Using the **difR** Package with Lertap5

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Document date: 14 April 2020

difR is the name of an R package designed to support "DIF" analyses, where DIF=differential item functioning. It is introduced at this webpage. When I undertook the work described below, I was using difR Version 5, published 2018-05-14.

The use of R packages with Lertap5 is discussed in this document. That document has a few examples of how R packages are installed. Following those examples, the difR package would be installed using

```
> install.packages("difR")
```

Lertap5 has its own DIF analysis capability based on the Mantel-Haenszel (M-H) method. The "Ibreaks" routine in Lertap5 is the gateway to M-H; a technical paper discussing and exemplifying the use of Lertap5 M-H is here.

The **difR** package has more extensive support for DIF researchers, featuring the M-H method and several others, including logistic regression and SIBTEST (to name just two of the others – there are more).

This paper is for those who have item response data in a Lertap5 workbook and would like to use the data with the **difR** package.

When test results are input to difR, it is expected that the input will consist of item scores and a group variable. Item scores will be zero and one (0,1) – these are often referred to as "binary" scores. The group variable is expected to have two categories[2]. It might, for example, be Gender with codes of F and M, or, as in the example below, Race with codes of B and W. The version of difR used for this paper would allow for missing data among the item scores, but not in the group variable. The codes used for the group variable could be letters or digits[3].

To prepare data for difR, Lertap5 users will have to get Lertap5 to make item scores, make sure that their group variable has just two codes, make sure that all data records have a group code (no missing data), and then prepare a "csv" file.

***Note** at 7 April 2020: the discussion on the next few pages describes how to set up a "csv" Excel workbook suitable for use with the difR program. Another way to set up such a workbook is to use the "difR1 special macro" – it's faster and easier, but not as "transparent" – the steps which follow below involve more work but allow greater flexibility in how the csv file's group variable is brought in. Readers who choose to use the special macro should do so, and then return here, to this document, skipping ahead to the section* "**M-H results with difR**".

As seen below, my suggestion is that the csv file start with columns having the item scores, one column per test item, and end with the group code in the last column. The first row in the csv file will be for variable "headers". The item headers will typically be, for example, Item1 or Q1.

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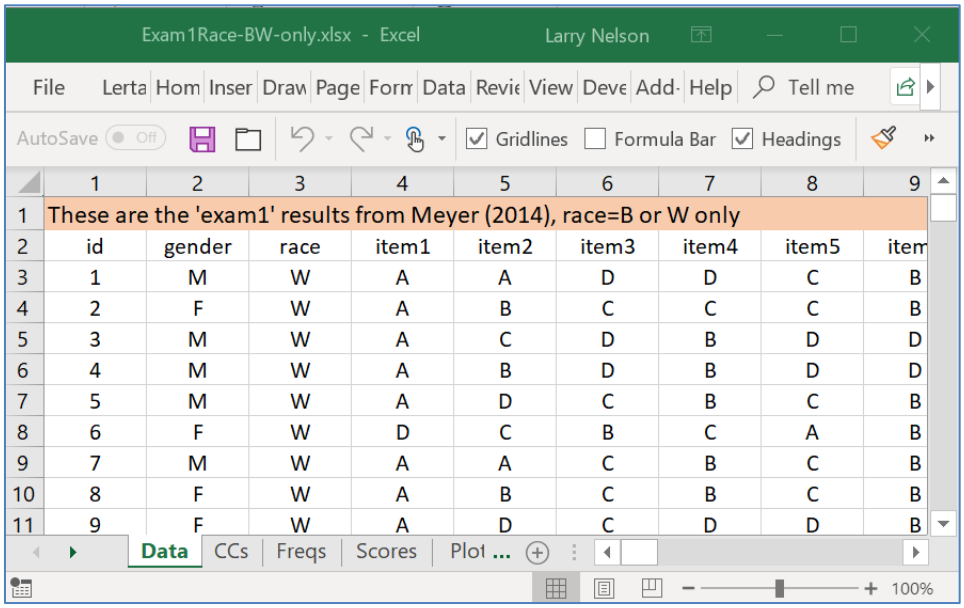
[1] Comments / questions may be sent to l.nelson@curtin.edu.au
[2] difR supports more than two groups.
[3] Lertap5 has a recode option that might be useful (for example, change {M,F} codes to {0,1})

Creating a csv file from a Lertap5 workbook

I have selected the "exam1" test results for this example. Exam1 is used as a major exhibit in Patrick Meyer's 2014 text "Applied Measurement with jMetrik" (see the Lertap5 references). I have used these results in my "GimmeABreak" paper, where they featured in Example 2 (pp. 15-19).



