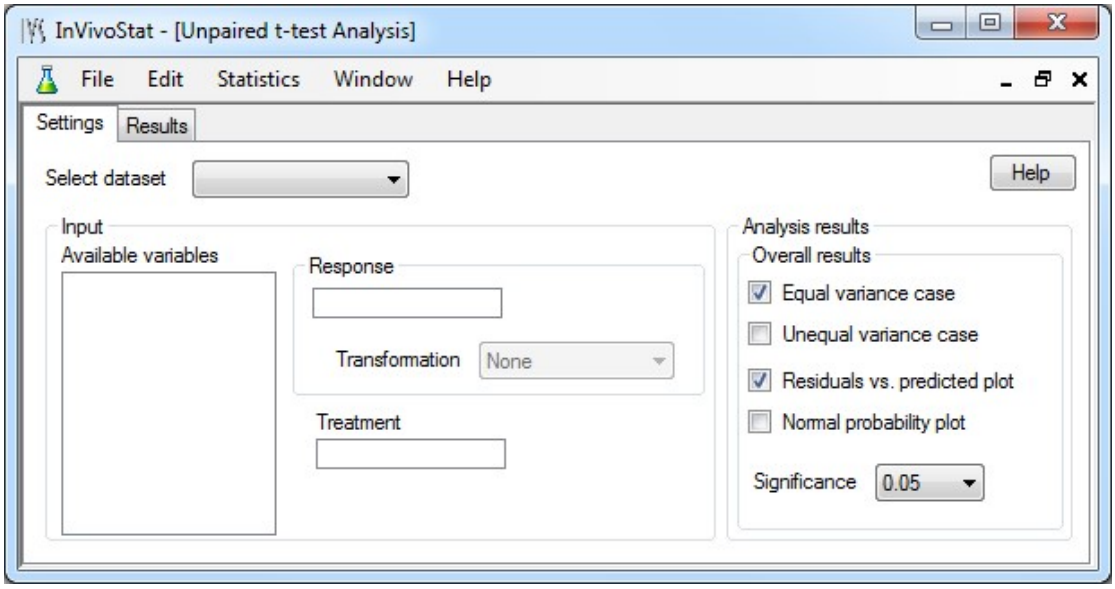
InVivoStat

Unpaired *t*-test Analysis Module

Tipsheet

The Unpaired t-test Analysis module in InVivoStat is available within the Additional Analyses sub-menu in the Statistics drop-down menu and is entitled "Unpaired t-test Analysis". The user interface is:

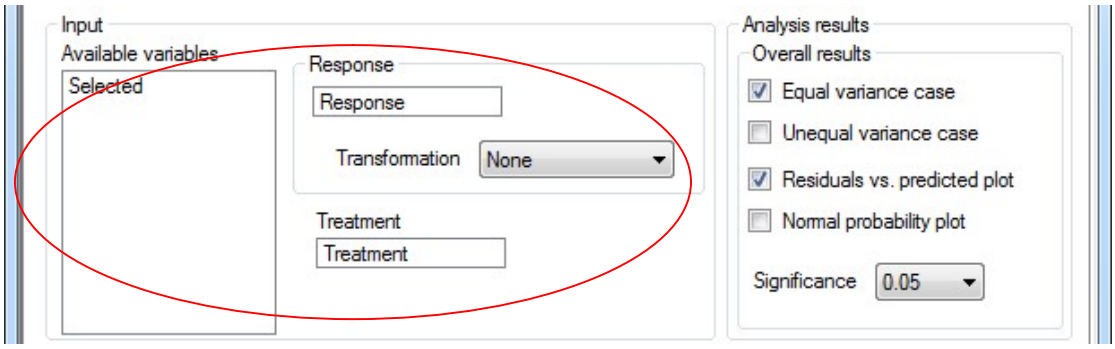


The Unpaired t-test Analysis module performs a t-test assuming equal and/or unequal variances between the two groups. The latter is an implementation of Welch's t-test for unequal variances.

For more complex designs, with more factors and/or more than two factor levels, we recommend using the Single Measures Parametric Analysis module.

