `RandomLogistic()`, `RandomLogNormal()`, `RandomUniform()`, `RandomizeTimer`, `SeedRNG()`

Name/Symbol: `RandomUniform()`

Description: Returns a random floating-point number between 0 and `<num>`.

Usage: `RandomUniform(<num>)`

Example:

See Also: `Random()`, `RandomBernoulli()`, `RandomBinomial`, `RandomDiscrete()`, `RandomExponential()`, `RandomLogistic()`, `RandomLogNormal()`, `RandomNormal()`, `RandomizeTimer()`, `SeedRNG()`

Name/Symbol: `Rank()`

Description: Returns a list of numbers describing the rank of each position, from min to max. The same as calling `Order(Order(x))`.

Usage: `Rank(<list-of-numbers>)`

Example:

```
n <- [33,12,1,5,9]
   o <- Rank(n)
    Print(o) #should print [5,4,1,2,3]
```

See Also: `Order()`

Name/Symbol: `ReadCSV()`

Description: Reads a comma-separated value file into a nested list. Need not be named with a .csv extension. It should properly strip quotes from cells, and not break entries on commas embedded within quoted text.

Usage: `ReadCSV(<filename>)`

Example: `table <- ReadCSV("datafile.csv")`

See Also: `FileReadTable()`, `FileReadList`, `StripQuotes`

Name/Symbol: `Rectangle()`

Description: Creates a rectangle for graphing at x,y with size dx and dy. Rectangles are only currently definable oriented in horizontal/vertical directions. A rectangle must be added to a parent widget before it can be drawn; it may be added to widgets other than a base window. The properties of rectangles may be changed by accessing their properties directly, including the FILLED property which makes the object an outline versus a filled shape.

Usage: `Rectangle(<x>, <y>, <dx>, <dy>, <color>)`

Example:

```
r <- Rectangle(30,30,20,10, MakeColor(green))
AddObject(r, win)
Draw()
```

See Also: `Circle()`, `Ellipse()`, `Square()`, `Line()`

Name/Symbol: `ReflectPoints`

Description: Takes a set of points (defined in a joined list [[x1,x2,x3,...],[y1,y2,y3,...]] and reflects them around the vertical axis x=0, returning a similar [[x],[y]] list. Identical to `ZoomPoints(pts,-1,1)`

Usage: `ReflectPoints(<points>)`

Example:

```
points <- [[1,2,3,4],[20,21,22,23]]
newpoints <- ReflectPoints(points)
```

See Also: `ZoomPoints()`, `RotatePoints`

Name/Symbol: `RegisterEvent()`

Description: Adds an event to the event loop. This function is currently experimental, and its usage may change in future versions of PEBL.

Usage: `USAGE CURRENTLY UNDOCUMENTED`

Example:

See Also: ClearEventLoop(), StartEventLoop()

Name/Symbol: RemoveObject()

Description: Removes a child widget from a parent. Useful if you are adding a local widget to a global window inside a loop. If you do not remove the object and only Hide() it, drawing will be sluggish. Objects that are local to a function are removed automatically when the function terminates, so you do not need to call RemoveObject() on them at the end of a function.

Usage:

```
RemoveObject( <object>, <parent>)
```

Example:

See Also:

Name/Symbol: RemoveSubset()

Description: Removes a subset of elements from a list. Creates a new list, and does not affect the original

Usage:

```
RemoveSubset(<list1>,<list-of-element-indices>])
```

Example:

```
list1 <- [1,2,2,4,5]
list2 <- RemoveSubset(list1,[2,3])
Print(list1) #[1,2,2,4,5]
Print(list2) #[1,4,5]
```

See Also: Merge(), Insert(), Rest()

Name/Symbol: Repeat()

Description: Makes and returns a list by repeating <object> <n> times. Has no effect on the object. Repeat will not make new copies of the object. If you later change the object, you will change every object in the list.

Usage:

```
Repeat(<object>, <n>)
```

Example:

```
x <- "potato"
y <- repeat(x, 10)
Print(y)
# produces ["potato","potato","potato",
            "potato","potato", "potato",
            "potato","potato","potato","potato"]
```

See Also: RepeatList()

Name/Symbol: RepeatList()

Description: Makes a longer list by repeating a shorter list <n> times. Has no effect on the list itself, but changes made to objects in the new list will also affect the old list.

Usage:

```
RepeatList(<list>, <n>)
```

Example:

```
RepeatList([1,2],3) # == [1,2,1,2,1,2]
```

See Also: Repeat(), Merge(), [ ]

Name/Symbol: Replace()

Description: Creates a copy of a (possibly nested) list in which items matching some list are replaced for other items. <template> can be any data structure, and can be nested. <replacementList> is a list containing two-item list pairs: the to-be-replaced item and to what it should be transformed.
Note: replacement searches the entire <replacementList> for matches. If multiple keys are identical, the item will be replaced with the last item that matches.

Usage:

```
Replace(<template>,<replacementList>)
```

Example:

```
x <- ["a","b","c","x"]
rep <- [["a","A"],["b","B"],["x","D"]]
Print(Replace(x,rep))
# Result:  [A, B, c, D]
```

See Also: ReplaceChar()

Name/Symbol: ReplaceChar()

Description: Substitutes <char2> for <char> in <string>. Useful for saving subject entry data in a file; replacing spaces with some other character. The second argument can either be a character to match, or a list of characters to match, in which case they all get replaced with the third argument.

Usage:

```
ReplaceChar(<string>,<char>,<char2>)
ReplaceChar(<string>,[<chara>, <charb>],<char2>)
```

Example:

```
x <- ["Sing a song of sixpence"]
rep <- ReplaceChar(x," ", "_")
Print(rep)
# Result:  Sing_a_song_of_sixpence

x <- ["sing a song of sixpence"]
rep <- ReplaceChar(x,["s","x"], "p")
Print(rep)
# Result:  ping a pong of pippence
```

See Also: for list items: `Replace()` , `\SplitString()`,

Name/Symbol: `ResetCanvas()`

Description: Resets a canvas, so that anything drawn onto it is erased and returned to its background color. Implemented by resetting the background color to itself:

```
canvas.color <- canvas.
```

The function does not return the canvas, but has the side effect of resetting it.

Usage: `ResetCanvas(<list>)`

Example:

```
#create a canvas, add pixel noise, then reset and repeat.
define Start(p)
{
  gWin <- MakeWindow()
  canvas <- MakeCanvas(100,100,MakeColor("black"))
  AddObject(canvas,gWin); Move(canvas,300,300)
  Draw()
  white <- MakeColor("white")
  ##add pixel noise
  j <- 1
  while(j < 5)
   {
  i <- 1
  while(i < 200)
   {
     SetPixel(canvas,Round(Random()*100),
               Round(Random()*100),white)
     i <- i +1
   }
```

```
  Draw()
  WaitForAnyKeyPress()
  ResetCanvas(canvas)
  Draw()
   j <- j + 1
  }
  WaitForAnyKeyPress()

}
```

See Also: +SetPixel()+, +MakeCanvas()+, +Draw()+

Name/Symbol: `Rest()`

Description: Returns the 'rest' of a list; a list minus its first element. If the list is empty or has a single member, it will return an empty list []. This is a very common function in LISP.

Usage: `Rest(<list>)`

Example:

```
x <- Sequence(1,5,1)
y <- Rest(x)
Print(rep)
# Result:  [2,3,4,5]
```

See Also: `Insert()`

Name/Symbol: `RGBtoHSV()`

Description: Converts a color object to HSV values. May be useful for computing color-space distances an so on. No HSVtoRGB is currently implemented.

Usage: `RGBtoHSV(<color>)`

Example:

```
x <- RGBtoHSV(MakeColor("red))
```

See Also: `MakeColor()`, `MakeColorRGB`

Name/Symbol: `return`

Description: Enables a function to return a value.

Usage:

```
define funcname()
{
 return 0
}
```

Example:

See Also:

Name/Symbol: Rotate()

Description: Returns a list created by rotating a list by <n> items. The new list will begin with the <n+1>th item of the old list (modulo its length), and contain all of its items in order, jumping back to the beginning and ending with the <n>th item. Rotate(<list>,0) has no effect. Rotate does not modify the original list.

Usage:

```
Rotate(<list-of-items>, <n>)
```

Example:

```
Rotate([1,11,111],1)  # == [11,111,1]
```

See Also: Transpose()

Name/Symbol: RotatePoints

Description: Takes a set of points (defined in a joined list [[x1,x2,x3,...], [y1,y2,y3,...]] and rotates them <angle> degrees around the point [0,0], returning a similar [[x],[y]] list.

Usage:

```
  ZoomPoints(<points>,<angle>)
```

Example:

```
  points <- [[1,2,3,4],[20,21,22,23]]
  newpoints <- RotatePoints(points,10)
```

See Also: ZoomPoints(), ReflectPoints

Name/Symbol: Round()

Description: Rounds <num> to nearest integer, or if optional <precision> argument is included, to nearest $10^{-precision}$.

Usage:

```
Round(<num>)
Round(<num>,<precision>)
```

Example:

```
Round(33.23)       # == 33
Round(56.65)       # == 57
Round(33.12234,2)  # == 33.12
Round(43134.23,-2) # == 43100
```

See Also: `Ceiling()`, `Floor()`, `AbsFloor()`, `ToInt()`

9.19 S

Name/Symbol: `Sample()`

Description: Samples a single item from a list, returning it. It is a bit more convenient at times than ShuffleN(list,1), which returns a list of length 1. Implemented as First(ShuffleN(list,1))

Usage:

```
Sample(<list>)
```

Example:

```
Sample([1,1,1,2,2])     # Returns a single number
Sample([1,2,3,4,5,6,7]) # Returns a single number
```

See Also: `SeedRNG()`, `Sample()` `ChooseN()`, `SampleNWithReplacement()`, `Subset()`

Name/Symbol: `SampleN()`

Description: Samples `<number>` items from list, returning a randomly- ordered list. Items are sampled without replacement, so once an item is chosen it will not be chosen again. If `<number>` is larger than the length of the list, the entire list is returned shuffled. It differs from `ChooseN` in that `ChooseN` returns items in the order they appeared in the originial list. It is implemented as `Shuffle(ChooseN())`.

Usage:

```
SampleN(<list>, <n>)
```

Example:

```
SampleN([1,1,1,2,2], 5)     # Returns 5 numbers
SampleN([1,2,3,4,5,6,7], 3) # Returns 3 numbers
```

See Also: `ChooseN()`, `SampleNWithReplacement()`, `Subset()`

Name/Symbol: `SampleNWithReplacement()`

Description: `SampleNWithReplacement` samples `<number>` items from `<list>`, replacing after each draw so that items can be sampled again. `<number>` can be larger than the length of the list. It has no side effects on its arguments.