	1	2	3	4	5	6	7	8	9
1	These are the 'exam1' results from Meyer (2014), race=B or W only								
2	id	gender	race	item1	item2	item3	item4	item5	item
3	1	M	W	A	A	D	D	C	B
4	2	F	W	A	B	C	C	C	B
5	3	M	W	A	C	D	B	D	D
6	4	M	W	A	B	D	B	D	D
7	5	M	W	A	D	C	B	C	B
8	6	F	W	D	C	B	C	A	B
9	7	M	W	A	A	C	B	C	B
10	8	F	W	A	B	C	B	C	B
11	9	F	W	A	D	C	D	D	B

The screen snapshot above displays some of the rows and columns in the Lertap5 Data worksheet corresponding to Meyer's "exam1" test results. In this case, the three initial columns were used to house descriptive information; these columns were followed by item responses. There were a total of 56 multiple-choice items; responses were found starting in column 4, ending in column 59.

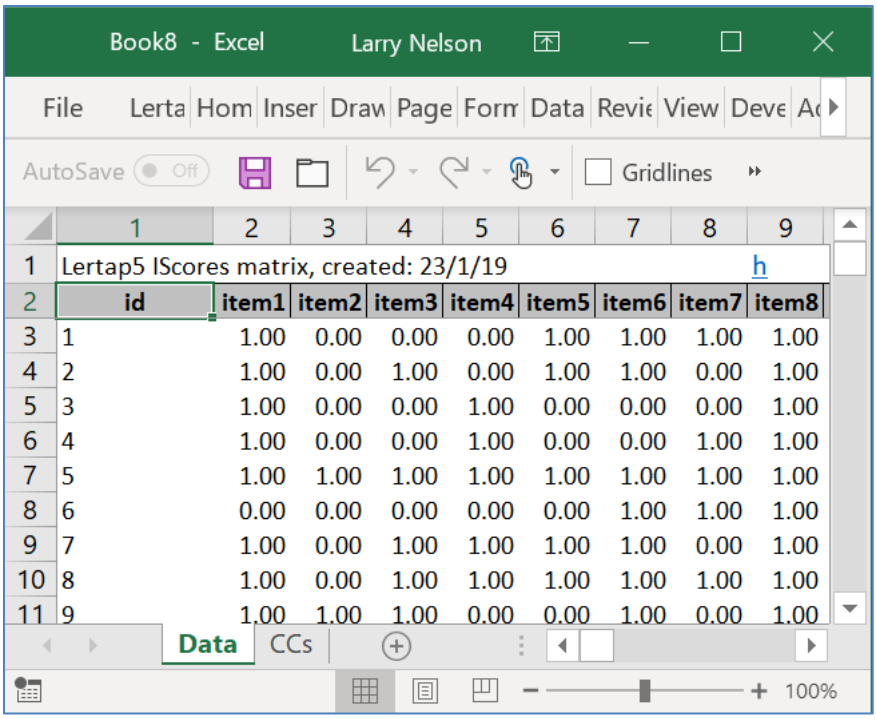
I will need to have item scores before I'm able to use the difR routines. The screen shot above shows item *responses*, not item *scores*. To get item scores, I'll use the "Item scores and correlations" option in Lertap5.

The "Item scores and correlations" option adds the "**IStats**" worksheet to the workbook. It has two sections: item scores, followed by item statistics and correlations.

Next, I take the "BinaryItems[4]" option in Lertap5. It creates a new workbook with item scores – here's how part of it looks at this stage:

Cautions: readers should make sure that the scores created are indeed {0.00, 1.00}. The difR package accepts only {0.00,1.00,NA} item scores, where NA=missing data). The Freqs report can be used to reveal the extent of missing data; in Lertap, missing data for cognitive items is usually converted to an item score of 0.00.