1 Setting up the model

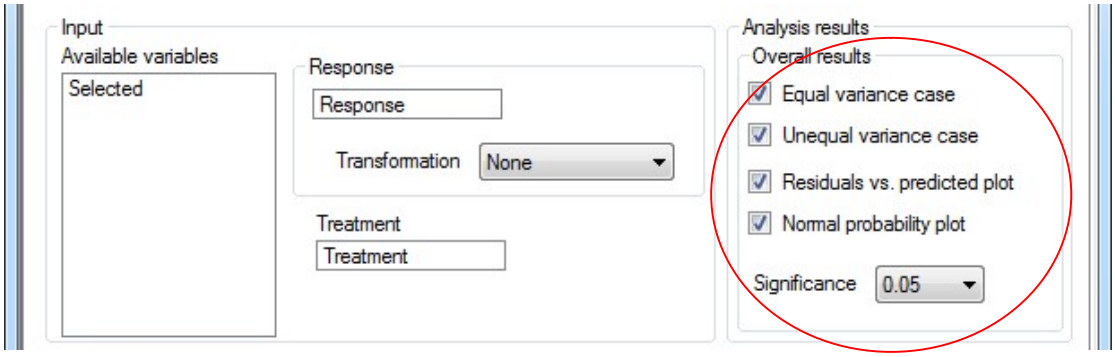
Once the dataset has been opened, the user can select the variables for the analysis by dragging and dropping them from the "Available variables" list into the "Response" and "Treatment" boxes.



Once selected, the user has the option of applying a transformation to the response variable, either $\log_{10}$, $\log_e$, square root, arcsine or rank.

2 Selecting the analysis options

There are several results that are available to the user. These are selected before running the analysis.



The output options include:

1) Equal variance case
Produces the result of the t-test under the assumption that the variances are the same in both groups. Analysis is performed using a pooled variance estimate.

2) Unequal variance case
Produces the result of Welch's t-test under the assumption that the variances are not the same across groups.

3) Residuals vs. predicted plot
Allows the user to check the homogeneity of variance assumption of the parametric analysis. Plot produced under the equal variance assumption.

4) Normal probability plot
Allows the user to check the normality assumption of the parametric analysis. Plot produced under the equal variances assumption.

5) Significance level
The default is 5%, although this can be changed.

3 Output Results

Response
InVivoStat identifies the response being analysed. This section also describes any transformation that has been applied.

Scatterplot of the raw data
InVivoStat produces a scatterplot of the raw data. This should be used to identify possible outliers. On the plot the X-axis corresponds to the two levels of the treatment factor and the Y-axis corresponds to the response.

t-test assuming equal variance table
This table gives results of the t-test under the assumption of equal variances between the groups.

Table of the least square (predicted) means
InVivoStat produces a table of the least square (predicted) means from the model assuming equal variances, with confidence intervals.

Comparison of the least square (predicted) means
InVivoStat produces a table of the difference between the least square (predicted) means from the model assuming equal variances, with confidence interval.

t-test assuming unequal variance table
This table gives results of the t-test under the assumption of unequal variances between the groups.

Table of the least square (predicted) means
InVivoStat produces a table of the least square (predicted) means from the model assuming unequal variances, with confidence intervals.

Comparison of the least square (predicted) means
InVivoStat produces a table of the difference between the least square (predicted) means from the model assuming unequal variances, with confidence interval.

Diagnostic plots
If requested InVivoStat produces the residuals vs. predicted plot and the normal probability plot. The residuals plotted on the residuals vs. predicted plot are the standardized residuals as these can provide a test for outliers. Any observation with a residual greater (or less than) 3 could be considered an outlier. These plots are produced using the equal variance model assumption.

References
Finally a list of references for the methods applied in the analysis is given.