Usage:

```
SampleNWithReplacement(<list>, <number>)
```

Example:
```
x <- Sequence(1:100,1)
SampleNWithReplacement(x, 10)
# Produces 10 numbers between 1 and 100, possibly
# repeating some.
```

See Also: `SampleN()`, `ChooseN()`, `Subset()`

Name/Symbol: `SetProperty`

Description: Sets a a property of a custom object. This works for custom or built-in objects, but new properties can only be set on custom object. This function works essentially identically to the obj.property assignment, but it allows you to create property names from input. It is used extensively for the PEBL parameter setting.

Usage: `SetProperty(obj,property, value)`

Example:
```
  obj <- MakeCustomObject("myobject")
  obj.taste <- "buttery"
  obj.texture <- "creamy"
  SetProperty(obj,"flavor","tasty")

  list <- GetPropertyList(obj)
  loop(i,list)
   {
     if(PropertyExists(obj,i)
      {
        Print(i  + ":  " + GetProperty(obj,i))
      }
   }
```

See Also: `GetProperty`, `PropertyExists`, `GetPropertyList` `MakeCustomObject`, `PrintProperties`

Name/Symbol: `SaveAudioToWaveFile`

Description: Saves a buffer, recorded using the GetAudioInputBuffer, to a .wav file for later analysis or archive.

Usage: `SaveAudioToWaveFile(filename, buffer)`

This will save a .wav file of a buffer that was recorded (e.g., using GetVocalResponseTime).

See number-stroop.pbl in the stroop directory of the test battery and testaudioin.pbl in demo/ for examples.

Example:

```
    gResponseBuffer <- MakeAudioInputBuffer(5000)
resp0 <-  GetVocalResponseTime(gResponseBuffer,.35, 200)
    SaveAudioToWaveFile("output.wav",gResponseBuffer)
```

See Also: `GetVocalResponseTime()`, `MakeAudioInputBuffer()`

Name/Symbol: `SDTBeta()`

Description: `SDTBeta` computes beta, as defined by signal detection theory. This is a measure of decision bias based on hit rate and false alarm rate.

Usage: `SDTDBeta(<hr>, <far>,<trunc>:.001)`

Here, hr and far should be bounded between 0 and 1.0. To avoid errors when 0 or 1.0, hr and far values are truncated to minimum of the optional argument trunc and 1.0-trunc, which defaults to .001. This will happen even for values between 0 and .001 or between .999 and 1.0. This is ad hoc, but should be reasonable because of the massive uncertainty about anything way out in the tails of the normal distribution.

Example:

```
Print(SDTBeta(.1,.9))
Print(SDTBeta(.1,.5))
Print(SDTBeta(.5,.5))
Print(SDTBeta(.8,.9))
Print(SDTbeta(.9,.95))
```

See Also: `SDTDPrime()`

Name/Symbol: `SDTDPrime()`

Description: `SDTDPrime` computes d-prime, as defined by signal detection theory. This is a measure of sensitivy based jointly on hit rate and false alarm rate.

Usage: `SDTDPrime(<hr>, <far>,<trunc>.001)`

Here, hr and far should be bounded between 0 and 1.0. To avoid errors when 0 or 1.0, hr and far values are truncated to minimum of the optional argument trunc and 1.0-trunc, which defaults to .001. This will happen even for values between 0 and .001 or between .999 and 1.0. This is ad hoc, but should be reasonable because of the massive uncertainty about anything way out in the tails of the normal distribution.

Example:

```
Print(SDTDPrime(.1,.9))  #2.56431
Print(SDTDPrime(.1,.5))  #1.28155
Print(SDTDPrime(.5,.5))  #0
Print(SDTDPrime(.8,.9))  #.43993
Print(SDTDPrime(.9,.95)) #.363302
```

See Also: `SDTBeta()`,

Name/Symbol: `SetCheckbox()`

Description: This sets the .status property of a checkbox and draws it. Its state can also be updated using the the `ClickCheckBox()` function, which flips the current state.

Usage:

```
SetCheckBox(obj, value)
```

Example:

```
ok <- MakeCheckbox("OK?",400,250,gWin,150)
Draw()
SetCheckBox(ok,1)
Draw()
Wait(1000)
SetCheckbox(ok,0)
Draw()
Wait(1000)
```

Examples of its use can be found in demo
ui.pbl

See Also: `MakeCheckBox()`, `ClickCheckBox()`

Name/Symbol: `SeedRNG()`

Description: Seeds the random number generator with `<num>` to reproduce a random sequence. This function can be used cleverly to create a multi-session experiment: Start by seeding the RNG with a single number for each subject; generate the stimulus sequence, then extract the appropriate stimuli for the current block. Remember to `RandomizeTimer()` afterward if necessary.

Usage: `SeedRNG(<num>)`

Example:

```
##This makes sure you get the same random order
## across sessions for individual subjects.
 SeedRNG(gSubNum)
 stimTmp <- Sequence(1:100,1)
 stim <- Shuffle(stimTmp)
 RandomizeTimer()
```

See Also: `RandomizeTimer()`

Name/Symbol: `SendData()`

Description: Sends data on network connection. Example of usage in demo/nim.pbl. You can only send text data.

Usage: `SendData(<network>,<data_as_string>)`

Example: On 'server':

```
  net <- WaitForNetworkConnection("localhost",1234)
  SendData(net,"Watson, come here. I need you.")
  CloseNetworkConnection(net)
```

On Client:

```
  net <- ConnectToHost("localhost",1234)
  value <-  GetData(net,20)
  Print(value)
  CloseNetworkConnection(net)
##should print out "Watson, come here. I need you."
```

See Also: `ConnectToIP`, `ConnectToHost`, `WaitForNetworkConnection`, `GetData`, `ConvertIPString`, `CloseNetworkConnection`

Name/Symbol: `SegmentsIntersect()`

Description: Determines whether two line segments, defined by four xy point pairs, intersect. Two line segments that share a corner return 0, although they could be considered to intersect.

This function is defined in pebl-lib/Graphics.pbl

Usage:

```
SegmentsIntersect(x1,y1,x2,y2,
                  a1,b1,a2,b2)
```

Example:

```
SegmentsIntersect(1,0,2,0,
                  1,2,2,2)  #0

#returns 0, though they share (1,0)
SegmentsIntersect(1,0,2,0,
                   1,0,2,2)
SegmentsIntersect(1,1,3,1,
                  2,2,2,0)  #1
```

See Also: GetAngle3, ToRight

Name/Symbol: Sequence()

Description: Makes a sequence of numbers from <start> to <end> at <step>-sized increments. If <step> is positive, <end> must be larger than <start>, and if <step> is negative, <end> must be smaller than <start>. If <start> + n*<step> does not exactly equal <end>, the last item in the sequence will be the number closest number to <end> in the direction of <start> (and thus <step>).

Usage: Sequence(<start>, <end>, <step>)

Example:

```
Sequence(0,10,3)    # == [0,3,6,9]
Sequence(0,10,1.5)  # == [0,1.5,3,4.5, 6, 7.5, 9]
Sequence(10,1,3)    # error
Sequence(10,0,-1)   # == [10,9,8,7,6,5,4,3,2,1]
```

See Also: Repeat(), RepeatList()

Name/Symbol: SetCursorPosition()

Description: Moves the editing cursor to a specified character position in a textbox.

Usage: SetCursorPosition(<textbox>, <integer>)

Example: SetCursorPosition(tb, 23)

See Also: SetEditable(), GetCursorPosition(), SetText(), GetText()

Name/Symbol: SetEditable()

Description: Sets the "editable" status of the textbox. All this really does is turns on or off the cursor; editing must be done with the (currently unsupported) device function `GetInput()`.

Usage: `SetEditable()`

Example:

```
SetEditable(tb, 0)
SetEditable(tb, 1)
```

See Also: `GetEditable()`

Name/Symbol: `SetElement()`

Description: Efficiently alter a specific item from a list. `SetElement` has length-constant access time, and so it can be efficient to pre-create a list structure and then populate it one-by-one.

Usage: `SetElement(<list>, <index>, <value>)`

Example:

```
 ##Set a random subset of elements to their index:
 list <- Repeat(0,10)
  index <- 1
  while(index <= 10)
  {
    if(Random()<.2)
     {
        SetElement(list,index,index)
      }
    index <- index + 1
   }
```

See Also: `Nth()`, `Append()`, `PushOnEnd()`

Name/Symbol: `SetFont()`

Description: Resets the font of a textbox or label. Change will not appear until the next `Draw()` function is called. Can be used, for example, to change the color of a label to give richer feedback about correctness on a trial (see example below). Font can alse be set by assigning to the object.font property of an object.

Usage: `SetFont(<text-widget>, <font>)`

Example:

```
fontGreen <- MakeFont("vera.ttf",1,22,
                      MakeColor("green"),
                      MakeColor("black"), 1)
fontRed   <- MakeFont("vera.ttf",1,22,
                      MakeColor("red"),
                      MakeColor("black"), 1)
label <- MakeLabel(fontGreen, "Correct")

#Do trial here.

if(response == 1)
{
SetText(label, "CORRECT")
SetFont(label, fontGreen)
} else {
SetText(label, "INCORRECT")
SetFont(label, "fontRed)
}
Draw()
```

See Also: `SetText()`

Name/Symbol: `SetMouseCursorPosition()`

Description: Sets the current x,y coordinates of the mouse pointer, 'warping' the mouse to that location immediately

Usage:

```
SetMouseCursorPosition(<x>,<y>)
```

Example:

```
##Set mouse to center of screen:
SetMouseCursorPosition(gVideoWidth/2,
                       gVideoHeight/2)
```

See Also: `ShowCursor`, `WaitForMouseButton`, `SetMouseCursorPosition`, `GetMouseCursorPosition`

Name/Symbol: `SetPanning()`

Description: Sets the audio panning; the volume of the left and right audio channels.

Usage:

```
SetPanning(<audio>,<left>,<right>)
```

Example:

```
one <- LoadSound("1.wav")
PlayForeground(one)
SetPanning(one,1.0,0.0)
PlayForeground(one)
SetPanning(one,.5,.5)
PlayForeground(one)
```

See Also: `LoadSound`

Name/Symbol: `SetPixel()`, `SetPoint()`

Description: Sets the pixel at x,y to a particular color. It can also be called using SetPoint(). SetPoint is primarily useful for images and canvases–labels and textboxes get re-rendered upon draw so any use of SetPixel will get overwritten when it gets drawn. It won't work on windows or shapes.

Usage:

```
SetPixel(<x>,<y>,<color>)
SetPoint(<x>,<y>,<color>)
```

Example:

```
back <- MakeCanvas(50,50)
AddObject(back,gWin)
col <- MakeColor("green")
xy <- [[10,10],[10,11],[10,12],[10,13]]
 loop(i,xy)
 {
  SetPixel(First(i),Second(i),col)
 }
Draw()
```

See Also: `SetPoint`, `MakeGabor`

Name/Symbol: `SetPPortMode`

Description: Sets a parallel port mode, either "<input>" or "<output>".

Usage: `SetPPortMode("<input>")`

Example:

See Also: `COMPortGetByte`, `COMPortSendByte`, `OpenPPort` `OpenCOMPort`, `SetPPortMode`, `GetPPortState`

Name/Symbol: `SetPPortState`

Description: Sets a parallel port state, using a list of 8 'bits' (1s or 0s).

Usage: `SetPPortState([0,0,0,0,0,0,0,0])`

Example:

See Also: `COMPortGetByte`, `COMPortSendByte`, `OpenPPort` `OpenCOMPort`, `SetPPortMode`, `GetPPortState`

Name/Symbol: `SetScrollingText()`

Description: This updates the text in a `ScrollingTextBox`. Because text must be parsed to be put into the box, you cannot just update the .text property, but instead should use this function.

Usage: `SetScrollingText(stb, newtext)`

Here, `stb` is a scrolling textbox created with `MakeScrollingTextBox`, and `newtext` is the new text you want to display.

Example: See ui.pbl in the demo directory for examples of the use of a scrolling text box. A brief example follows:

```
textscroll <- MakeScrollingTextBox("",200,50,gWin,12,
                                        300,150,0)

SetScrollingText(textscroll,FileReadText("Uppercase.txt"))
 Draw()
resp <- WaitForClickOntarget([textscroll],[1])
 CallFunction(textscroll.clickon,[textscroll,gClick])
```

See Also: `MakeScrollingTextBox` `MakeScrollBox` `UpdateScrollBox` `DrawScrollBox` `ClickOnScrollBox`

Name/Symbol: `SetPlayRepeats(<reps>)`

Description: Sets repetition count on an audio file. When played back, i will play this sound reps+1 times. If set to 0, it will play just once. If set to -1, it will repeat indefinitely.

Usage: `SetPlayRepeats(<audio>,<reps>)`

Example:

```
one <- LoadSound("1.wav")
PlayForeground(one)
SetPlayRepeats(one,5)
PlayForeground(one)
SetPanning(one,-1)
PlayBackground(one)
Wait(5000)
Stop(one)
```

See Also: `LoadSound`

Name/Symbol: `SetText()`

Description: Resets the text of a textbox or label. Change will not appear until the next `Draw()` function is called. The object.text property can also be used to change text of an object, by doing: `object.text <- "new text"`

Usage: `SetText(<text-widget>, <text>)`

Example:

```
# Fixation Cross:
label <- MakeLabel(font, "+")
Draw()

SetText(label, "X")
Wait(100)
Draw()
```

See Also: `GetText()`, `SetFont()`

Name/Symbol: `Show()`

Description: Sets a widget to visible, once it has been added to a parent widget. This just changes the visibility property, it does not make the widget appear. The widget will not be displayed until the `Draw()` function is called. The .visible property of objects can also be used to hide or show the object.

Usage: `Show(<object>)`

Example:
```
window <- MakeWindow()
image1  <- MakeImage("pebl.bmp")
image2  <- MakeImage("pebl.bmp")
AddObject(image1, window)
AddObject(image2, window)
Hide(image2)
Draw()
Wait(300)
Show(image2)
Draw()
```

See Also: `Hide()`

Name/Symbol: `ShowCursor()`

Description: Hides or shows the mouse cursor. Currently, the mouse is not used, but on some systems in some configurations, the mouse cursor shows up. Calling `ShowCursor(0)` will turn off the cursor, and `ShowCursor(1)` will turn it back on. Be sure to turn it on at the end of the experiment, or you may actually lose the cursor for good.

Usage: `ShowCursor(<value>)`

Example:
```
window <- MakeWindow()
ShowCursor(0)
## Do experiment here
##

## Turn mouse back on.
ShowCursor(1)
```

See Also:

Name/Symbol: `Shuffle()`

Description: Randomly shuffles a list.

Usage: `Shuffle(list)`

Example:
```
Print(Shuffle([1,2,3,4,5]))
# Results might be anything, like [5,3,2,1,4]
```

See Also: `Sort()`, `SortBy()`, `ShuffleRepeat()`, `ShuffleWithoutAdjacents()`

Name/Symbol: `ShuffleRepeat()`

Description: Randomly shuffles <list>, repeating <n> times. Shuffles each iteration of the list separately, so you are guaranteed to go through all elements of the list before you get another. Returns a nested list.

Usage:

```
ShuffleRepeat(<list>, <n>)
```

Example:

```
Print(ShuffleRepeat([1,2,3,4,5]),3)
##  Results might be anything, like:
## [[5,3,2,1,4], [3,2,5,1,4], [1,4,5,3,2]]
```

Typically, you will want to flatten before using:

```
list <-  Flatten(ShuffleRepeat([1,2,3], 5))
```

See Also: `Sort()`, `SortBy()`, `ShuffleRepeat()`, `ShuffleWithoutAdjacents()`

Name/Symbol: `ShuffleWithoutAdjacents()`

Description: Randomly shuffles <nested-list>, attempting to create a list where the nested elements do not appear adjacently in the new list. Returns a list that is flattened one level. It will always return a shuffled list, but it is not guaranteed to return one that has the non-adjecent structure specified, because this is sometimes impossible or very difficult to do randomly. Given small enough non-adjacent constraints with enough fillers, it should be able to find something satisfactory.

Usage:

```
ShuffleWithoutAdjacents(<nested-list>)
```

Example:

```
Print(ShuffleWithoutAdjacents([[1,2,3],
                                [4,5,6],
                                [7,8,9]])
## Example Output:
## [8, 5, 2, 7, 4, 1, 6, 9, 3]
## [7, 4, 8, 1, 9, 2, 5, 3, 6]

## Non-nested items are shuffled without constraint
Print(ShuffleWithoutAdjacents([[1,2,3],
                               11,12,13,14,15,16]))
## output: [13, 11, 2, 14, 3, 15, 1, 16, 12]
##         [13, 12, 2, 16, 15, 11, 1, 14, 3]
```

```
##         [11, 1, 15, 2, 12, 16, 14, 13, 3]

## Sometimes the constraints cannot be satisfied.
## 9 will always appear in position 2
Print(ShuffleWithoutAdjacents([[1,2,3], 9])
## output: [3, 9, 1, 2]
##         [2, 9, 3, 1]
##         [3, 9, 2, 1]
```

See Also: `Shuffle()`, `Sort()`, `SortBy()`, `ShuffleRepeat()`, `ShuffleWithoutAdjacents()`

Name/Symbol: `Sign()`

Description: Returns +1 or -1, depending on sign of argument.

Usage: `Sign(<num>)`

Example:

```
Sign(-332.1)  # == -1
Sign(65)      # == 1
```

See Also: `Abs()`

Name/Symbol: `SignalFatalError()`

Description: Stops PEBL and prints `<message>` to stderr. In addition, when possible, it will pop-up a window with the error message. Useful for type-checking in user-defined functions. If you want to end an experiment directly, use `ExitQuietly` instead.

Usage: `SignalFatalError(<message>)`

Example:

```
If(not IsList(x))
{
 SignalFatalError("Tried to frobnicate a List.")
}
##Prints out error message and
##line/filename of function
```

See Also: `Print()`, `ExitQuietly()`

Name/Symbol: `Sin()`

Description: Sine of <deg> degrees.

Usage: Sin(<deg>)

Example:

```
Sin(180)
Sin(0)
```

See Also: Cos(), Tan(), ATan(), ACos(), ATan()

Name/Symbol: Sort()

Description: Sorts a list by its values from smallest to largest.

Usage: Sort(<list>)

Example:

```
Sort([3,4,2,1,5]) # == [1,2,3,4,5]
```

See Also: SortBy(), Shuffle()

Name/Symbol: SortBy()

Description: Sorts a list by the values in another list, in ascending order.

Usage: SortBy(<value-list>, <key-list>)

Example:

```
SortBy(["Bobby","Greg","Peter"], [3,1,2])
# == ["Greg","Peter","Bobby"]
```

See Also: Shuffle(), Sort()

Name/Symbol: SplitString()

Description: Splits a string into tokens. <split> must be a string. If <split> is not found in <string>, a list containing the entire string is returned; if split is equal to "", the each letter in the string is placed into a different item in the list. Only the first character of <split> is used. IF you need a multicharacter split, you can use <SplitStringSlow>, which can handle multi-character splits but is relatively slower. This should not matter for short strings, but if you are using splitstring on long files, it could make a difference.

Usage: SplitString(<string>, <split>)

Example:

```
SplitString("Everybody Loves a Clown", " ")
# Produces ["Everybody", "Loves", "a", "Clown"]
```

See Also: `FindInString()`, `ReplaceChar`, `SplitStringSlow`

Name/Symbol: `SplitStringSlow()`

Description: Splits a string into tokens. `<split>` must be a string. If `<split>` is not found in `<string>`, a list containing the entire string is returned; if split is equal to `""`, the each letter in the string is placed into a different item in the list. The entire text of `<split>` is used to tokenize, but as a consequence this function is relatively slow, and should be avoided if your string is longer than a few hundred characters.

Usage: `SplitStringSlow(<string>, <split>)`

Example:
```
SplitStringSlow("Everybody Loves a Clown", " ")
# Produces ["Everybody", "Loves", "a", "Clown"]
SplitStringSlow("she sells seashells", "ll")
#produces ["she se","s seashe", "s"]
```

See Also: `Splitstring` `FindInString()`, `ReplaceChar`

Name/Symbol: `Square()`

Description: Creates a square for graphing at x,y with size `<size>`. Squares are only currently definable oriented in horizontal/vertical directions. A square must be added to a parent widget before it can be drawn; it may be added to widgets other than a base window. The properties of squares may be changed by accessing their properties directly, including the FILLED property which makes the object an outline versus a filled shape.

Usage: `Ellipse(<x>, <y>, <size>, <color>)`

Example:
```
s <- Square(30,30,20, MakeColor(green))
AddObject(s, win)
Draw()
```

See Also: `Circle()`, `Ellipse()`, `Rectangle()`, `Line()`

Name/Symbol: `Sqrt()`

Description: Square root of <num>.

Usage: Sqrt(<num>)

Example: Sqrt(100) # == 10

See Also:

Name/Symbol: StartEventLoop()

Description: Starts the event loop with currently-registered events. This function is currently experimental, and its usage may change in future versions of PEBL.

Usage: StartEventLoop()

Example:

See Also: RegisterEvent(), ClearEventLoop()

Name/Symbol: StartPlayback()

Description: Initiates playback of a movie so that it will play in the background when a Wait() or WaitFor() function is called. This allows one to collect a response while playing a movie. The movie will not actually play until the event loop is started, typically with something like Wait().

Usage: StartPlayBack(movie)

Example:

```
movie <- LoadMovie("movie.avi",gWin,640,480)
PrintProperties(movie)
Move(movie,20,20)
Draw()
StartPlayback(movie)
Wait(500) #Play 500 ms of the movie.
PausePlayback(movie)
```

See Also: LoadAudioFile(), LoadMovie(), PlayMovie(), PausePlayback()

Name/Symbol: StDev()

Description: Returns the standard deviation of <list>.

Usage: StDev(<list>)

Example:

```
sd <- StDev([3,5,99,12,1.3,15])
```

See Also: `Min()`, `Max()`, `Mean()`, `Median()`, `Quantile()`, `Sum()`

Name/Symbol: `Stop()`

Description: Stops a sound playing in the background from playing. Calling `Stop()` on a sound object that is not playing should have no effect, but if an object is aliased, `Stop()` will stop the file. Note that sounds play in a separate thread, so interrupting the thread has a granularity up to the duration of the thread-switching quantum on your computer; this may be tens of milliseconds.

Usage:

```
Stop(<sound-object>)
```

Example:

```
buzz <- LoadSound("buzz.wav")
PlayBackground(buzz)
Wait(50)
Stop(buzz)
```

See Also: `PlayForeground()`, `PlayBackGround()`

Name/Symbol: `StringLength()`

Description: Determines the length of a string, in characters.

Usage:

```
StringLength(<string>)
```

Example:

```
StringLength("absolute")     # == 8
StringLength("   spaces   ") # == 12
StringLength("")             # == 0
```

See Also: `Length()`, `SubString()`

Name/Symbol: `StripQuotes()`

Description: Strips quotation marks from the outside of a string. Useful if you are reading in data that is quoted.

Usage:

```
StripQuotes(<text>)
```

Example:

```
text <- gQuote + "abcd" + gQuote
Print(StripQuotes(text))  ## abcd
Print(StripQuotes("aaa")) ##aaa
```

See Also: `StripSpace()`

Name/Symbol: `StripSpace()`

Description: Strips spaces from the start and end of a string. Useful for cleaning up input and such.

Usage: `StripSpaces(<text>)`

Example:

```
text <-  " abcd  "
Print(StripSpace(text))  ## 'abcd'
Print(StripSpace("aaa")) ## 'aaa'
```

See Also: `StripQuotes()`

Name/Symbol: `SubList()`

Description: Extracts a list from another list, by specifying beginning and end points of new sublist.

Usage: `SubList(<list>, <begin>, <end>)`

Example: `SubList([1,2,3,4,5,6],3,5) # == [3,4,5]`

See Also: `SubSet()`, `ExtractListItems()`

Name/Symbol: `Subset()`

Description: Extracts a subset of items from another list, returning a new list that includes items from the original list only once and in their original orders. Item indices in the second argument that do not exist in the first argument are ignored. It has no side effects on its arguments.

Usage: `Subset(<list>, <list-of-indices>)`

Example:

```
Subset([1,2,3,4,5,6],[5,3,1,1]) # == [1,3,5]
Subset([1,2,3,4,5], [23,4,2]) # == [2,4]
```

See Also: `SubList()`, `ExtractItems()`, `SampleN()`

Name/Symbol: `SubString()`

Description: Extracts a substring from a longer string.

Usage: SubString(<string>,<position>,<length>)

If position is outside the bounds of the string (less than 1 or greater than its length), a fatal error occurs, so this should be checked if it is in question. In this respect, its behavior in 2.0 differs from earlier, when an empty string was returned. If position + length exceeds the length of the string, a string from <position> to the last character of the string is returned.

Example:

```
SubString("abcdefghijklmnop",3,5) # == "cdefg"
```

See Also:

Name/Symbol: Sum()

Description: Returns the sum of <list>.

Usage: Sum(<list>)

Example:

```
sum <- Sum([3,5,99,12,1.3,15])      # == 135.3
```

See Also: Min(), Max(), Mean(), Median(), Quantile(), StDev()

Name/Symbol: SummaryStats()

Description: Computes summary statistics for a data list, aggregated by labels in a condition list. For each condition (distinct label in the <cond> list), it will return a list with the following entries: <cond> <N> <median> <mean> <sd>

Usage: SummaryStats(<data>,<cond>)

Example:

```
dat <- [1.1,1.2,1.3,2.1,2.2,2.3]
cond <- [1,1,1,2,2,2]
Print(SummaryStats(dat,cond))
```

Result:

```
[[1, 3, 1.1, 1.2, 0.0816497]
, [2, 3, 2.1, 2.2, 0.0816497]
]
```

See Also: StDev(), Min(), Max(), Mean(), Median(), Quantile(), Sum()

Name/Symbol: SystemCall()

Description: Calls/runs another operating system command. Can also be used to launch another PEBL program. Useful to check GetSystemType() before running.

Note that the output of a command-line argument is generally not passed back into PEBL; just the function's return code, which is usually 0 on success or some other number on failure (depending upon the type of failure). Some uses might include:

Usage:
```
SystemCall("text-of-command")
SystemCall("text-of-command","command-line-options")
```

Example:
```
   if(GetSystemType() == "WINDOWS")
     {
       x <- SystemCall("dir input.txt")
     } else {
       x <- SystemCall("ls input.txt")
     }
      if(x <> 0)
      {
         SignalFatalError("Expected file ["+
               "input.txt] does not exist")
      }
```

See Also: `GetSystemType()`

9.20 T

Name/Symbol: `Tab()`

Description: Produces a tab character which can be added to a string. If displayed in a text box, it will use a 4-item tab stop.

Usage: `Tab(3)`

Example:

```
Print("Number: "  Tab(1) + number )
Print("Value: "  Tab(1) + value )
Print("Size: "  Tab(1) + size )
```

See Also: `Format()`, `CR()`

Name/Symbol: `Tan()`

Description: Tangent of <deg> degrees.

Usage:

```
Tan(<deg>)
```

Example: `Tan(180)`

See Also: `Cos()`, `Sin()`, `ATan()`, `ACos()`, `ATan()`

Name/Symbol: `ThickLine()`

Description: Makes a thick line between two coordinates. This uses the SDL_gfx thickline primitive.

Usage:

```
ThickLine(<x1>,<y1>,<x2>,<y2>,
          <size-in-pixels>,<color>)
```

Example:

```
a <- ThickLine(10,10,300,400,20,
             MakeColor("red"))
AddObject(a,gWin)
Draw()
```

See Also: `Line()`, `Polygon()`

Name/Symbol: `TimeStamp()`

Description: Returns a string containing the date-and-time, formatted according to local conventions. Should be used for documenting the time-of-day and date an experiment was run, but not for keeping track of timing accuracy. For that, use `GetTime()`.

Usage:

```
TimeStamp()
```

Example:

```
a <- TimeStamp()
Print(a)
```

See Also: `GetTime()`

Name/Symbol: `ToInteger()`

Description: Rounds a number to an integer, changing internal representation.

Usage:

```
ToInteger(<number>)
ToInteger(<floating-point>)
ToInteger(<string-as-number>)
```

Example:

```
ToInteger(33.332)  # == 33
ToInteger("3213")  # == 3213
```

See Also: `Round()`, `Ceiling()`, `AbsCeiling()`, `Floor()`, `AbsFloor()`

Name/Symbol: `ToFloat()`

Description: Converts number to internal floating-point representation.

Usage:

```
ToFloat(<number>)
```

Example:

See Also:

Name/Symbol: `ToNumber()`

Description: Converts a variant to a number. Most useful for character strings that are interpretable as a number, but may also work for other subtypes.

Usage:

```
ToNumber(<string)
ToNumber(<number>)
```

Example:
```
a <- ToNumber("3232")
Print(a + 1) # produces the output 3233.
```

See Also: `ToString()`, `ToFloat()`, `Round()`

Name/Symbol: `ToRight()`

Description: Determines whether a point p3 is 'to the right' of a line segment defined by p1 to p2. Works essentially by computing the determinant.

Usage:
```
ToRight(<p1>,<p2>,<p3>)
```

Example:
```
a <- [100,0]
b <- [100,100]
c <- [150,50]
ToRight(a,b,c) # returns 1; true
ToRight(b,a,c) # returns 0; false
```

See Also: `GetAngle()` `GetAngle3`, `SegmentsIntersect`

Name/Symbol: `ToString()`

Description: Converts value to a string representation. Most useful for numerical values. This conversion is done automatically when strings are combined with numbers.

Usage:
```
ToString(<number>)
ToString(<string>)
```

Example:
```
a <- ToString(333.232)
Print(a + "111")
# produces the output '333.232111'.
```

See Also: `ToString()`, `+`.

Name/Symbol: `TranslateKeyCode()`

Description: Translates a code corresponding to a keyboard key into a keyboard value. This code is returned by some event/device polling functions.

Usage:

Example:

See Also:

Name/Symbol: `Transpose()`

Description: Transposes or "rotates" a list of lists. Each sublist must be of the same length.

Usage: `Transpose(<list-of-lists>)`

Example:

```
Transpose([[1,11,111],[2,22,222],
           [3,33,333], [4,44,444]])
# == [[1,2,3,4],[11,22,33,44],
#      [111,222,333,444]]
```

See Also: `Rotate()`

9.21 U

Name/Symbol: `UpdatePulldown()`

Description: This changes the list being used in a Pulldown object. It tries to maintain the same selected option (matching the text of the previous selection), but if not found will select index 1. It calls `DrawPullDown` when complete, but a `Draw()` command must be issued before the pulldown changes will appear.

Usage:

```
UpdatePullDown(object, newlist)
```

Example:

```
options  <- MakePulldownButton(["A",B","C"],400,250,gWin,14,100,3)
Draw()
WaitForAnyKeyPress()

##This should add a fourth option but C should still be selected.
UpdatePullDown(options,["A","B","C","D"])
Draw()
WaitForAnyKeyPress()
```

See Also: `MakePullDown()`, `Pulldown()`, `DrawPulldown`

Name/Symbol: `UpdateScrollbox()`

Description: This updates the layout of a `ScrollBox`. It should be used if you manually change the .list or .listoffset properties. It won't actually redraw the scrollbox (which is done by DrawScrollbox).

Usage:

```
UpdateScrollBox(sb)
```

Here, `sb` is the scrollbox object.

Example: See ui.pbl in the demo directory for examples of the use of a scrolling text box. A brief example follows:

```
sb <- MakeScrollBox(Sequence(1,50,1),"The numbers",40,40,gWin,12,150,5
Draw()

resp <- WaitForClickOntarget([sb],[1])
CallFunction(sb.clickon,[sb,gClick])
#Alternately: ClickOnScrollbox(sb,gClick)

##change the selected items
sb.list <- Sequence(sb.selected,sb.selected+50,1)
UpdateScrollbox(sb)
DrawScrollbox(sb)
Draw()
```

See Also: MakeScrollingTextBox MakeScrollBox DrawScrollBox ClickOnScrollBox

---

Name/Symbol: Uppercase()

Description: Changes a string to uppercase. Useful for testing user input against a stored value, to ensure case differences are not detected.

Usage: Uppercase(<string>)

Example: Uppercase("POtaTo") # == "POTATO"

See Also: Lowercase()

9.22 V

Name/Symbol: `VariableExists()`

Description: Tests whether a variable exists.

Usage: `Uppercase("variablename")`

This is a low-level function that tests whether a variable exists. It is used for error-checking in some functions within the launcher.

Example:

```
if(not VariableExists("underwear"))
 {
   underwear <- "Under there"
 }
```

See Also: `PropertyExists()`

Name/Symbol: `VecSum()`

Description: Returns the pairwise sums of `<list1>` and `<list2>`.

Usage: `VecSum(<list1>,<list2>)`

Example:

```
sum <- VecSum([1,1,1,1,2],[2,3,4,3,2])
## == [3,4,5,4,4]
```

See Also: `VecTimes()`, `CumSum()`, `Median()`, `Quantile()`

Name/Symbol: `VecTimes()`

Description: Returns the pairwise sums of `<list1>` and `<list2>`.

Usage: `VecSum(<list1>,<list2>)`

Example:

```
sum <- VecSum([1,1,2,2,3],[2,3,4,3,2])
## == [2,3,8,6,6]
```

See Also: `VecSum()`, `Mean()`, `CumSum()`

9.23 W

Name/Symbol: `Wait()`

Description: Waits the specified number of milliseconds, then returns.

Usage: `Wait(<time>)`

Example:
```
Wait(100)
Wait(15)
```

See Also:

Name/Symbol: `WaitForAllKeysUp()`

Description: Wait until all keyboard keys are in the up position. This includes numlock, capslock, etc.

Usage:

Example:

See Also:

Name/Symbol: `WaitForAnyKeyDown()`

Description: Waits for any key to be detected in the down position. This includes numlock, capslock, etc, which can be locked in the down position even if they are not being held down. Will return immediately if a key is being held down before the function is called.

Usage: This checks for keyboard state. Users should prefer `WaitForAnyKeyPress()`

Example:

See Also: `WaitForAnyKeyPress()`

Name/Symbol: `WaitForAnyKeyDownWithTimeout()`

Description: Waits until any key is detected in the down position, but will return after a specified number of milliseconds. This tests for the key position on each cycle; users should prefer using WaitForAnyKeyPressWithTimout() which waits for the keypress event.

Usage:

```
WaitForAnyKeyDownWithTimeout(<time>)
```

This returns "<anykey>" if pressed, and <timeout> if not pressed in time.

Example:

See Also: `WaitForAnyKeyPressWithTimeout()`, `WaitListKeyPressWithTimeout()`, `WaitForAnyKeyPress()`, `WaitListKeyPress()`

Name/Symbol: `WaitForAnyKeyPress()`

Description: Waits until any key is pressed, and returns the key pressed. This waits for the keyboard event, which is typically more reliable and less computationally taxing than waiting for the keyboard state (which updates based on those events anyway).

Usage:

```
WaitForKeyPress(<time>)
```

This returns a text representation of the key pressed.

Example:

```
cont <- 1
 while(cont)
  {
       key <- WaitForAnyKEyPress()
       if(key == "x")
        {
          cont <- 0
        }
  }
```

See Also: `WaitForAnyKeyPressWithTimeout()`, `WaitListKeyPressWithTimeout()`, `WaitListKeyPress()`

Name/Symbol: `WaitForAnyKeyPressWithTimeout()`

Description: Waits until any key is detected in the down position, but will return after a specified number of milliseconds. This tests for the key position on each cycle; users should prefer using WaitForAnyKeyPressWithTimout() which waits for the keypress event.

Usage: `WaitForAnyKeyDownWithTimeout(<time>)`

This returns "<anykey>" if pressed, and <timeout> if not pressed in time.

Example:

See Also: `WaitForAnyKeyPressWithTimeout()`, `WaitListKeyPressWithTimeout()`

Name/Symbol: `WaitForClickOnTarget()`

Description: Allows you to specify a list of graphical objects in `<objectlist>` and awaits a click on any one of them, returning the corresponding key in <keylist>. Also, sets the global variable gClick which saves the location of the click, if you need it for something else.

Usage:

```
x <- WaitForClickOnTarget(<objectlist>,<keylist>)
```

Example:

```
resp <- Sequence(1,5,1)
objs <- []
loop(i,resp)
{
  tmp <- EasyLabel(i +". ",
           100+50*i,100,gWin,25)
  objs <- Append(objs, tmp)
}
Draw()
click  <- WaitForClickOnTarget(objs,resp)
Print("You clicked on " + click)
Print("Click location: [" + First(gClick) +
      ", " + Second(gClick) + "]")
```

See Also:

Name/Symbol: `WaitForClickOnTargetWithTimeout()`

Description: Allows you to specify a list of graphical objects in `<objectlist>` and awaits a click on any one of them, returning the corresponding key in `<keylist>`. Also, sets the global variable gClick which saves the location of the click, if you need it for something else. The function will return after the specified time limit.

If no response is made by timeout, the text <timeout> will be returned (instead of the corresponding keylist element), and gClick will be set to [-1, -1].

This function can also be useful to dynamically update some visual object while waiting for a response. Give timeout some small number (below 50 ms, as low as 1-5), and loop over this repeatedly until a 'proper' response is given, redrawing a timer or other dynamic visual element each time.

By default, this will only activate when a normal (left-click) is made on button 1. However, the three optional arguments button1, button2, and button3 permit waiting for any or all left, right, or center buttons.

Usage:

```
x <- WaitForClickOnTargetWithTimeout(<objectlist>,<keylist>,<timeout-in-ms>,
       opt:button1,opt:button2,opt:button3)
```

Example:

```
resp <- Sequence(1,5,1)
objs <- []
loop(i,resp)
{
  tmp <- EasyLabel(i +". ",
            100+50*i,100,gWin,25)
  objs <- Append(objs, tmp)
}
Draw()
click  <- WaitForClickOnTargetWithTimeout(objs,resp,3000)
Print("You clicked on " + click)
Print("Click location: [" + First(gClick) +
      ", " + Second(gClick) + "]")

##wait for a center-click.
click  <- WaitForClickOnTargetWithTimeout(objs,resp,3000,0,0,1)
```

See Also: WaitForDownClick(), WaitForMouseButton()

Name/Symbol: WaitForDownClick()

Description: Will wait until the mouse button is clicked down. Returns the same 4-tuple as WaitForMouseButton:

```
[xpos,
  ypos,
  button id [1-3],
  "<pressed>" or "<released>"]
```

but the last element will always be <pressed>. Useful as a 'click mouse to continue' probe.

Usage:

```
WaitForDownClick()
```

Example:

```
x <- WaitForDownClick()
Print("Click location: [" + First(x) +
      ", " + Second(x) + "]")
```

See Also: WaitForClickOnTarget(), WaitForMouseButton()

Name/Symbol: WaitForKeyListDown()

Description: Returns when any one of the keys specified in the argument is down. If a key is down when called, it will return immediately.

Usage: WaitForKeyListDown(<list-of-keys>)

Example: WaitForKeyListDown(["a","z"])

See Also:

Name/Symbol: WaitForListKeyPressWithTimeout()

Description: Returns when any one of the keys specified in the argument is pressed, or when the timeout has elapsed; whichever comes first. Will only return on a new keyboard/timeout events, and so a previously pressed key will not trip this function, unlike WaitForKeyListDown(). The optional <style> parameter is currently unused, but may be deployed in the future for differences in how or when things should be returned. Returns the value of the pressed key. If the function terminates by exceeding the <timeout>, it will return the string "<timeout>". Note: previous to 2.0, returned a list ["<timeout>"], which may mean updating logic for tests designed in the 0.x series.

Usage:

```
WaitForListKeyPressWithTimeout(<list-of-keys>,
                               <timeout>,opt:<style>)
```

<list-of-keys> can include text versions of many keys. See Chapter 4, section “Keyboard Entry” for complete list of keynames.

Example:

```
x <- WaitForListKeyPressWithTimeout(["a","z"],
                                    2000)
if(IsList(x))
{
   Print("Did Not Respond.")
}
```

See Also: `WaitForKeyListDown`, `WaitForListKeyPress`, `WaitForKeyPressWithTimeout`

Name/Symbol: `WaitForListKeyPress()`

Description: Returns when any one of the keys specified in the argument is pressed. Will only return on a new keyboard event, and so a previously pressed key will not trip this function, unlike `WaitForKeyListDown()` Returns a string indicating the value of the keypress.

Usage: `WaitForListKeyPress(<list-of-keys>)`

Example: `WaitForListKeyPress(["a","z"])`

See Also: `WaitForKeyListDown`, `WaitForListKeyPressWithTimeout`

Name/Symbol: `WaitForKeyPress()`

Description: Waits for a keypress event that matches the specified key. Usage of this function is preferred over `WaitForKeyDown()`, which tests the state of the key. Returns the value of the key pressed.

Usage: `WaitForKeyPress(<key>)`

Example:

See Also: `WaitForAnyKeyPress()`, `WaitForKeyRelease()`, `WaitForListKeyPress()`

Name/Symbol: `WaitForKeyUp()`

Description:

Usage:

Example:

See Also:

Name/Symbol: `WaitForMouseButton()`

Description: Waits for a mouse click event to occur. This takes no arguments, and returns a 4-tuple list, indicating:

```
[xpos,
 ypos,
 button id [1-3],
 "<pressed>" or "<released>"]
```

Usage: `WaitForMouseButton()`

Example:

```
## Here is how to wait for a mouse down-click

 continue <- 1
 while(continue)
 {
     x <- WaitForMouseButton()
     if(Nth(x,4)=="<pressed>")
      {
          continue <- 0
      }
 }
 Print("Clicked")
```

See Also: `ShowCursor`, `WaitForMouseButtonWithTimeout` `SetMouseCursorPosition`, `GetMouseCursorPosition`

Name/Symbol: `WaitForMouseButtonWithTimeout(delay)`

Description: Waits for a mouse click event to occur, or a timeout to be reached. This takes a single argument: timeout delay in ms. When clicked, it returns a 4-tuple list, indicating:

```
[xpos,
 ypos,
 button id [1-3],
 "<pressed>" or "<released>"]
```

when not click and timeout is reached, it returns a list: `[timeout]`

Usage: `WaitForMouseButtonWithTimeOut(10)`

Example:

```
## Here is how to wait for a mouse down-click

 continue <- 1
 while(continue)
 {
     x <- WaitForMouseButtonWithTimeout(500)
     if(First(x)=="<timeout>")
```

```
      {
         Print("time is "+GetTime())
          continue <- 1
      } else {
          continue <- 0
      }
 }
 Print("Clicked")
```

See Also: `ShowCursor`, `SetMouseCursorPosition`, `GetMouseCursorPosition`

Name/Symbol: `WaitForNetworkConnection()`

Description: Listens on a port, waiting until another computer or process connects. Return a network object that can be used for communication.

Usage:

```
WaitForNetworkConnection(<port>)
```

Example: See nim.pbl for example of two-way network connection.

```
net <- WaitForNetworkConnection(1234)
dat <- GetData(net,20)
Print(dat)
CloseNetworkConnection(net)
```

See Also: `ConnectToHost`, `ConnectToIP`, `GetData`, `WaitForNetworkConnection`, `SendData`, `ConvertIPString`, `CloseNetworkConnection`

Name/Symbol: `while`

Description: 'while' is a keyword, and so is part of the syntax, not a function per se. It executes the code inside the `{}` brackets until the test inside the `()` executes as false. This can easily lead to an infinite loop if conditions are not met. Also, there is currently no break statement to allow execution to halt early. Unlike some other languages, PEBL requires that the `{}` be present.

Usage:

```
while(<test expression>)
{
 code line 1
 code line 2
}
```

Example:

```
i <- 1
while(i <= 10)
{
 Print(i)
 i <- i + 1
} # prints out the numbers 1 through 10
```

See Also: `loop()`, `{ }`

Name/Symbol: `WritePNG()`

Description: WritePNG() creates a graphic file of the screen or a widget on the screen. It can also be given an arbitrary widget. For the most part, widgets added to other widgets will be captured fine, but sometimes polygons and shapes added to other widgets may not appear in the output png.

Usage:

```
x <-  WritePNG("screen1.png",gWin)

## Use like this to create an animated screencast
 define DrawMe()
  {
    pname <- "fileout"+ZeroPad(gid,5)+".png"
    Draw()
    WritePNG(pname,gWin)
  }

 define Start(p)
 {
   gid <- 1
   gWin <- MakeWindow()
   img <- MakeImage("pebl.png")
   AddObject(img,gWin)
   while(gid < 100)
    {
       Move(img,RandomDiscrete(800),
                RandomDiscrete(600))

       DrawMe()
       gid <- gid + 1
    }

 }
```

See Also: `FileWriteTable`

9.24 Z

Name/Symbol: `ZeroPad`

Description: Takes a number and pads it with zeroes left of the decimal point so that its length is equal to <size>. Argument must be a positive integer and less than ten digits. Returns a string.

Usage:

```
ZeroPad(<number>, <length>)
```

Example:

```
Print(ZeroPad(33,5))     # "00033"
Print(ZeroPad(123456,6)) #"123456"
Print(ZeroPad(1,8))      #"00000001"
```

See Also: `Format()`

Name/Symbol: `ZoomPoints`

Description: Takes a set of points (defined in a joined list [[x1,x2,x3,...],[y1,y2,y3,...]] and adjusts them in the x and y direction independently, returning a similar [[x],[y]] list.

Note: The original points should be centered at zero, because the get adjusted relative to zero, not relative to their center.

Usage:

```
ZoomPoints(points,<xzoom>,<yzoom>)
```

Example:

```
points <- [[1,2,3,4],[20,21,22,23]]
newpoints <- ZoomPoints(points,2,.5)
##Produces [[2,4,6,8],[10,11.5,11,11.5]]
```

See Also: `RotatePoints()`, `ReflectPoints`

Chapter 10

Color Name Reference

In PEBL, around 750 colors can be accessed by name, using the MakeColor() function. Each name corresponds to a specific RGB value. The following table provides examples of the particular color names, RGB values, and the obtained shade produced by PEBL.

Table 10.1: Color Reference

Color Name	Red	Green	Blue	Example
ALICE BLUE	240	248	255	
ALICEBLUE	240	248	255	
ANTIQUE WHITE	250	235	215	
ANTIQUEWHITE	250	235	215	
ANTIQUEWHITE1	255	239	219	
ANTIQUEWHITE2	238	223	204	
ANTIQUEWHITE3	205	192	176	
ANTIQUEWHITE4	139	131	120	
AQUAMARINE	127	255	212	
AQUAMARINE1	127	255	212	
AQUAMARINE2	118	238	198	
AQUAMARINE3	102	205	170	
AQUAMARINE4	69	139	116	
AZURE	240	255	255	
AZURE1	240	255	255	
AZURE2	224	238	238	
AZURE3	193	205	205	
AZURE4	131	139	139	
BEIGE	245	245	220	
BISQUE	255	228	196	
BISQUE1	255	228	196	
BISQUE2	238	213	183	

Color Name	Red	Green	Blue	Example
BISQUE3	205	183	158	
BISQUE4	139	125	107	
BLACK	0	0	0	
BLANCHED ALMOND	255	235	205	
BLANCHEDALMOND	255	235	205	
BLUE	0	0	255	
BLUE VIOLET	138	43	226	
BLUE1	0	0	255	
BLUE2	0	0	238	
BLUE3	0	0	205	
BLUE4	0	0	139	
BLUEVIOLET	138	43	226	
BROWN	165	42	42	
BROWN1	255	64	64	
BROWN2	238	59	59	
BROWN3	205	51	51	
BROWN4	139	35	35	
BURLYWOOD	222	184	135	
BURLYWOOD1	255	211	155	
BURLYWOOD2	238	197	145	
BURLYWOOD3	205	170	125	
BURLYWOOD4	139	115	85	
CADET BLUE	95	158	160	
CADETBLUE	95	158	160	
CADETBLUE1	152	245	255	
CADETBLUE2	142	229	238	
CADETBLUE3	122	197	205	
CADETBLUE4	83	134	139	
CHARTREUSE	127	255	0	
CHARTREUSE1	127	255	0	
CHARTREUSE2	118	238	0	
CHARTREUSE3	102	205	0	
CHARTREUSE4	69	139	0	
CHOCOLATE	210	105	30	
CHOCOLATE1	255	127	36	
CHOCOLATE2	238	118	33	
CHOCOLATE3	205	102	29	
CHOCOLATE4	139	69	19	
CORAL	255	127	80	
CORAL1	255	114	86	
CORAL2	238	106	80	
CORAL3	205	91	69	
CORAL4	139	62	47	

Color Name	Red	Green	Blue	Example
CORNFLOWER BLUE	100	149	237	
CORNFLOWERBLUE	100	149	237	
CORNSILK	255	248	220	
CORNSILK1	255	248	220	
CORNSILK2	238	232	205	
CORNSILK3	205	200	177	
CORNSILK4	139	136	120	
CYAN	0	255	255	
CYAN1	0	255	255	
CYAN2	0	238	238	
CYAN3	0	205	205	
CYAN4	0	139	139	
DARK BLUE	0	0	139	
DARK CYAN	0	139	139	
DARK GOLDENROD	184	134	11	
DARK GRAY	169	169	169	
DARK GREEN	0	100	0	
DARK GREY	169	169	169	
DARK KHAKI	189	183	107	
DARK MAGENTA	139	0	139	
DARK OLIVE GREEN	85	107	47	
DARK ORANGE	255	140	0	
DARK ORCHID	153	50	204	
DARK RED	139	0	0	
DARK SALMON	233	150	122	
DARK SEA GREEN	143	188	143	
DARK SLATE BLUE	72	61	139	
DARK SLATE GRAY	47	79	79	
DARK SLATE GREY	47	79	79	
DARK TURQUOISE	0	206	209	
DARK VIOLET	148	0	211	
DARKBLUE	0	0	139	
DARKCYAN	0	139	139	
DARKGOLDENROD	184	134	11	
DARKGOLDENROD1	255	185	15	
DARKGOLDENROD2	238	173	14	
DARKGOLDENROD3	205	149	12	
DARKGOLDENROD4	139	101	8	
DARKGRAY	169	169	169	
DARKGREEN	0	100	0	
DARKGREY	169	169	169	
DARKKHAKI	189	183	107	
DARKMAGENTA	139	0	139	

Color Name	Red	Green	Blue	Example
DARKOLIVEGREEN	85	107	47	
DARKOLIVEGREEN1	202	255	112	
DARKOLIVEGREEN2	188	238	104	
DARKOLIVEGREEN3	162	205	90	
DARKOLIVEGREEN4	110	139	61	
DARKORANGE	255	140	0	
DARKORANGE1	255	127	0	
DARKORANGE2	238	118	0	
DARKORANGE3	205	102	0	
DARKORANGE4	139	69	0	
DARKORCHID	153	50	204	
DARKORCHID1	191	62	255	
DARKORCHID2	178	58	238	
DARKORCHID3	154	50	205	
DARKORCHID4	104	34	139	
DARKRED	139	0	0	
DARKSALMON	233	150	122	
DARKSEAGREEN	143	188	143	
DARKSEAGREEN1	193	255	193	
DARKSEAGREEN2	180	238	180	
DARKSEAGREEN3	155	205	155	
DARKSEAGREEN4	105	139	105	
DARKSLATEBLUE	72	61	139	
DARKSLATEGRAY	47	79	79	
DARKSLATEGRAY1	151	255	255	
DARKSLATEGRAY2	141	238	238	
DARKSLATEGRAY3	121	205	205	
DARKSLATEGRAY4	82	139	139	
DARKSLATEGREY	47	79	79	
DARKTURQUOISE	0	206	209	
DARKVIOLET	148	0	211	
DEEP PINK	255	20	147	
DEEP SKY BLUE	0	191	255	
DEEPPINK	255	20	147	
DEEPPINK1	255	20	147	
DEEPPINK2	238	18	137	
DEEPPINK3	205	16	118	
DEEPPINK4	139	10	80	
DEEPSKYBLUE	0	191	255	
DEEPSKYBLUE1	0	191	255	
DEEPSKYBLUE2	0	178	238	
DEEPSKYBLUE3	0	154	205	
DEEPSKYBLUE4	0	104	139	

Color Name	Red	Green	Blue	Example
DIM GRAY	105	105	105	
DIM GREY	105	105	105	
DIMGRAY	105	105	105	
DIMGREY	105	105	105	
DODGER BLUE	30	144	255	
DODGERBLUE	30	144	255	
DODGERBLUE1	30	144	255	
DODGERBLUE2	28	134	238	
DODGERBLUE3	24	116	205	
DODGERBLUE4	16	78	139	
FIREBRICK	178	34	34	
FIREBRICK1	255	48	48	
FIREBRICK2	238	44	44	
FIREBRICK3	205	38	38	
FIREBRICK4	139	26	26	
FLORAL WHITE	255	250	240	
FLORALWHITE	255	250	240	
FOREST GREEN	34	139	34	
FORESTGREEN	34	139	34	
GAINSBORO	220	220	220	
GHOST WHITE	248	248	255	
GHOSTWHITE	248	248	255	
GOLD	255	215	0	
GOLD1	255	215	0	
GOLD2	238	201	0	
GOLD3	205	173	0	
GOLD4	139	117	0	
GOLDENROD	218	165	32	
GOLDENROD1	255	193	37	
GOLDENROD2	238	180	34	
GOLDENROD3	205	155	29	
GOLDENROD4	139	105	20	
GRAY	190	190	190	
GRAY0	0	0	0	
GRAY1	3	3	3	
GRAY2	5	5	5	
GRAY3	8	8	8	
GRAY4	10	10	10	
GRAY5	13	13	13	
GRAY6	15	15	15	
GRAY7	18	18	18	
GRAY8	20	20	20	
GRAY9	23	23	23	

Color Name	Red	Green	Blue	Example
GRAY10	26	26	26	
GRAY11	28	28	28	
GRAY12	31	31	31	
GRAY13	33	33	33	
GRAY14	36	36	36	
GRAY15	38	38	38	
GRAY16	41	41	41	
GRAY17	43	43	43	
GRAY18	46	46	46	
GRAY19	48	48	48	
GRAY20	51	51	51	
GRAY21	54	54	54	
GRAY22	56	56	56	
GRAY23	59	59	59	
GRAY24	61	61	61	
GRAY25	64	64	64	
GRAY26	66	66	66	
GRAY27	69	69	69	
GRAY28	71	71	71	
GRAY29	74	74	74	
GRAY30	77	77	77	
GRAY31	79	79	79	
GRAY32	82	82	82	
GRAY33	84	84	84	
GRAY34	87	87	87	
GRAY35	89	89	89	
GRAY36	92	92	92	
GRAY37	94	94	94	
GRAY38	97	97	97	
GRAY39	99	99	99	
GRAY40	102	102	102	
GRAY41	105	105	105	
GRAY42	107	107	107	
GRAY43	110	110	110	
GRAY44	112	112	112	
GRAY45	115	115	115	
GRAY46	117	117	117	
GRAY47	120	120	120	
GRAY48	122	122	122	
GRAY49	125	125	125	
GRAY50	127	127	127	
GRAY51	130	130	130	
GRAY52	133	133	133	

Color Name	Red	Green	Blue	Example
GRAY53	135	135	135	
GRAY54	138	138	138	
GRAY55	140	140	140	
GRAY56	143	143	143	
GRAY57	145	145	145	
GRAY58	148	148	148	
GRAY59	150	150	150	
GRAY60	153	153	153	
GRAY61	156	156	156	
GRAY62	158	158	158	
GRAY63	161	161	161	
GRAY64	163	163	163	
GRAY65	166	166	166	
GRAY66	168	168	168	
GRAY67	171	171	171	
GRAY68	173	173	173	
GRAY69	176	176	176	
GRAY70	179	179	179	
GRAY71	181	181	181	
GRAY72	184	184	184	
GRAY73	186	186	186	
GRAY74	189	189	189	
GRAY75	191	191	191	
GRAY76	194	194	194	
GRAY77	196	196	196	
GRAY78	199	199	199	
GRAY79	201	201	201	
GRAY80	204	204	204	
GRAY81	207	207	207	
GRAY82	209	209	209	
GRAY83	212	212	212	
GRAY84	214	214	214	
GRAY85	217	217	217	
GRAY86	219	219	219	
GRAY87	222	222	222	
GRAY88	224	224	224	
GRAY89	227	227	227	
GRAY90	229	229	229	
GRAY91	232	232	232	
GRAY92	235	235	235	
GRAY93	237	237	237	
GRAY94	240	240	240	
GRAY95	242	242	242	

Color Name	Red	Green	Blue	Example
GRAY96	245	245	245	
GRAY97	247	247	247	
GRAY98	250	250	250	
GRAY99	252	252	252	
GRAY100	255	255	255	
GREEN	0	255	0	
GREEN YELLOW	173	255	47	
GREEN1	0	255	0	
GREEN2	0	238	0	
GREEN3	0	205	0	
GREEN4	0	139	0	
GREENYELLOW	173	255	47	
GREY	190	190	190	
GREY0	0	0	0	
GREY1	3	3	3	
GREY2	5	5	5	
GREY3	8	8	8	
GREY4	10	10	10	
GREY5	13	13	13	
GREY6	15	15	15	
GREY7	18	18	18	
GREY8	20	20	20	
GREY9	23	23	23	
GREY10	26	26	26	
GREY11	28	28	28	
GREY12	31	31	31	
GREY13	33	33	33	
GREY14	36	36	36	
GREY15	38	38	38	
GREY16	41	41	41	
GREY17	43	43	43	
GREY18	46	46	46	
GREY19	48	48	48	
GREY20	51	51	51	
GREY21	54	54	54	
GREY22	56	56	56	
GREY23	59	59	59	
GREY24	61	61	61	
GREY25	64	64	64	
GREY26	66	66	66	
GREY27	69	69	69	
GREY28	71	71	71	
GREY29	74	74	74	

Color Name	Red	Green	Blue	Example
GREY30	77	77	77	
GREY31	79	79	79	
GREY32	82	82	82	
GREY33	84	84	84	
GREY34	87	87	87	
GREY35	89	89	89	
GREY36	92	92	92	
GREY37	94	94	94	
GREY38	97	97	97	
GREY39	99	99	99	
GREY40	102	102	102	
GREY41	105	105	105	
GREY42	107	107	107	
GREY43	110	110	110	
GREY44	112	112	112	
GREY45	115	115	115	
GREY46	117	117	117	
GREY47	120	120	120	
GREY48	122	122	122	
GREY49	125	125	125	
GREY50	127	127	127	
GREY51	130	130	130	
GREY52	133	133	133	
GREY53	135	135	135	
GREY54	138	138	138	
GREY55	140	140	140	
GREY56	143	143	143	
GREY57	145	145	145	
GREY58	148	148	148	
GREY59	150	150	150	
GREY60	153	153	153	
GREY61	156	156	156	
GREY62	158	158	158	
GREY63	161	161	161	
GREY64	163	163	163	
GREY65	166	166	166	
GREY66	168	168	168	
GREY67	171	171	171	
GREY68	173	173	173	
GREY69	176	176	176	
GREY70	179	179	179	
GREY71	181	181	181	
GREY72	184	184	184	

Color Name	Red	Green	Blue	Example
GREY73	186	186	186	
GREY74	189	189	189	
GREY75	191	191	191	
GREY76	194	194	194	
GREY77	196	196	196	
GREY78	199	199	199	
GREY79	201	201	201	
GREY80	204	204	204	
GREY81	207	207	207	
GREY82	209	209	209	
GREY83	212	212	212	
GREY84	214	214	214	
GREY85	217	217	217	
GREY86	219	219	219	
GREY87	222	222	222	
GREY88	224	224	224	
GREY89	227	227	227	
GREY90	229	229	229	
GREY91	232	232	232	
GREY92	235	235	235	
GREY93	237	237	237	
GREY94	240	240	240	
GREY95	242	242	242	
GREY96	245	245	245	
GREY97	247	247	247	
GREY98	250	250	250	
GREY99	252	252	252	
GREY100	255	255	255	
HONEYDEW	240	255	240	
HONEYDEW1	240	255	240	
HONEYDEW2	224	238	224	
HONEYDEW3	193	205	193	
HONEYDEW4	131	139	131	
HOT PINK	255	105	180	
HOTPINK	255	105	180	
HOTPINK1	255	110	180	
HOTPINK2	238	106	167	
HOTPINK3	205	96	144	
HOTPINK4	139	58	98	
INDIAN RED	205	92	92	
INDIANRED	205	92	92	
INDIANRED1	255	106	106	
INDIANRED2	238	99	99	

Color Name	Red	Green	Blue	Example
INDIANRED3	205	85	85	
INDIANRED4	139	58	58	
IVORY	255	255	240	
IVORY1	255	255	240	
IVORY2	238	238	224	
IVORY3	205	205	193	
IVORY4	139	139	131	
KHAKI	240	230	140	
KHAKI1	255	246	143	
KHAKI2	238	230	133	
KHAKI3	205	198	115	
KHAKI4	139	134	78	
LAVENDER	230	230	250	
LAVENDER BLUSH	255	240	245	
LAVENDERBLUSH	255	240	245	
LAVENDERBLUSH1	255	240	245	
LAVENDERBLUSH2	238	224	229	
LAVENDERBLUSH3	205	193	197	
LAVENDERBLUSH4	139	131	134	
LAWN GREEN	124	252	0	
LAWNGREEN	124	252	0	
LEMON CHIFFON	255	250	205	
LEMONCHIFFON	255	250	205	
LEMONCHIFFON1	255	250	205	
LEMONCHIFFON2	238	233	191	
LEMONCHIFFON3	205	201	165	
LEMONCHIFFON4	139	137	112	
LIGHT BLUE	173	216	230	
LIGHT CORAL	240	128	128	
LIGHT CYAN	224	255	255	
LIGHT GOLDENROD YELLOW	250	250	210	
LIGHT GOLDENROD	238	221	130	
LIGHT GRAY	211	211	211	
LIGHT GREEN	144	238	144	
LIGHT GREY	211	211	211	
LIGHT PINK	255	182	193	
LIGHT SALMON	255	160	122	
LIGHT SEA GREEN	32	178	170	
LIGHT SKY BLUE	135	206	250	
LIGHT SLATE BLUE	132	112	255	
LIGHT SLATE GRAY	119	136	153	
LIGHT SLATE GREY	119	136	153	
LIGHT STEEL BLUE	176	196	222	

Color Name	Red	Green	Blue	Example
LIGHT YELLOW	255	255	224	
LIGHTBLUE	173	216	230	
LIGHTBLUE1	191	239	255	
LIGHTBLUE2	178	223	238	
LIGHTBLUE3	154	192	205	
LIGHTBLUE4	104	131	139	
LIGHTCORAL	240	128	128	
LIGHTCYAN	224	255	255	
LIGHTCYAN1	224	255	255	
LIGHTCYAN2	209	238	238	
LIGHTCYAN3	180	205	205	
LIGHTCYAN4	122	139	139	
LIGHTGOLDENROD	238	221	130	
LIGHTGOLDENROD1	255	236	139	
LIGHTGOLDENROD2	238	220	130	
LIGHTGOLDENROD3	205	190	112	
LIGHTGOLDENROD4	139	129	76	
LIGHTGOLDENRODYELLOW	250	250	210	
LIGHTGRAY	211	211	211	
LIGHTGREEN	144	238	144	
LIGHTGREY	211	211	211	
LIGHTPINK	255	182	193	
LIGHTPINK1	255	174	185	
LIGHTPINK2	238	162	173	
LIGHTPINK3	205	140	149	
LIGHTPINK4	139	95	101	
LIGHTSALMON	255	160	122	
LIGHTSALMON1	255	160	122	
LIGHTSALMON2	238	149	114	
LIGHTSALMON3	205	129	98	
LIGHTSALMON4	139	87	66	
LIGHTSEAGREEN	32	178	170	
LIGHTSKYBLUE	135	206	250	
LIGHTSKYBLUE1	176	226	255	
LIGHTSKYBLUE2	164	211	238	
LIGHTSKYBLUE3	141	182	205	
LIGHTSKYBLUE4	96	123	139	
LIGHTSLATEBLUE	132	112	255	
LIGHTSLATEGRAY	119	136	153	
LIGHTSLATEGREY	119	136	153	
LIGHTSTEELBLUE	176	196	222	
LIGHTSTEELBLUE1	202	225	255	
LIGHTSTEELBLUE2	188	210	238	

Color Name	Red	Green	Blue	Example
LIGHTSTEELBLUE3	162	181	205	
LIGHTSTEELBLUE4	110	123	139	
LIGHTYELLOW	255	255	224	
LIGHTYELLOW1	255	255	224	
LIGHTYELLOW2	238	238	209	
LIGHTYELLOW3	205	205	180	
LIGHTYELLOW4	139	139	122	
LIME GREEN	50	205	50	
LIMEGREEN	50	205	50	
LINEN	250	240	230	
MAGENTA	255	0	255	
MAGENTA1	255	0	255	
MAGENTA2	238	0	238	
MAGENTA3	205	0	205	
MAGENTA4	139	0	139	
MAROON	176	48	96	
MAROON1	255	52	179	
MAROON2	238	48	167	
MAROON3	205	41	144	
MAROON4	139	28	98	
MEDIUM AQUAMARINE	102	205	170	
MEDIUM BLUE	0	0	205	
MEDIUM ORCHID	186	85	211	
MEDIUM PURPLE	147	112	219	
MEDIUM SEA GREEN	60	179	113	
MEDIUM SLATE BLUE	123	104	238	
MEDIUM SPRING GREEN	0	250	154	
MEDIUM TURQUOISE	72	209	204	
MEDIUM VIOLET RED	199	21	133	
MEDIUMAQUAMARINE	102	205	170	
MEDIUMBLUE	0	0	205	
MEDIUMORCHID	186	85	211	
MEDIUMORCHID1	224	102	255	
MEDIUMORCHID2	209	95	238	
MEDIUMORCHID3	180	82	205	
MEDIUMORCHID4	122	55	139	
MEDIUMPURPLE	147	112	219	
MEDIUMPURPLE1	171	130	255	
MEDIUMPURPLE2	159	121	238	
MEDIUMPURPLE3	137	104	205	
MEDIUMPURPLE4	93	71	139	
MEDIUMSEAGREEN	60	179	113	
MEDIUMSLATEBLUE	123	104	238	

Color Name	**Red**	**Green**	**Blue**	**Example**
MEDIUMSPRINGGREEN	0	250	154	
MEDIUMTURQUOISE	72	209	204	
MEDIUMVIOLETRED	199	21	133	
MIDNIGHT BLUE	25	25	112	
MIDNIGHTBLUE	25	25	112	
MINT CREAM	245	255	250	
MINTCREAM	245	255	250	
MISTY ROSE	255	228	225	
MISTYROSE	255	228	225	
MISTYROSE1	255	228	225	
MISTYROSE2	238	213	210	
MISTYROSE3	205	183	181	
MISTYROSE4	139	125	123	
MOCCASIN	255	228	181	
NAVAJO WHITE	255	222	173	
NAVAJOWHITE	255	222	173	
NAVAJOWHITE1	255	222	173	
NAVAJOWHITE2	238	207	161	
NAVAJOWHITE3	205	179	139	
NAVAJOWHITE4	139	121	94	
NAVY	0	0	128	
NAVY BLUE	0	0	128	
NAVYBLUE	0	0	128	
OLD LACE	253	245	230	
OLDLACE	253	245	230	
OLIVE DRAB	107	142	35	
OLIVEDRAB	107	142	35	
OLIVEDRAB1	192	255	62	
OLIVEDRAB2	179	238	58	
OLIVEDRAB3	154	205	50	
OLIVEDRAB4	105	139	34	
ORANGE	255	165	0	
ORANGE RED	255	69	0	
ORANGE1	255	165	0	
ORANGE2	238	154	0	
ORANGE3	205	133	0	
ORANGE4	139	90	0	
ORANGERED	255	69	0	
ORANGERED1	255	69	0	
ORANGERED2	238	64	0	
ORANGERED3	205	55	0	
ORANGERED4	139	37	0	
ORCHID	218	112	214	

Color Name	Red	Green	Blue	Example
ORCHID1	255	131	250	
ORCHID2	238	122	233	
ORCHID3	205	105	201	
ORCHID4	139	71	137	
PALE GOLDENROD	238	232	170	
PALE GREEN	152	251	152	
PALE TURQUOISE	175	238	238	
PALE VIOLET RED	219	112	147	
PALEGOLDENROD	238	232	170	
PALEGREEN	152	251	152	
PALEGREEN1	154	255	154	
PALEGREEN2	144	238	144	
PALEGREEN3	124	205	124	
PALEGREEN4	84	139	84	
PALETURQUOISE	175	238	238	
PALETURQUOISE1	187	255	255	
PALETURQUOISE2	174	238	238	
PALETURQUOISE3	150	205	205	
PALETURQUOISE4	102	139	139	
PALEVIOLETRED	219	112	147	
PALEVIOLETRED1	255	130	171	
PALEVIOLETRED2	238	121	159	
PALEVIOLETRED3	205	104	137	
PALEVIOLETRED4	139	71	93	
PAPAYA WHIP	255	239	213	
PAPAYAWHIP	255	239	213	
PEACH PUFF	255	218	185	
PEACHPUFF	255	218	185	
PEACHPUFF1	255	218	185	
PEACHPUFF2	238	203	173	
PEACHPUFF3	205	175	149	
PEACHPUFF4	139	119	101	
PERU	205	133	63	
PINK	255	192	203	
PINK1	255	181	197	
PINK2	238	169	184	
PINK3	205	145	158	
PINK4	139	99	108	
PLUM	221	160	221	
PLUM1	255	187	255	
PLUM2	238	174	238	
PLUM3	205	150	205	
PLUM4	139	102	139	

Color Name	Red	Green	Blue	Example
POWDER BLUE	176	224	230	
POWDERBLUE	176	224	230	
PURPLE	160	32	240	
PURPLE1	155	48	255	
PURPLE2	145	44	238	
PURPLE3	125	38	205	
PURPLE4	85	26	139	
RED	255	0	0	
RED1	255	0	0	
RED2	238	0	0	
RED3	205	0	0	
RED4	139	0	0	
ROSY BROWN	188	143	143	
ROSYBROWN	188	143	143	
ROSYBROWN1	255	193	193	
ROSYBROWN2	238	180	180	
ROSYBROWN3	205	155	155	
ROSYBROWN4	139	105	105	
ROYAL BLUE	65	105	225	
ROYALBLUE	65	105	225	
ROYALBLUE1	72	118	255	
ROYALBLUE2	67	110	238	
ROYALBLUE3	58	95	205	
ROYALBLUE4	39	64	139	
SADDLE BROWN	139	69	19	
SADDLEBROWN	139	69	19	
SALMON	250	128	114	
SALMON1	255	140	105	
SALMON2	238	130	98	
SALMON3	205	112	84	
SALMON4	139	76	57	
SANDY BROWN	244	164	96	
SANDYBROWN	244	164	96	
SEA GREEN	46	139	87	
SEAGREEN	46	139	87	
SEAGREEN1	84	255	159	
SEAGREEN2	78	238	148	
SEAGREEN3	67	205	128	
SEAGREEN4	46	139	87	
SEASHELL	255	245	238	
SEASHELL1	255	245	238	
SEASHELL2	238	229	222	
SEASHELL3	205	197	191	

Color Name	Red	Green	Blue	Example
SEASHELL4	139	134	130	
SIENNA	160	82	45	
SIENNA1	255	130	71	
SIENNA2	238	121	66	
SIENNA3	205	104	57	
SIENNA4	139	71	38	
SKY BLUE	135	206	235	
SKYBLUE	135	206	235	
SKYBLUE1	135	206	255	
SKYBLUE2	126	192	238	
SKYBLUE3	108	166	205	
SKYBLUE4	74	112	139	
SLATE BLUE	106	90	205	
SLATE GRAY	112	128	144	
SLATE GREY	112	128	144	
SLATEBLUE	106	90	205	
SLATEBLUE1	131	111	255	
SLATEBLUE2	122	103	238	
SLATEBLUE3	105	89	205	
SLATEBLUE4	71	60	139	
SLATEGRAY	112	128	144	
SLATEGRAY1	198	226	255	
SLATEGRAY2	185	211	238	
SLATEGRAY3	159	182	205	
SLATEGRAY4	108	123	139	
SLATEGREY	112	128	144	
SNOW	255	250	250	
SNOW1	255	250	250	
SNOW2	238	233	233	
SNOW3	205	201	201	
SNOW4	139	137	137	
SPRING GREEN	0	255	127	
SPRINGGREEN	0	255	127	
SPRINGGREEN1	0	255	127	
SPRINGGREEN2	0	238	118	
SPRINGGREEN3	0	205	102	
SPRINGGREEN4	0	139	69	
STEEL BLUE	70	130	180	
STEELBLUE	70	130	180	
STEELBLUE1	99	184	255	
STEELBLUE2	92	172	238	
STEELBLUE3	79	148	205	
STEELBLUE4	54	100	139	

Color Name	Red	Green	Blue	Example
TAN	210	180	140	
TAN1	255	165	79	
TAN2	238	154	73	
TAN3	205	133	63	
TAN4	139	90	43	
THISTLE	216	191	216	
THISTLE1	255	225	255	
THISTLE2	238	210	238	
THISTLE3	205	181	205	
THISTLE4	139	123	139	
TOMATO	255	99	71	
TOMATO1	255	99	71	
TOMATO2	238	92	66	
TOMATO3	205	79	57	
TOMATO4	139	54	38	
TURQUOISE	64	224	208	
TURQUOISE1	0	245	255	
TURQUOISE2	0	229	238	
TURQUOISE3	0	197	205	
TURQUOISE4	0	134	139	
VIOLET	238	130	238	
VIOLET RED	208	32	144	
VIOLETRED	208	32	144	
VIOLETRED1	255	62	150	
VIOLETRED2	238	58	140	
VIOLETRED3	205	50	120	
VIOLETRED4	139	34	82	
WHEAT	245	222	179	
WHEAT1	255	231	186	
WHEAT2	238	216	174	
WHEAT3	205	186	150	
WHEAT4	139	126	102	
WHITE	255	255	255	
WHITE SMOKE	245	245	245	
WHITESMOKE	245	245	245	
YELLOW	255	255	0	
YELLOW GREEN	154	205	50	
YELLOW1	255	255	0	
YELLOW2	238	238	0	
YELLOW3	205	205	0	
YELLOW4	139	139	0	
YELLOWGREEN	154	205	50	