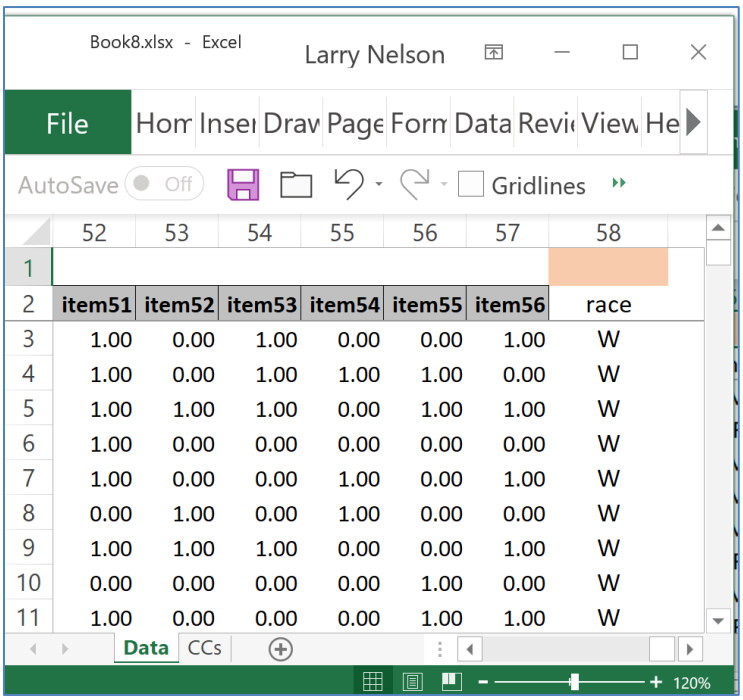
[4] Caution: the BinaryItems option does not check to make sure that cognitive items are in use.



Lertap5 IScores matrix, created: 23/1/19

id	item1	item2	item3	item4	item5	item6	item7	item8
1	1.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00
2	1.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00
3	1.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00
4	1.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00
7	1.00	0.00	1.00	1.00	1.00	1.00	0.00	1.00
8	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	0.00	0.00	1.00	0.00	1.00

Notice that the BinaryItems option has not copied the Gender and Race information from the original workbook. As I'd like to look at results based on race, I now need to copy the race column from the original workbook and paste it into the new workbook's Data sheet. When I do so, I paste it on the right-hand side of the new workbook:



item51	item52	item53	item54	item55	item56	race
1.00	0.00	1.00	0.00	0.00	1.00	W
1.00	0.00	1.00	1.00	1.00	0.00	W
1.00	1.00	1.00	0.00	1.00	1.00	W
1.00	0.00	0.00	0.00	0.00	0.00	W
1.00	0.00	0.00	1.00	0.00	1.00	W
0.00	1.00	0.00	1.00	0.00	0.00	W
1.00	1.00	1.00	0.00	0.00	1.00	W
0.00	0.00	0.00	0.00	1.00	0.00	W
1.00	0.00	0.00	0.00	1.00	1.00	W

Next I need to delete the first row so that what shows as row 2 below will become the first row. I will not need the id column, and will delete it.

	1	2	3	4	5	6	7	8	9
1	Lertap5 IScores matrix, created: 23/1/19								h
2	id	item1	item2	item3	item4	item5	item6	item7	item8
3	1	1.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00

I now tell Excel to save this new workbook, giving it an appropriate name: "Exam1RaceItemScores-BW-only.xlsx".

Exam1RaceItemScores-BW-only.xlsx - Excel Larry Nelson

File Hom Inse Drav Page Form Data Revi View Help Tell me

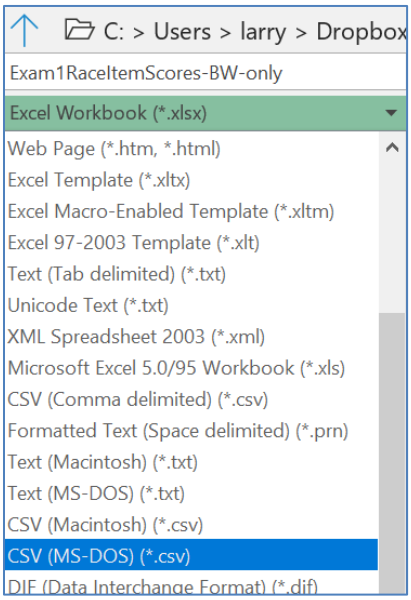
AutoSave Off Gridlines Formula Bar

	1	2	3	4	53	54	55	56	57
1	item1	item2	item3	item4	item53	item54	item55	item56	race
2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	W
3	1.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00	W
4	1.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	W
5	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	W
6	1.00	1.00	1.00	1.00	0.00	1.00	0.00	1.00	W
7	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	W
8	1.00	0.00	1.00	1.00	1.00	0.00	0.00	1.00	W
9	1.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00	W
10	1.00	1.00	1.00	0.00	0.00	0.00	1.00	1.00	W
11	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	W
12	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	W
13	1.00	1.00	1.00	0.00	1.00	0.00	0.00	1.00	W