4 Controlling the output

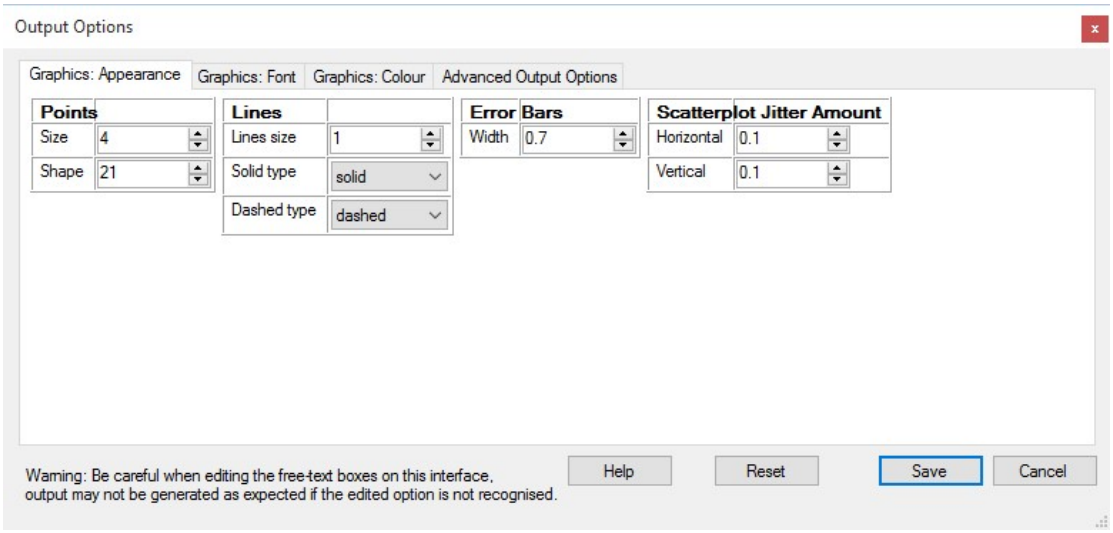
The user has the ability to control various aspects of the output. These are available from the

Statistics → Options → Output Options

menu and should be selected before performing the analysis.

Users can manipulate various global characteristics of the plots produced. Plots can be generated in pdf format and also in black and white.

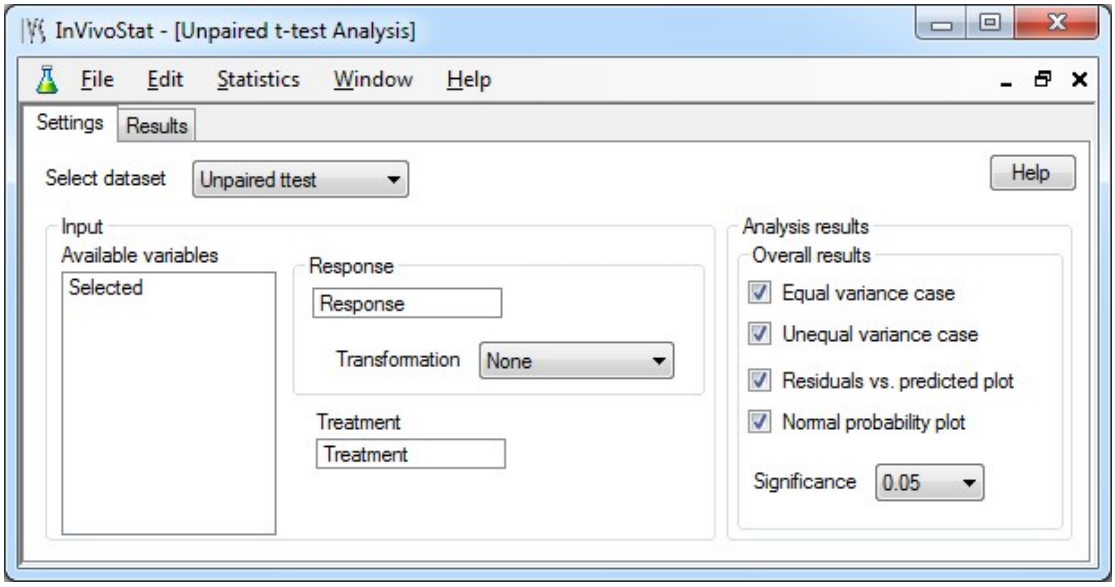
If the response has been log transformed, by selecting 'Display geometric means' the back transformed means are given (and plotted).



More information on the options can be found in the Getting Started Tipsheet.

5 Sample output

Options:



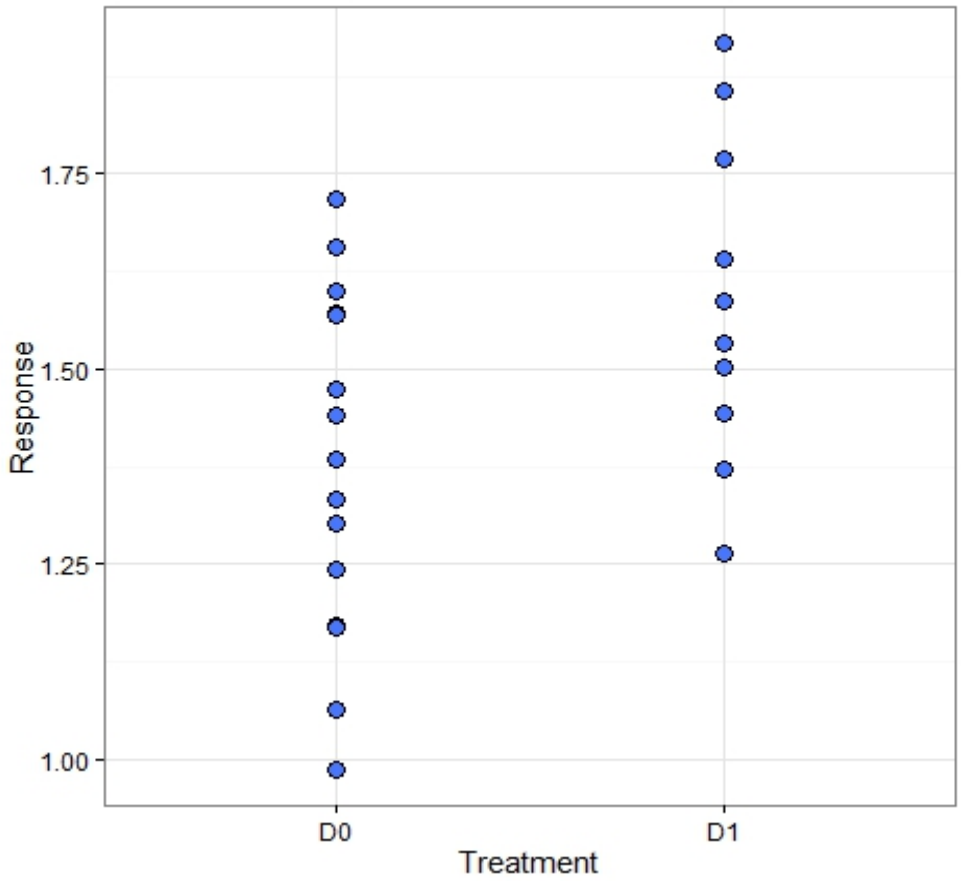
InVivoStat Unpaired t-test Analysis

Response

The Response response is currently being analysed by the Unpaired t-test Analysis module.

For more information on the theoretical approaches that are implemented within this module, see Bate and Clark (2014).

Scatterplot of the raw data



Tip: Use this plot to identify possible outliers.

Unpaired t-test assuming equal variances

	t-statistic	Degrees of freedom	p-value
Equal variance unpaired t-test	-2.408	36	0.0213

Conclusion: There is a statistically significant difference between the levels of Response at the 5% level.

Table of the least square (predicted) means with 95% confidence intervals (assuming equal variances)

	Mean	Lower 95% CI	Upper 95% CI
Treatment level			
D0	1.399	1.298	1.500
D1	1.564	1.468	1.660

Comparison of the least square (predicted) means with 95% confidence interval (assuming equal variances)

	Difference	Lower 95% CI	Upper 95% CI	Std error	p-value
Comparison					
D0 vs. D1	-0.165	-0.305	-0.026	0.069	0.0213

Unpaired t-test assuming unequal variances

The analysis presented is Welch's t-test for unequal variances.

	t-statistic	Degrees of freedom	p-value
Unequal variance unpaired t-test	-2.387	33.52	0.0228

Conclusion: There is a statistically significant difference between the levels of Response at the 5% level.

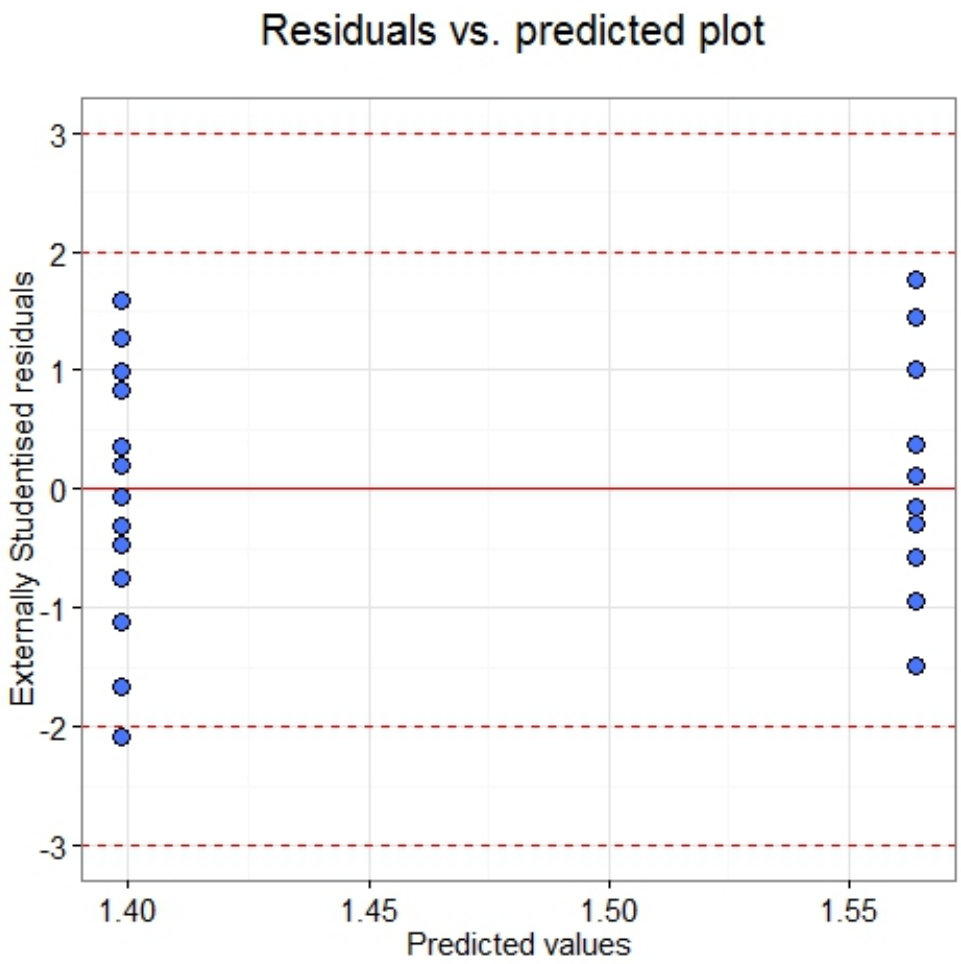
Table of the least square (predicted) means with 95% confidence intervals (assuming unequal variances)

	Mean	Lower 95% CI	Upper 95% CI
Treatment level			
D0	1.399	1.285	1.513
D1	1.564	1.473	1.655

Comparison of the least square (predicted) means with 95% confidence interval (assuming unequal variances)

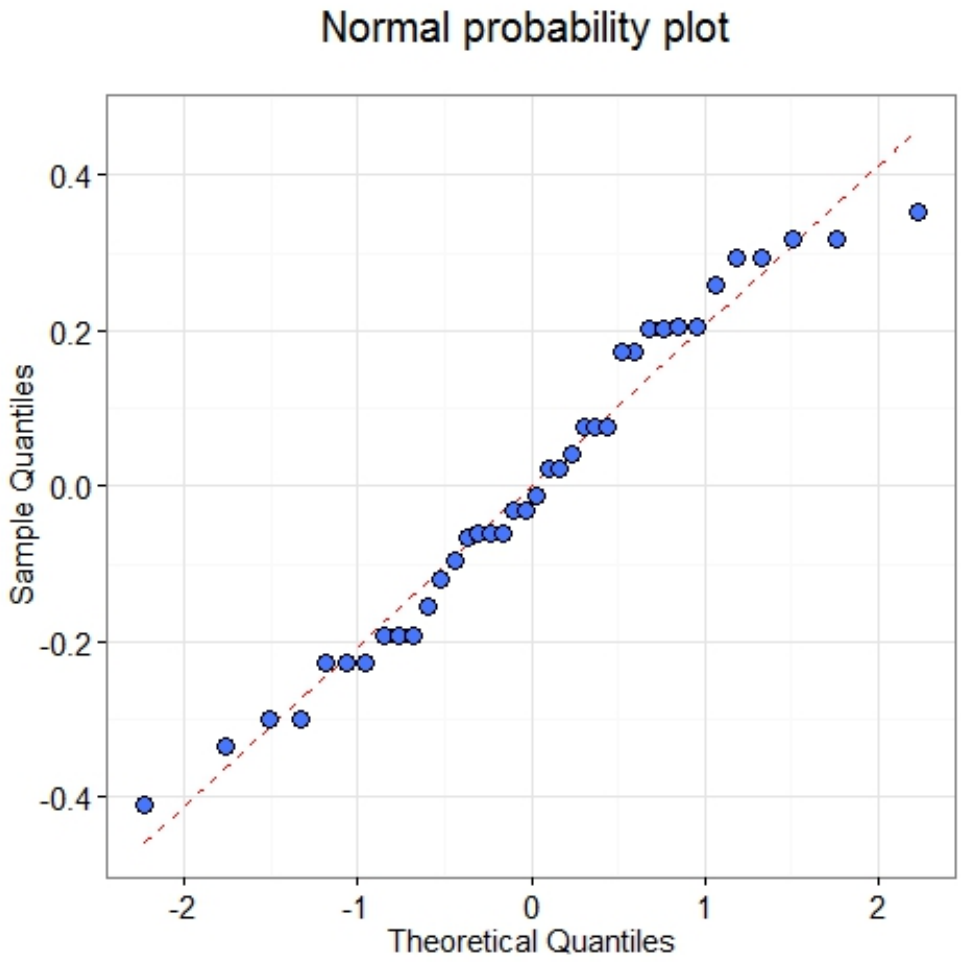
	Difference	Lower 95% CI	Upper 95% CI	p-value
Comparison				
D0 vs. D1	-0.165	-0.306	-0.024	0.0228

Diagnostic plots (assuming equal variances)



Tip: On this plot look to see if the spread of the points increases as the predicted values increase. If so the response may need transforming or the unequal variance assumption selected.

Tip: Any observation with a residual less than -3 or greater than 3 (SD) should be investigated as a possible outlier.



Tip: Check that the points lie along the dotted line. If not then the data may be non-normally distributed.

Statistical references

Bate ST and Clark RA. (2014). The Design and Statistical Analysis of Animal Experiments. Cambridge University Press.

Welch BL. (1947). The generalization of Student's problem when several different population variances are involved. Biometrika, 34(1-2), 28-35.

R references

R Development Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org.

Barret Schloerke, Jason Crowley, Di Cook, Heike Hofmann, Hadley Wickham, Francois Briatte, Moritz Marbach and Edwin Thoen (2014). GGally: Extension to ggplot2. R package version 0.4.5. http://CRAN.R-project.org/package=GGally

Erich Neuwirth (2011). RColorBrewer: ColorBrewer palettes. R package version 1.0-5. http://CRAN.R-project.org/package=RColorBrewer

H. Wickham. ggplot2: elegant graphics for data analysis. Springer New York, 2009.

H. Wickham. Reshaping data with the reshape package. Journal of Statistical Software, 21(12), 2007.

Hadley Wickham (2011). The Split-Apply-Combine Strategy for Data Analysis. Journal of Statistical Software, 40(1), 1-29. URL http://www.jstatsoft.org/v40/i01/.

Hadley Wickham (2012). scales: Scale functions for graphics. R package version 0.2.3. http://CRAN.R-project.org/package=scales

Lecoutre, Eric (2003). The R2HTML Package. R News, Vol 3. N. 3, Vienna, Austria.

Louis Kates and Thomas Petzoldt (2012). proto: Prototype object-based programming. R package version 0.3-10. http://CRAN.R-project.org/package=proto

Torsten Hothorn, Frank Bretz and Peter Westfall (2008). Simultaneous Inference in General Parametric Models. Biometrical Journal 50(3), 346--363.

Analysis dataset

	Response	Treatment
1	1.17	D0
2	1.30	D0
3	1.72	D0
4	1.17	D0
5	1.39	D0
6	1.44	D0
7	1.60	D0
8	1.57	D0
9	1.33	D0

10	1.57	D0
11	1.66	D0
12	1.47	D0
13	1.72	D0
14	1.17	D0
15	1.06	D0
16	1.24	D0
17	1.60	D0
18	0.99	D0
19	1.37	D1
20	1.50	D1
21	1.59	D1
22	1.37	D1
23	1.50	D1
24	1.37	D1
25	1.64	D1
26	1.53	D1
27	1.50	D1
28	1.59	D1
29	1.77	D1
30	1.86	D1
31	1.26	D1
32	1.64	D1
33	1.53	D1
34	1.77	D1
35	1.44	D1
36	1.92	D1
37	1.86	D1
38	1.26	D1