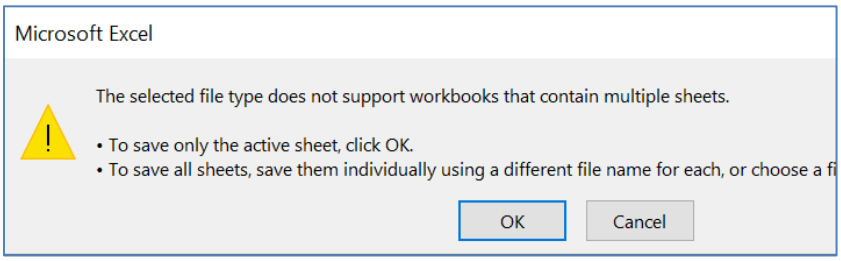
Data CCs

The snapshot above shows that the new workbook has **item1** scores in the first column, then more item scores, and, at the end, **race** in column 57. This exemplifies the format for a workbook that will best serve my needs when using **difR**: columns with item scores followed by the "group" variable for DIF (which is 'race' in the case).

Now, with the focus on the Data sheet (as in the snapshot above), I ask Excel to save as a "CSV (MS-DOS)" file, highlighted in blue below:

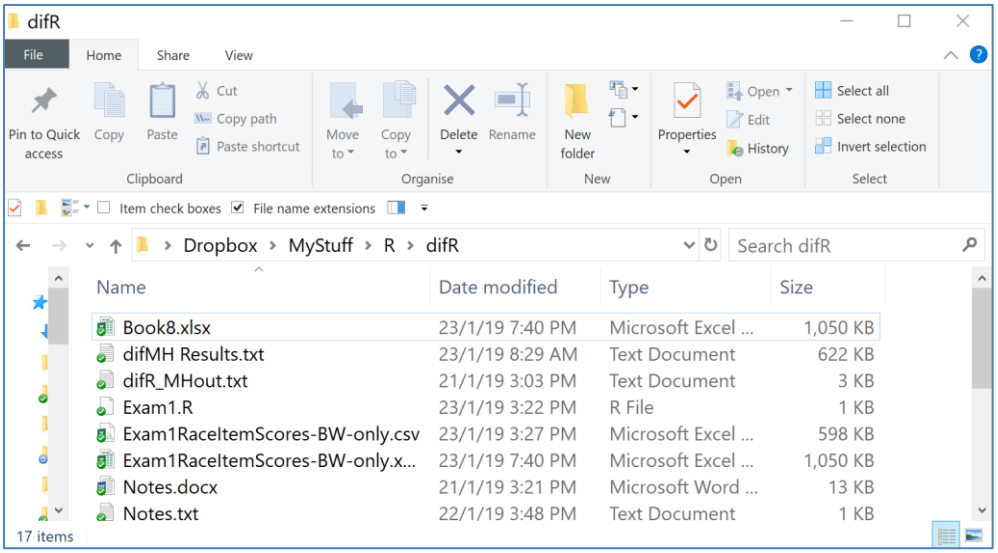


Excel sounds a warning:



I click OK and close the workbook.

By using the Windows file manager I can confirm that the workbook has indeed been saved as a file named "Exam1RaceItemScores-BW-only.csv"[5].



I now have a csv file that can readily be used with the **difR** package.

[5] If the difR1 special macro has been used, the name of the csv file will always be "difR-IScores.csv".

M-H results with difR

I have both R and RStudio installed on my laptop, as mentioned in this paper. Were I to continue using **difR**, and well I might, I'd probably develop a special script for use with RStudio. For the moment, however, I'll just run with R.

The "Exam1.R" script file shows in the file list above; its contents are shown below:

```
# Made to work with the Exam1 dataset, 24 January 2019
# By Larry Nelson, Curtin University, Western Australia
# l.nelson@curtin.edu.au
setwd("C:/Users/larry/Dropbox/MyStuff/R/difR/Exam1")
library(difR)
dir()
AAitems <-read.csv(file="Exam1RaceItemScores-BW-only.csv")
difItems<-AAitems[colnames(AAitems)]
head(difItems)
difMH(difItems, group="race", focal.name="W", save.output=TRUE)
```

When R finishes running the code lines, it provides this message:

```
Output was captured and saved into file
 'C:/Users/larry/Dropbox/MyStuff/R/difR/Exam1/out.txt'
```

Some of the output is shown below:

```
Mantel-Haenszel Chi-square statistic:

       Stat.   P-value
item1  19.3862  0.0000 ***
item2  14.5016  0.0001 ***
item3   7.1053  0.0077 **
item4  21.0385  0.0000 ***
item5   1.4150  0.2342
item6  17.1696  0.0000 ***
item7   0.1694  0.6806
item8   0.9321  0.3343
item9   6.5306  0.0106 *
item10  0.0695  0.7920

Items detected as exhibiting DIF:

 item1
 item2
 item3
 item4
 item6
 item9
 item16
```

(this is a partial listing; there were 25 items in the whole list, all with P-values less than .05)

```
Effect size (ETS Delta scale):

Effect size code:
 'A': negligible effect
 'B': moderate effect
 'C': large effect
```

```
       alphaMH deltaMH
item1   0.7198  0.7726 A
item2   0.7791  0.5865 A
item3   0.7722  0.6076 A
item4   0.7396  0.7090 A
item5   0.9179  0.2014 A
item6   1.4001 -0.7909 A
item7   1.0295 -0.0683 A
item8   0.8904  0.2728 A
item9   0.8404  0.4085 A
item10  1.0327 -0.0756 A

item37  2.0179 -1.6499 C

item45  1.8638 -1.4632 B
```

Only two items, item37 and item45, evidenced practical significance as indexed by the deltaMH statistic.

As I mentioned earlier, difR can look for possible DIF using numerous methods – here I've used only one, Mantel-Haenszel, the method used in Lertap5, and a method with good support in the literature.

difR is able to make graphical summaries of DIF.

Have a look at these URLs:

https://cran.r-project.org/web/packages/difR/difR.pdf

https://eeecon.uibk.ac.at/psychoco/2011/slides/Magis_hdt.pdf

The following Appendix has other examples of running difR.

Appendix

```
# Made to work with the Exam1 dataset, 13 February 2019
# By Larry Nelson, Curtin University, Western Australia
# l.nelson@curtin.edu.au
setwd("C:/Users/larry/Dropbox/MyStuff/R/difR/Exam1")
library(difR)
dir()
AAitems <-read.csv(file="Exam1RaceItemScores-BW-only.csv")
difItems<-AAitems[colnames(AAitems)]
head(difItems)
# difMH(difItems, group="race", focal.name="W", save.output=TRUE)
# difMH(difItems, group="race", focal.name="W")
#dichoDif(difItems, group="race", focal.name="W",
#   method = c("TID", "MH", "Std", "Logistic","SIBTEST"), correct =
FALSE,
#   thrSTD = 0.08, thrTID = 1, purify = TRUE, save.output = TRUE,
output = c("dichodif1", "default"))
#dichoDif(difItems, group="race", focal.name="W",
#   method = c("TID", "MH", "Std", "Logistic", "SIBTEST"), correct =
FALSE,
#   thrSTD = 0.08, thrTID = 1, purify = FALSE, save.output = TRUE,
output = c("dichodif1", "default"))
dichoDif(difItems, group="race", focal.name="W",
   method = c("MH", "Std", "Logistic", "SIBTEST"), correct = FALSE,
   thrSTD = 0.08, thrTID = 1, purify = FALSE, save.output = TRUE,
output = c("dichodif1", "default"))
```

The R code above displays some of my experiments with difR. *All lines that begin with the # character are just comments.* The last of `dichoDif` code lines above are repeated below (for convenience)

```
dichoDif(difItems, group="race", focal.name="W",
   method = c("MH", "Std", "Logistic", "SIBTEST"), correct = FALSE,
   thrSTD = 0.08, thrTID = 1, purify = FALSE, save.output = TRUE,
output = c("dichodif1", "default"))
```

and, when run, resulted in this output from difR:

```
Comparison of DIF detection results using 4 methods

Methods used:
 Mantel-Haenszel
 Standardization
 Logistic regression
 Crossing-SIBTEST

Matching variable: test score

No set of anchor items was provided

Parameters:
 Significance level: 0.05
 Standardization threshold: 0.08
 Mantel-Haenszel DIF statistic: Chi-square statistic
 Mantel-Haenszel continuity correction: No
 Type of Mantel-Haenszel test: asymptotic test
 Weights for standardized P-DIF statistic: based on the focal group
 Logistic regression DIF statistic: LRT statistic
```

```
 DIF effect(s) tested by logistic regression: both DIF effects
 Item purification: No

No p-value adjustment for multiple comparisons

Comparison of DIF detection results:

       M-H   Stand. Logistic CSIBTEST #DIF
item1   DIF  NoDIF   DIF      DIF      3/4
item2   DIF  NoDIF   DIF      DIF      3/4
item3   DIF  NoDIF   DIF      DIF      3/4
item4   DIF  NoDIF   DIF      DIF      3/4
item5  NoDIF NoDIF  NoDIF    NoDIF     0/4
item6   DIF  NoDIF   DIF      DIF      3/4
item7  NoDIF NoDIF   DIF      DIF      2/4
item8  NoDIF NoDIF  NoDIF    NoDIF     0/4
item9   DIF  NoDIF   DIF      DIF      3/4
item10 NoDIF NoDIF   DIF     NoDIF     1/4
item11 NoDIF NoDIF  NoDIF    NoDIF     0/4
item12 NoDIF NoDIF  NoDIF    NoDIF     0/4
item13 NoDIF NoDIF  NoDIF    NoDIF     0/4
item14 NoDIF NoDIF   DIF     NoDIF     1/4
item15 NoDIF NoDIF  NoDIF    NoDIF     0/4
item16  DIF  NoDIF   DIF      DIF      3/4
item17 NoDIF NoDIF  NoDIF    NoDIF     0/4
item18 NoDIF NoDIF  NoDIF    NoDIF     0/4
item19 NoDIF NoDIF  NoDIF    NoDIF     0/4
item20  DIF  NoDIF   DIF      DIF      3/4
item21 NoDIF NoDIF  NoDIF    NoDIF     0/4
item22 NoDIF NoDIF   DIF     NoDIF     1/4
item23  DIF  NoDIF   DIF      DIF      3/4
item24 NoDIF NoDIF   DIF     NoDIF     1/4
item25  DIF  NoDIF   DIF     NoDIF     2/4
item26  DIF  NoDIF   DIF     NoDIF     2/4
item27  DIF  NoDIF   DIF      DIF      3/4
item28 NoDIF NoDIF  NoDIF    NoDIF     0/4
item29  DIF  NoDIF   DIF      DIF      3/4
item30  DIF  NoDIF   DIF      DIF      3/4
item31 NoDIF NoDIF  NoDIF    NoDIF     0/4
item32  DIF  NoDIF   DIF      DIF      3/4
item33 NoDIF NoDIF   DIF     NoDIF     1/4
item34  DIF  NoDIF   DIF      DIF      3/4
item35 NoDIF NoDIF  NoDIF    NoDIF     0/4
item36  DIF  NoDIF   DIF      DIF      3/4
item37  DIF   DIF    DIF      DIF      4/4
item38 NoDIF NoDIF  NoDIF    NoDIF     0/4
item39  DIF  NoDIF  NoDIF     DIF      2/4
item40 NoDIF NoDIF  NoDIF    NoDIF     0/4
item41 NoDIF NoDIF  NoDIF    NoDIF     0/4
item42  DIF  NoDIF   DIF      DIF      3/4
item43 NoDIF NoDIF  NoDIF    NoDIF     0/4
item44  DIF  NoDIF   DIF      DIF      3/4
item45  DIF   DIF    DIF      DIF      4/4
item46  DIF  NoDIF   DIF      DIF      3/4
item47 NoDIF NoDIF   DIF     NoDIF     1/4
item48 NoDIF NoDIF   DIF     NoDIF     1/4
item49 NoDIF NoDIF  NoDIF    NoDIF     0/4
item50 NoDIF NoDIF  NoDIF     DIF      1/4
item51 NoDIF NoDIF  NoDIF    NoDIF     0/4
item52  DIF  NoDIF  NoDIF     DIF      2/4
item53  DIF  NoDIF   DIF      DIF      3/4
item54 NoDIF NoDIF  NoDIF    NoDIF     0/4
```

```
item55 NoDIF NoDIF  NoDIF    NoDIF     0/4
item56 NoDIF NoDIF  NoDIF     DIF      1/4
```

The following line draws on the "Standardization DIF method" in difR:

```
plot(difStd(difItems,group="race",focal.name = "W"))
```

and when run resulted in this plot: