Klasik Test Teorisi(KTT)

Madde analizi

Dr. Kübra Atalay Kabasakal

Paketler

```r
library("dplyr") # veri düzenleme
library("car")   # veri düzenleme
library("skimr")  # veri inceleme
library("DataExplorer") # veri inceleme
library("ggcorrplot")   # veri inceleme
library("psych")  #KTK analizler
library("CTT")   #KTK analizler
library("ShinyItemAnalysis") #KTK analizler
# devtools::install_github("zief0002/QME")
library("QME") #KTK analizler
library("difR") #KTK analizler
```

Madde Analizi

- Kullanılacak veri seti, 651 üniversite öğrencisinin Homeostasis Concept Inventory (HCI) çoktan seçmeli testine verdiği yanıtlardan oluşmaktadır.
- Bu veri kümesi orijinal olarak **ShinyItemAnalysis** paketinden yer almaktadır (bkz. `?ShinyItemAnalysis::HCItest`). Veri
- item1 to item20: Answers to multiple-choice items (A, B, C, D, or E)
- gender: “F” for female and “M” for male
- eng_first_lang: “yes” if English is the student’s first language, otherwise “no”
- study_year: The student’s year of study at the university
- major: öğrenci yaşam bilimlerinde ana dal yapmayı planlıyorsa 1, aksi takdirde 0

Veri Okuma{.smaller}

```r
hci <- read.csv("hci.csv", header = TRUE)
head(hci)
```

```
  item1 item2 item3 item4 item5 item6 item7 item8 item9 item10 item11 item12 item13 item14 item15 item16
1     D     B     A     D     B     B     B     C     D      A      A      D      A      A      D      A
2     D     B     A     D     B     C     B     C     D      A      A      D      A      A      C      A
3     D     B     A     D     C     C     B     C     D      A      A      D      A      A      A      A
4     D     B     A     D     B     C     C     C     D      A      A      D      A      A      C      A
5     D     B     A     D     B     C     C     C     D      A      A      D      A      A      D      A
6     D     B     A     D     B     C     C     C     D      A      A      D      A      A      C      A
  item17 item18 item19 item20 gender eng_first_lang study_year major
1      D      C      C      D      F            yes          4     1
2      C      C      C      D      F            yes          4     1
3      C      C      C      D      M            yes          4     1
4      C      C      C      D      M            yes          4     1
5      C      C      C      D      M            yes          4     1
6      C      C      C      D      F            yes          4     1
```

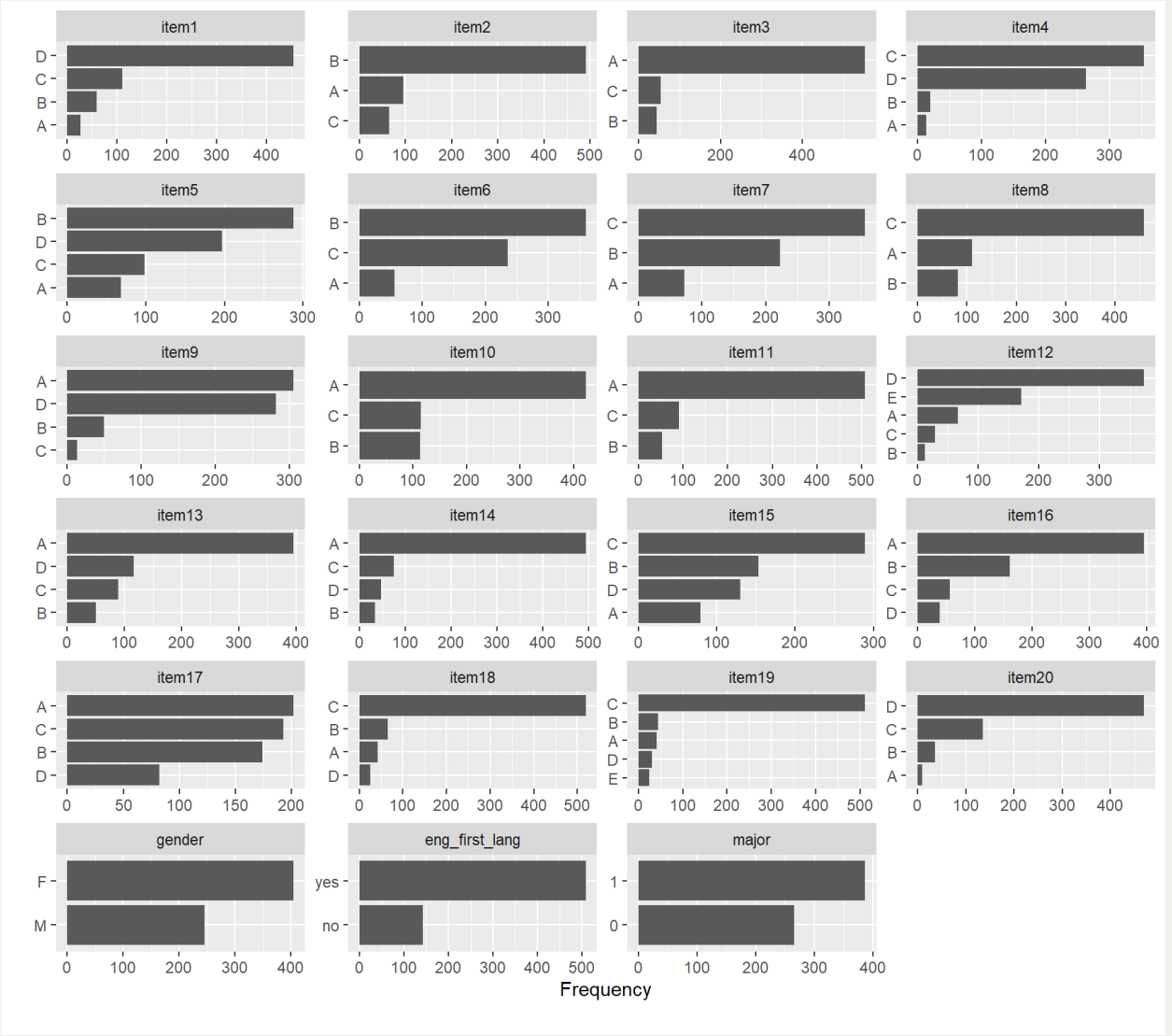
```r
str(hci)
```

```
'data.frame':   651 obs. of  24 variables:
 $ item1          : chr  "D" "D" "D" "D" ...
 $ item2          : chr  "B" "B" "B" "B" ...
 $ item3          : chr  "A" "A" "A" "A" ...
 $ item4          : chr  "D" "D" "D" "D" ...
 $ item5          : chr  "B" "B" "C" "B" ...
 $ item6          : chr  "B" "C" "C" "C" ...
 $ item7          : chr  "B" "B" "B" "C" ...
 $ item8          : chr  "C" "C" "C" "C" ...
 $ item9          : chr  "D" "D" "D" "D" ...
 $ item10         : chr  "A" "A" "A" "A" ...
 $ item11         : chr  "A" "A" "A" "A" ...
 $ item12         : chr  "D" "D" "D" "D" ...
 $ item13         : chr  "A" "A" "A" "A" ...
 $ item14         : chr  "A" "A" "A" "A" ...
```

```
$ item15        : chr  "D" "C" "A" "C" ...
$ item16        : chr  "A" "A" "A" "A" ...
$ item17        : chr  "D" "C" "C" "C" ...
$ item18        : chr  "C" "C" "C" "C" ...
$ item19        : chr  "C" "C" "C" "C" ...
$ item20        : chr  "D" "D" "D" "D" ...
$ gender        : chr  "F" "F" "M" "M"
```

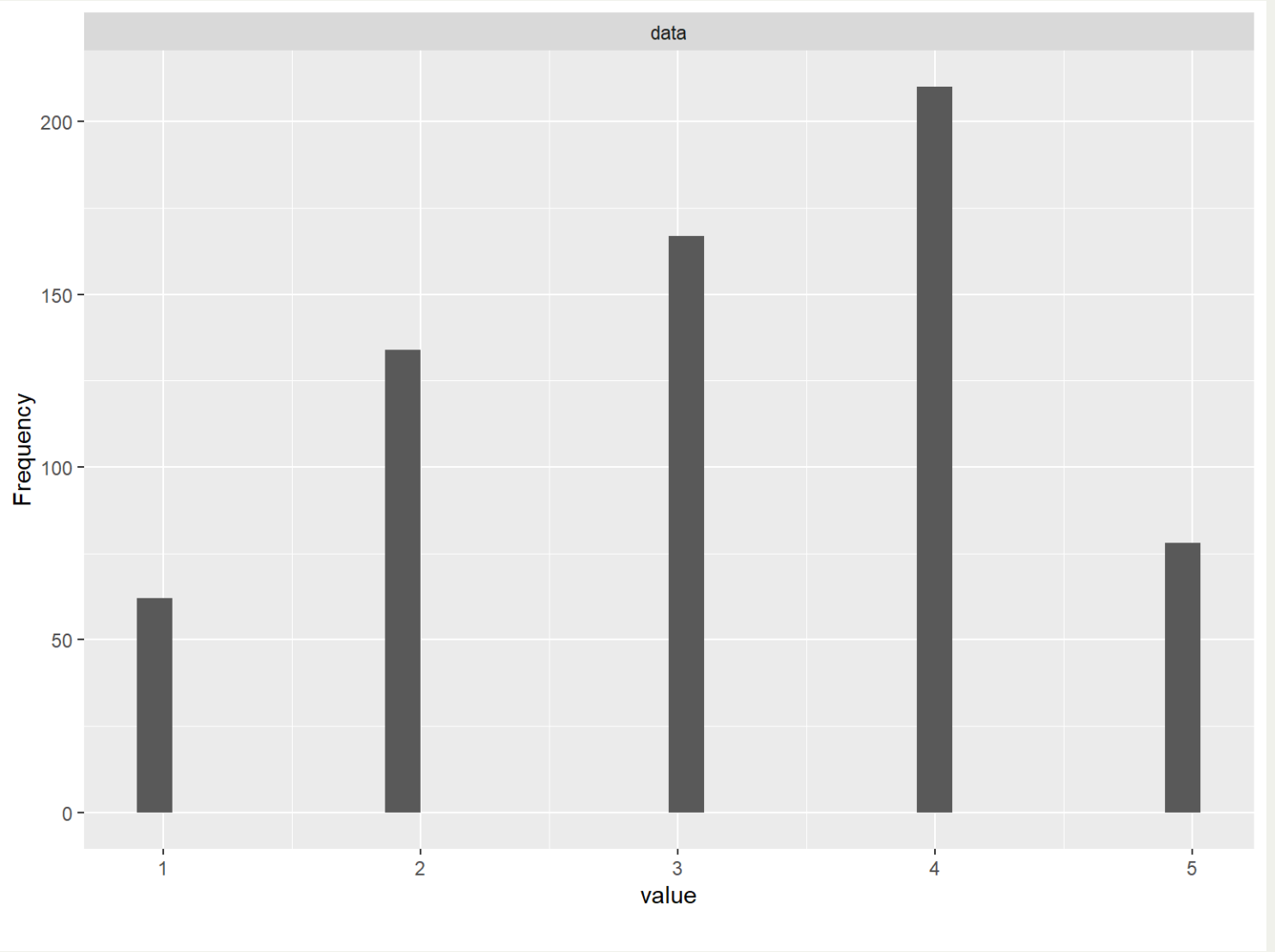
Veri İnceleme

```
1  DataExplorer::plot_bar(data = hci, nrow = 6, ncol = 4)
```



Veri İnceleme

```
1  DataExplorer::plot_histogram(data = hci[, c("study_year")])
```



Çeldirici Analiz

- Bir çeldirici aşağıdaki gibi çeşitli nedenlerden dolayı iyi çalışmayabilir:
  - çoğunlukla yeterli içerik bilgisine sahip öğrencilerin çeldiriciyi seçmesi
  - neredeyse hiçbir öğrenci çeldiriciyi seçmemesi
  - çoğu öğrenci (yeterli içerik bilgisine sahip olanlar da dahil) doğru seçenek yerine çeldiriciyi seçmesi

Çeldirici Analiz

```r
key <- read.csv("hci_key.csv", header = TRUE)
```

```r
hci_items <- dplyr::select(hci,
                           starts_with("item"))
head(hci_items)
```

```
  item1 item2 item3 item4 item5 item6 item7 item8 item9 item10 item11 item12 item13 item14 item15 item16
1     D     B     A     D     B     B     B     C     D      A      A      D      A      A      D      A
2     D     B     A     D     B     C     B     C     D      A      A      D      A      A      C      A
3     D     B     A     D     C     C     B     C     D      A      A      D      A      A      A      A
4     D     B     A     D     B     C     C     C     D      A      A      D      A      A      C      A
5     D     B     A     D     B     C     C     C     D      A      A      D      A      A      D      A
6     D     B     A     D     B     C     C     C     D      A      A      D      A      A      C      A
  item17 item18 item19 item20
1      D      C      C      D
2      C      C      C      D
3      C      C      C      D
4      C      C      C      D
5      C      C      C      D
6      C      C      C      D
```

Çeldirici Analiz

```
1 CTT::distractorAnalysis(items = hci_items, key = key)
```

```
$item1
  correct key   n       rspP       pBis     discrim      lower      mid50       mid75      upper
A           A  27 0.04147465 -0.2461507 -0.09049774 0.09049774 0.05263158 0.005524862 0.00000000
B           B  59 0.09062980 -0.1662783 -0.05838780 0.11764706 0.07017544 0.093922652 0.05925926
C           C 110 0.16897081 -0.4081448 -0.28422993 0.32126697 0.16666667 0.082872928 0.03703704
D       *   D 455 0.69892473  0.2884191  0.43311547 0.47058824 0.71052632 0.817679558 0.90370370
E           E   0 0.00000000         NA  0.00000000 0.00000000 0.00000000 0.000000000 0.00000000

$item2
  correct key   n       rspP       pBis     discrim     lower     mid50      mid75      upper
A           A  96 0.14746544 -0.3951782 -0.24062343 0.2850679 0.1140351 0.07734807 0.04444444
B       *   B 490 0.75268817  0.2206134  0.32575834 0.5927602 0.7280702 0.83977901 0.91851852
C           C  65 0.09984639 -0.1896673 -0.08513491 0.1221719 0.1578947 0.08287293 0.03703704
D           D   0 0.00000000         NA  0.00000000 0.0000000 0.0000000 0.00000000 0.00000000
E           E   0 0.00000000         NA  0.00000000 0.0000000 0.0000000 0.00000000 0.00000000

$item3
  correct key   n       rspP       pBis    discrim     lower      mid50      mid75       upper
A       *   A 552 0.84792627  0.3500418  0.3229093 0.6696833 0.82456140 0.97237569 0.992592593
B           B  45 0.06912442 -0.3794204 -0.1583710 0.1583710 0.07017544 0.01104972 0.000000000
C           C  54 0.08294931 -0.3411496 -0.1645383 0.1719457 0.10526316 0.01657459 0.007407407
D           D   0 0.00000000         NA  0.0000000 0.0000000 0.00000000 0.00000000 0.000000000
```

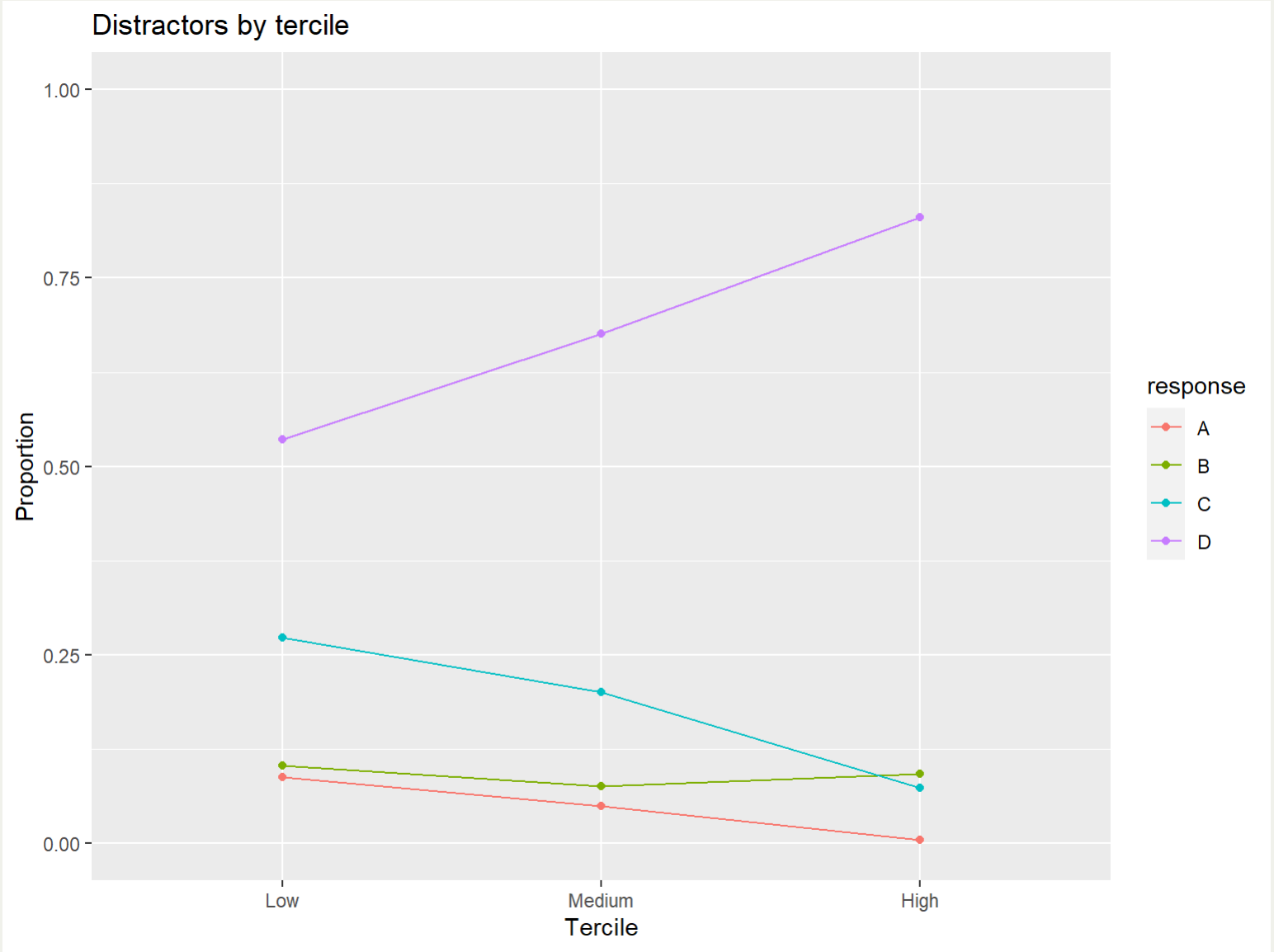
Çeldirici Analiz

```
key2 <- read.csv("hci_key2.csv" , header = TRUE)
print(key2)
```

```
  response item1 item2 item3 item4 item5 item6 item7 item8 item9 item10 item11
1        A     0     0     1     0     0     0     0     0     0      1      1
2        B     0     1     0     0     1     0     0     0     0      0      0
3        C     0     0     0     0     0     1     1     1     0      0      0
4        D     1    NA    NA     1     0    NA    NA    NA     1     NA     NA
5        E    NA    NA    NA    NA    NA    NA    NA    NA    NA     NA     NA
  item12 item13 item14 item15 item16 item17 item18 item19 item20
1      0      1      1      0      1      0      0      0      0
2      0      0      0      0      0      0      0      0      0
3      0      0      0      1      0      1      1      1      0
4      1      0      0      0      0      0      0      0      1
5      0     NA     NA     NA     NA     NA     NA      0     NA
```

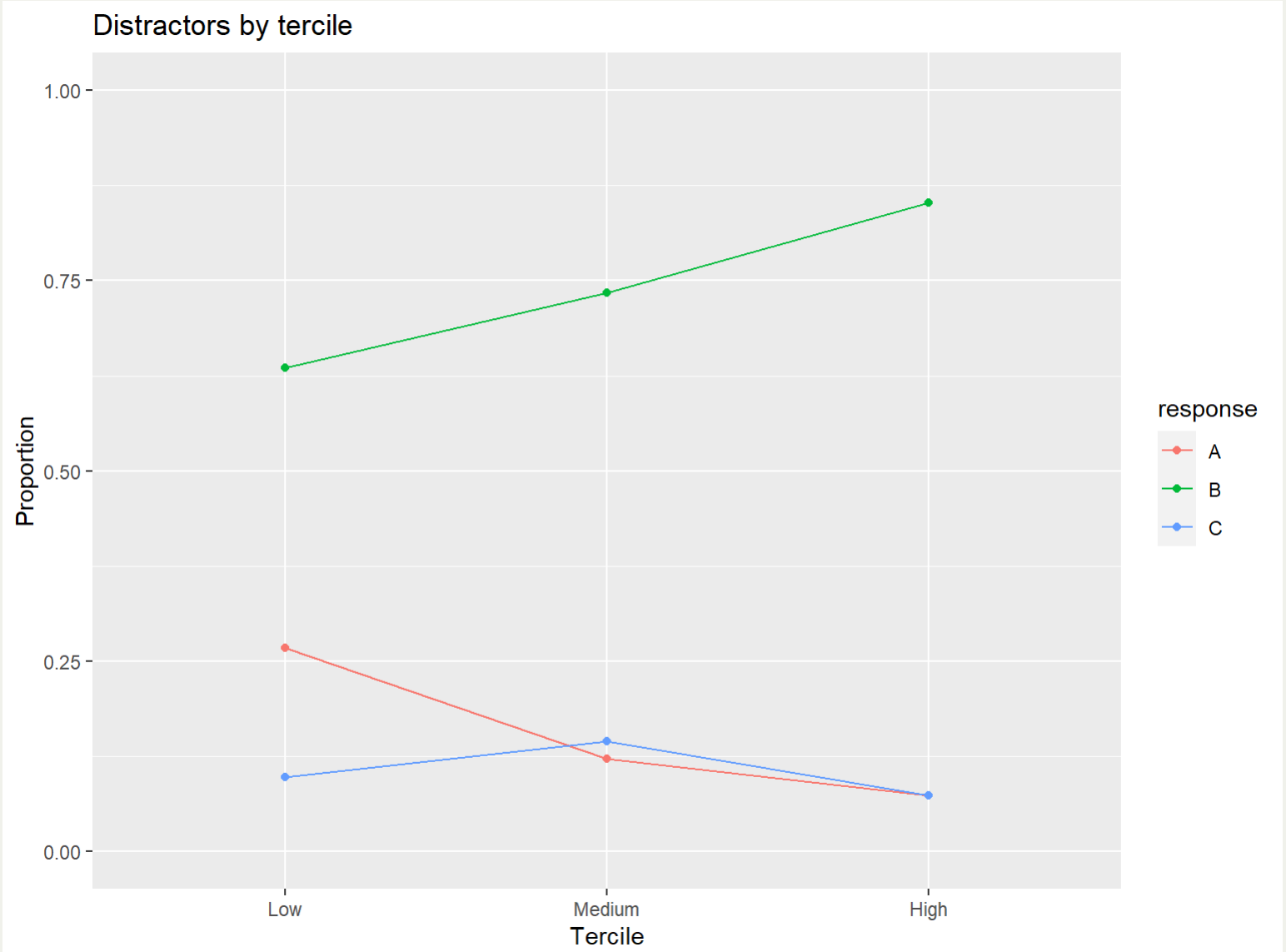
```
hci_analysis <- QME::analyze(test = hci_items, key = key2, id = FALSE)
QME::distractor_report(x = hci_analysis)
```

```
### Details for ` item1`
```




```
<table>
 <thead>
  <tr>
   <th style="text-align:left;"> Choice </th>
```

<th style="text-align:right;"> Key </th>
<th style="text-align:right;"> Proportions </th>
<th style="text-align:right;"> Response Discrimination </th>
</tr>
</thead>
<tbody>
<tr>
<td style="text-align:left;"> A </td>
<td style="text-align:right;"> 0 </td>
<td style="text-align:right;"> 0.04 </td>
<td style="text-align:right;"> -0.23 </td>
</tr>
<tr>
<td style="text-align:left;"> B </td>
<td style="text-align:right;"> 0 </td>

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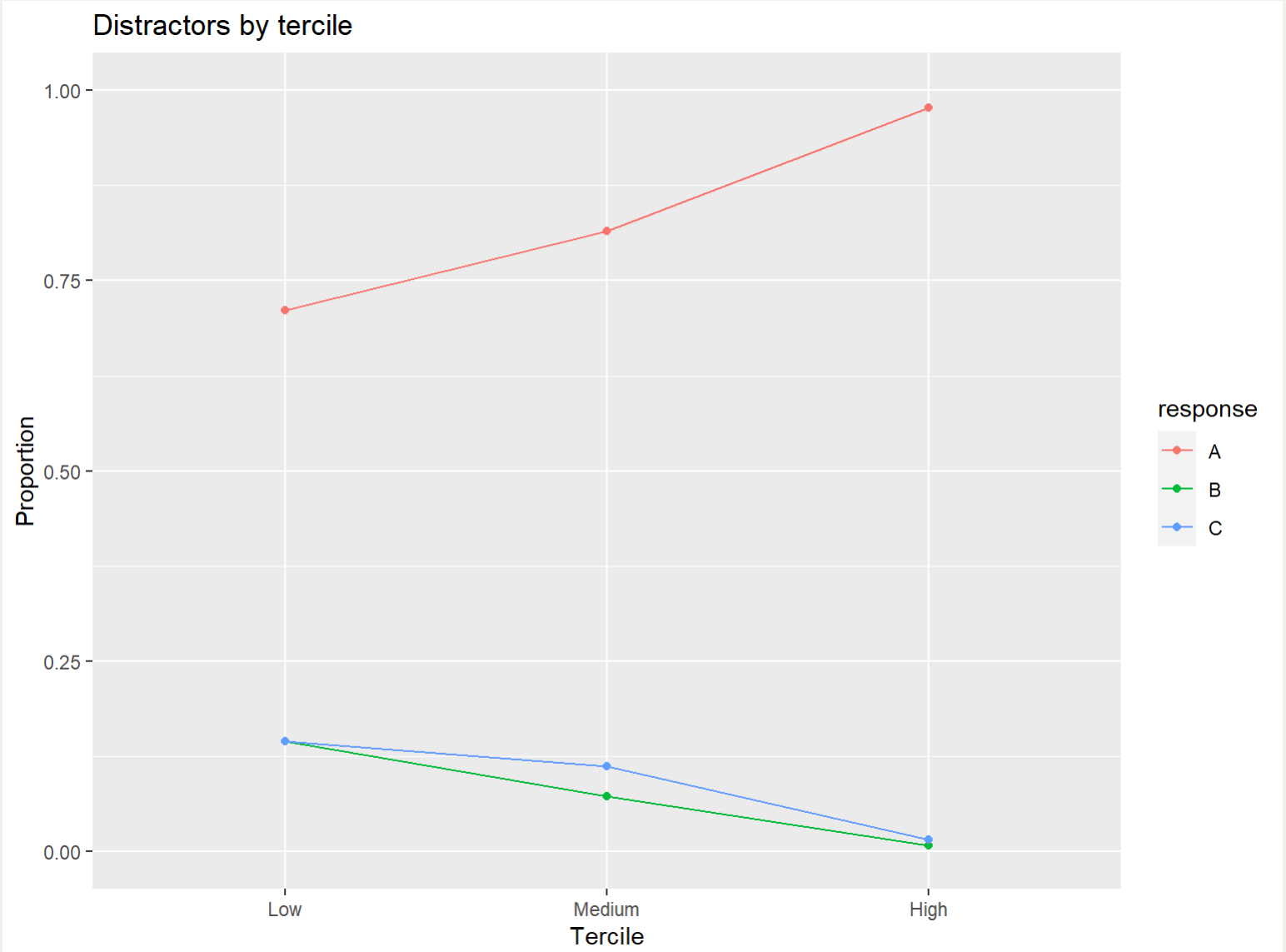
   </tr>
  </thead>
 <tbody>
   <tr>
    <td style="text-align:left;"> A </td>
    <td style="text-align:right;"> 0 </td>
    <td style="text-align:right;"> 0.15 </td>
    <td style="text-align:right;"> -0.25 </td>
   </tr>
   <tr>
    <td style="text-align:left;"> B </td>
    <td style="text-align:right;"> 1 </td>
```

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 <tbody>
   <tr>
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    <td style="text-align:right;"> 0.85 </td>
    <td style="text-align:right;"> 0.35 </td>
   </tr>
   <tr>
    <td style="text-align:left;"> B </td>
    <td style="text-align:right;"> 0 </td>
```

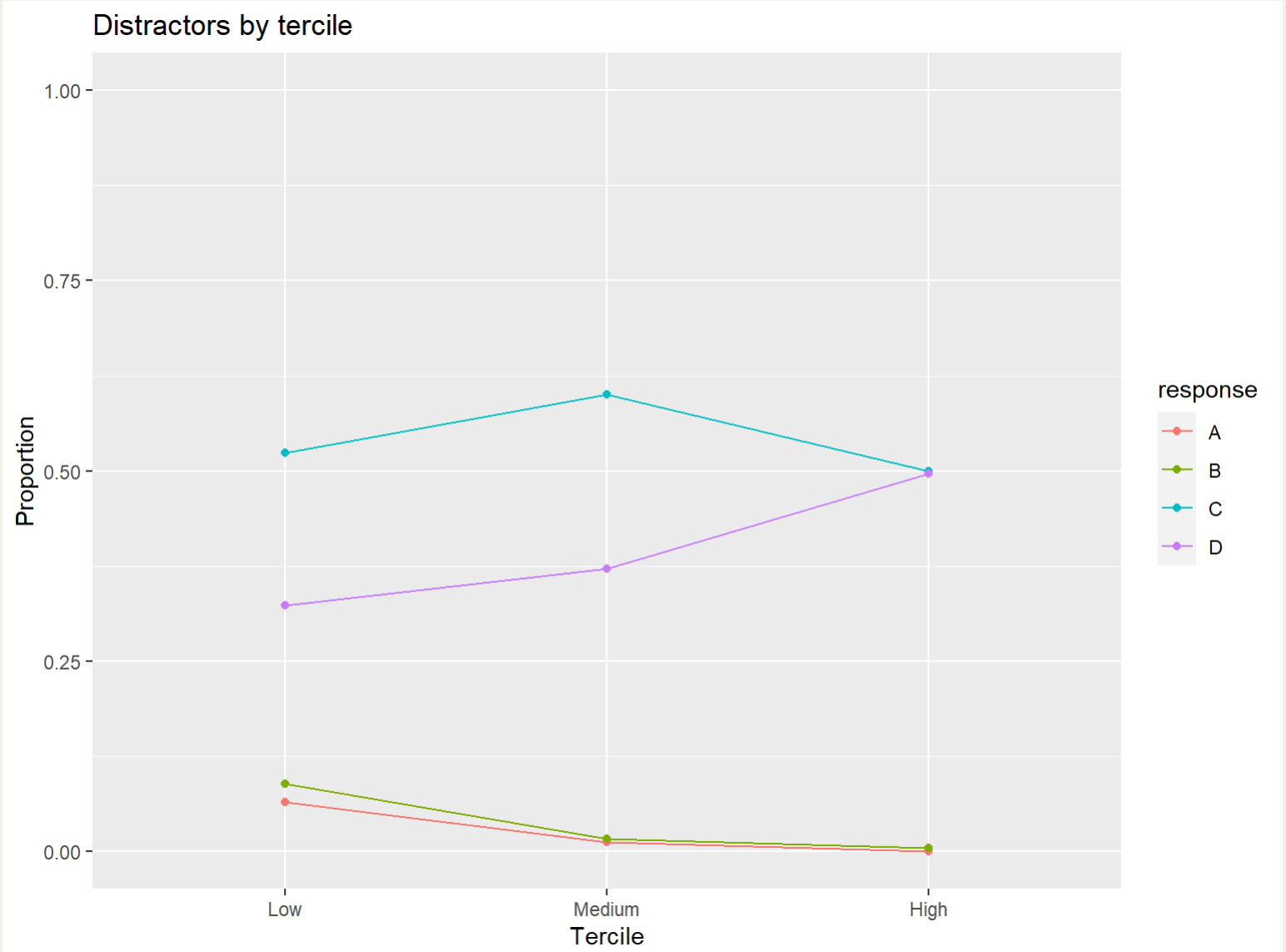


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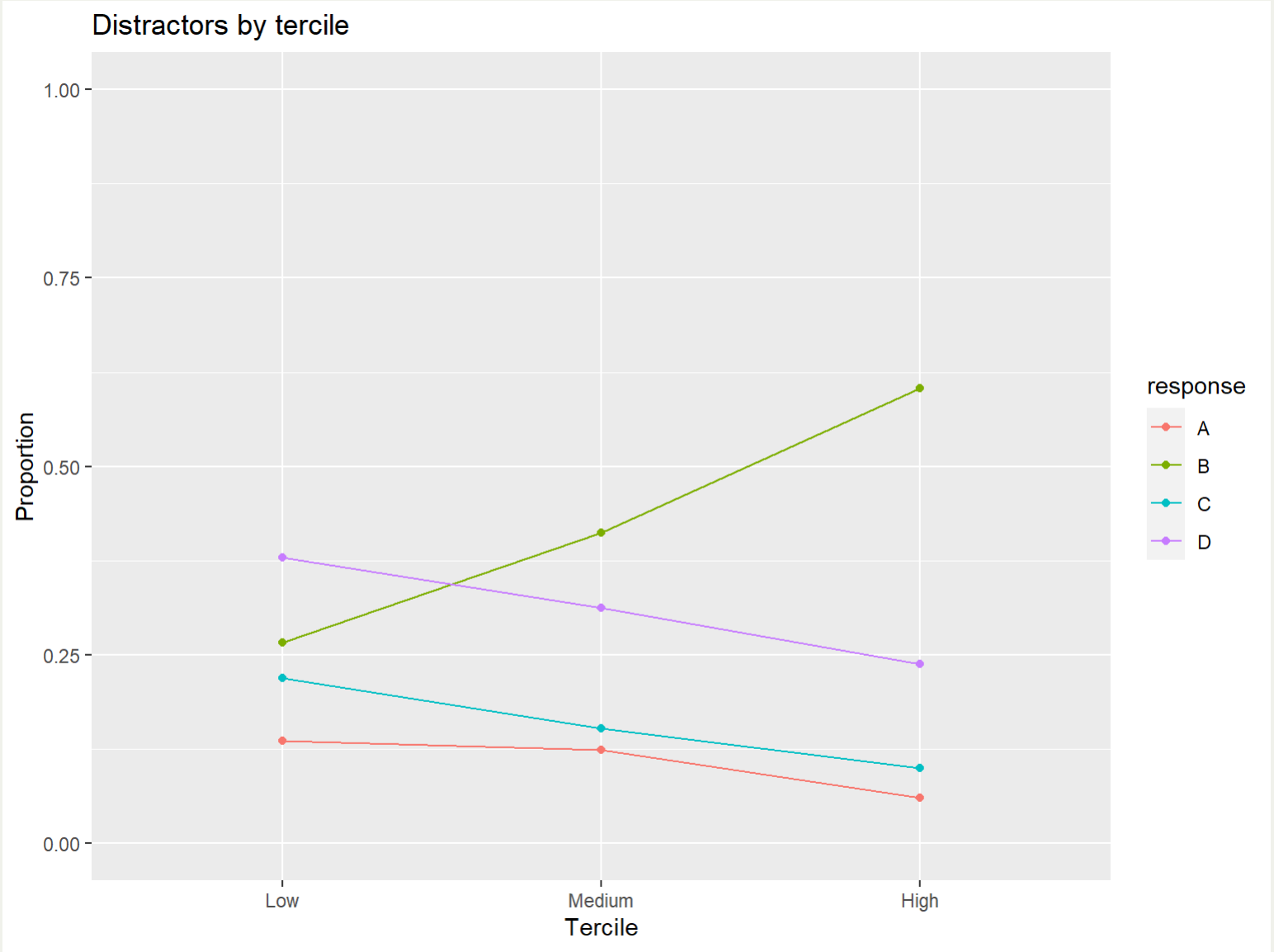
   <tr>
    <td style="text-align:left;"> A </td>
    <td style="text-align:right;"> 0 </td>
    <td style="text-align:right;"> 0.02 </td>
    <td style="text-align:right;"> -0.33 </td>
   </tr>
   <tr>
    <td style="text-align:left;"> B </td>
    <td style="text-align:right;"> 0 </td>
```

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  </thead>
 <tbody>
   <tr>
    <td style="text-align:left;"> A </td>
    <td style="text-align:right;"> 0 </td>
    <td style="text-align:right;"> 0.10 </td>
    <td style="text-align:right;"> -0.26 </td>
   </tr>
   <tr>
    <td style="text-align:left;"> B </td>
    <td style="text-align:right;"> 1 </td>
```

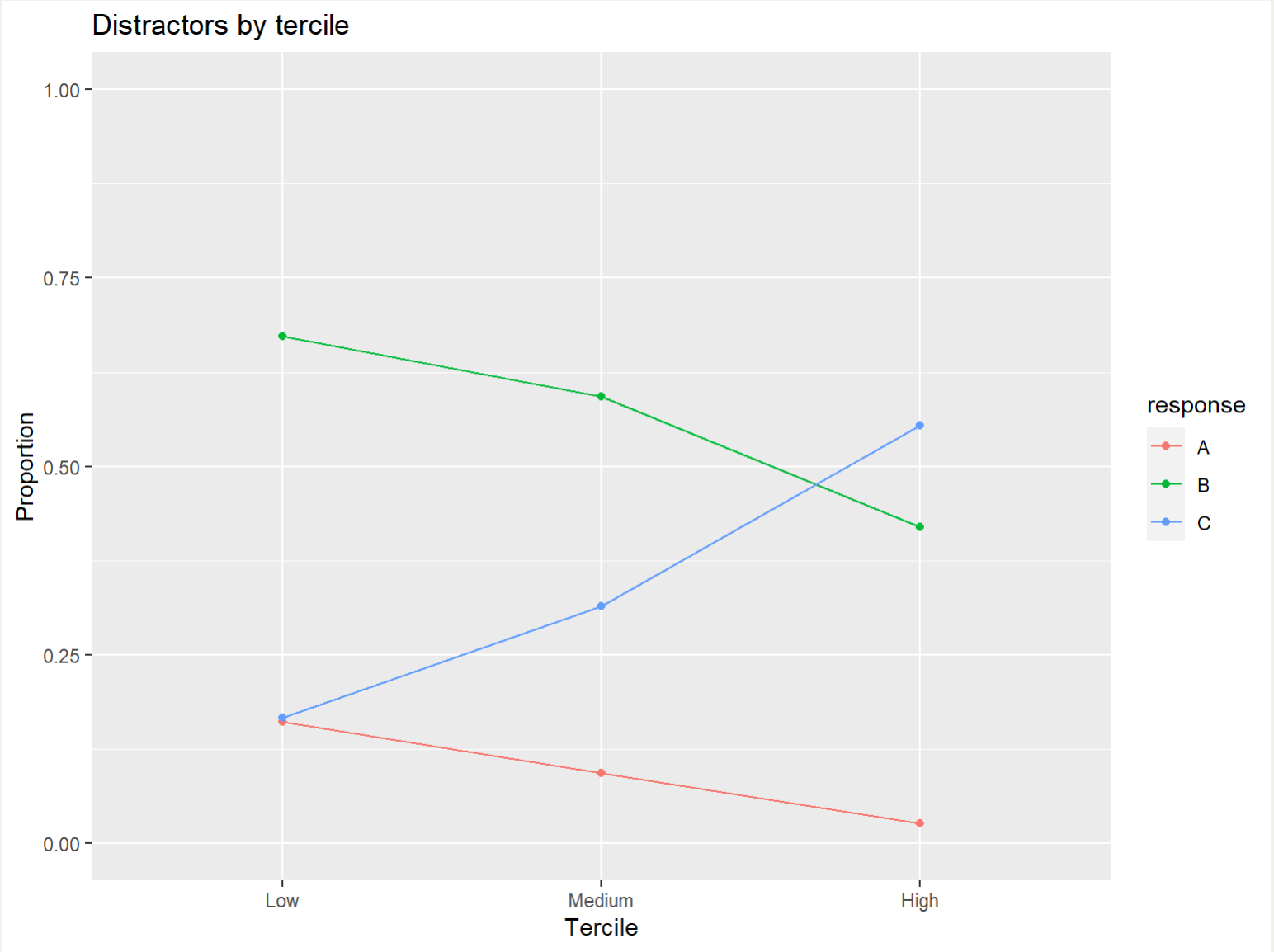


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   <tr>
    <td style="text-align:left;"> A </td>
    <td style="text-align:right;"> 0 </td>
    <td style="text-align:right;"> 0.09 </td>
    <td style="text-align:right;"> -0.46 </td>
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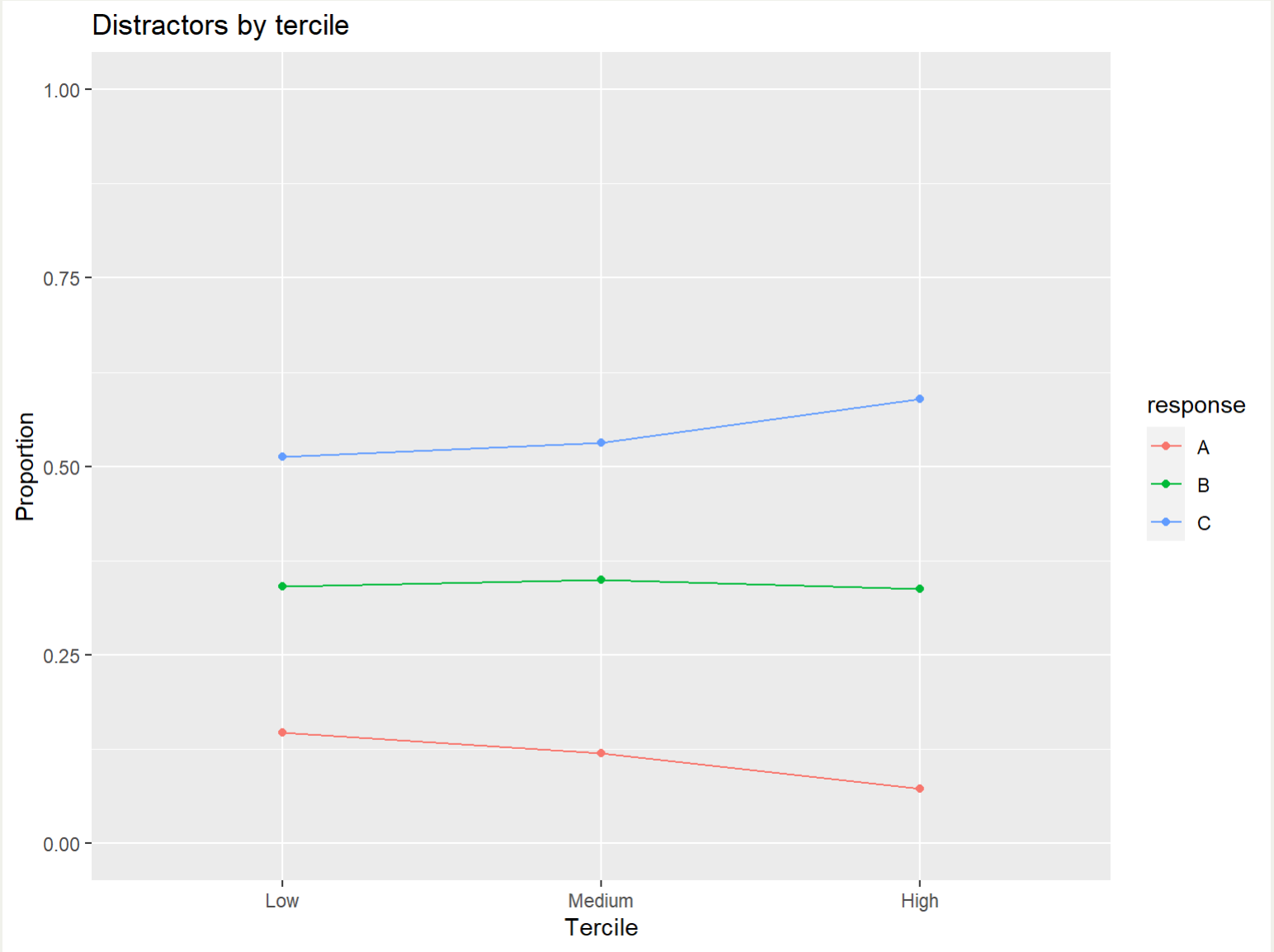
    <td style="text-align:left;"> B </td>
    <td style="text-align:right;"> 0 </td>
```

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    <td style="text-align:left;"> A </td>
    <td style="text-align:right;"> 0 </td>
    <td style="text-align:right;"> 0.11 </td>
    <td style="text-align:right;"> -0.15 </td>
   </tr>
   <tr>
    <td style="text-align:left;"> B </td>
    <td style="text-align:right;"> 0 </td>
```

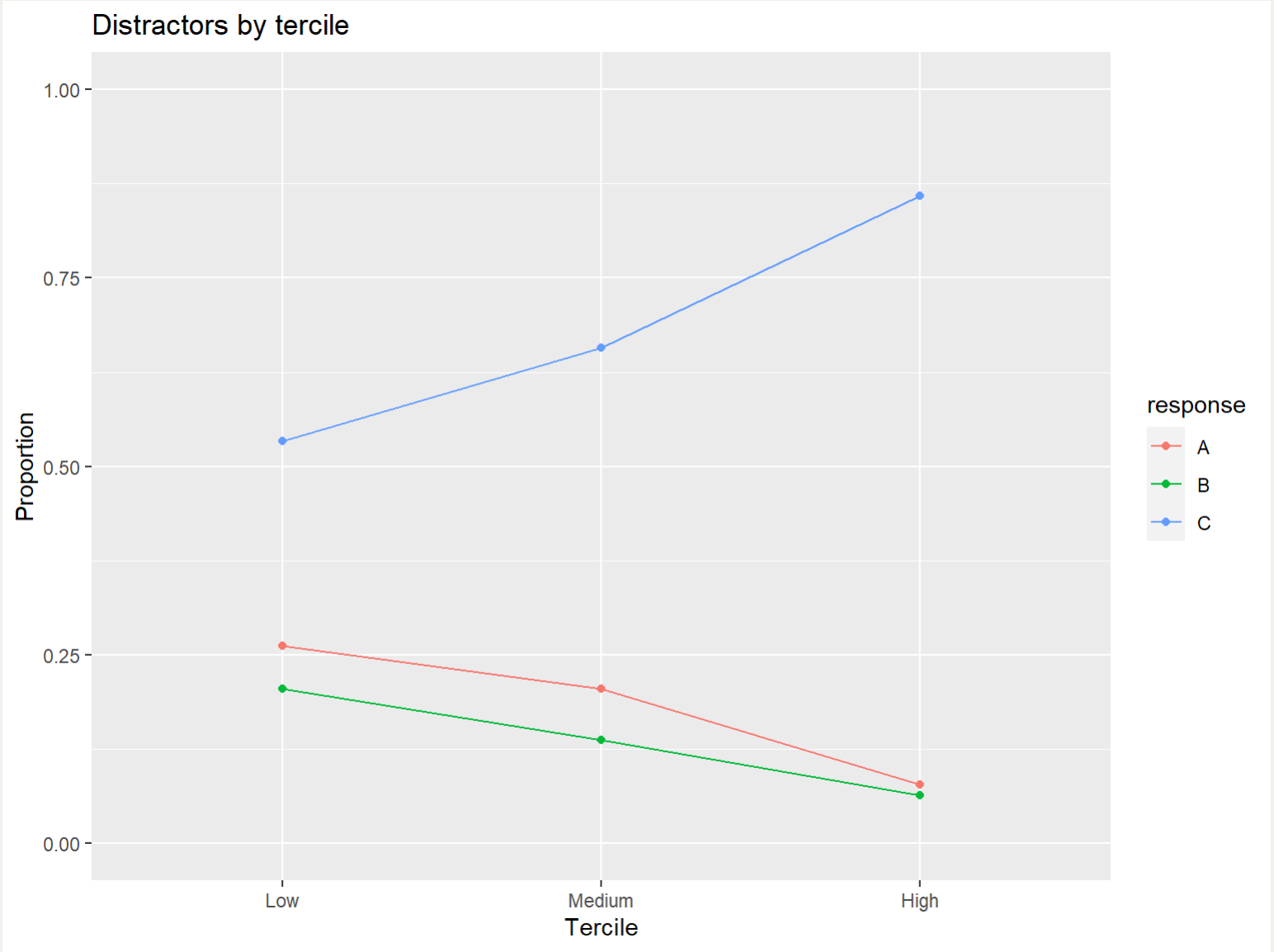


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    <td style="text-align:right;"> 0.17 </td>
    <td style="text-align:right;"> -0.27 </td>
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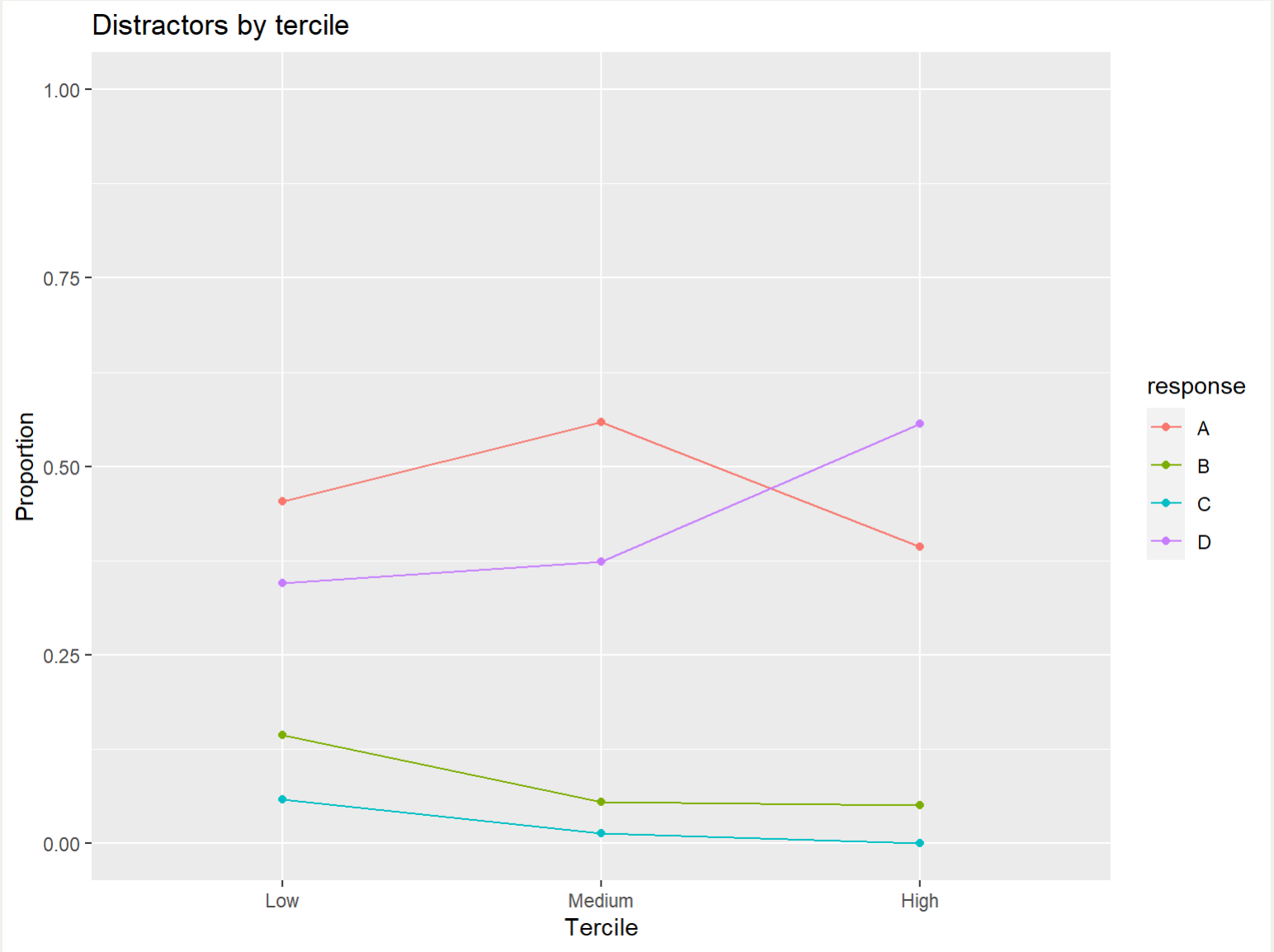
    <td style="text-align:right;"> 0 </td>
```

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   <tr>
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    <td style="text-align:right;"> 0 </td>
    <td style="text-align:right;"> 0.47 </td>
    <td style="text-align:right;"> -0.16 </td>
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    <td style="text-align:left;"> B </td>
    <td style="text-align:right;"> 0 </td>
```

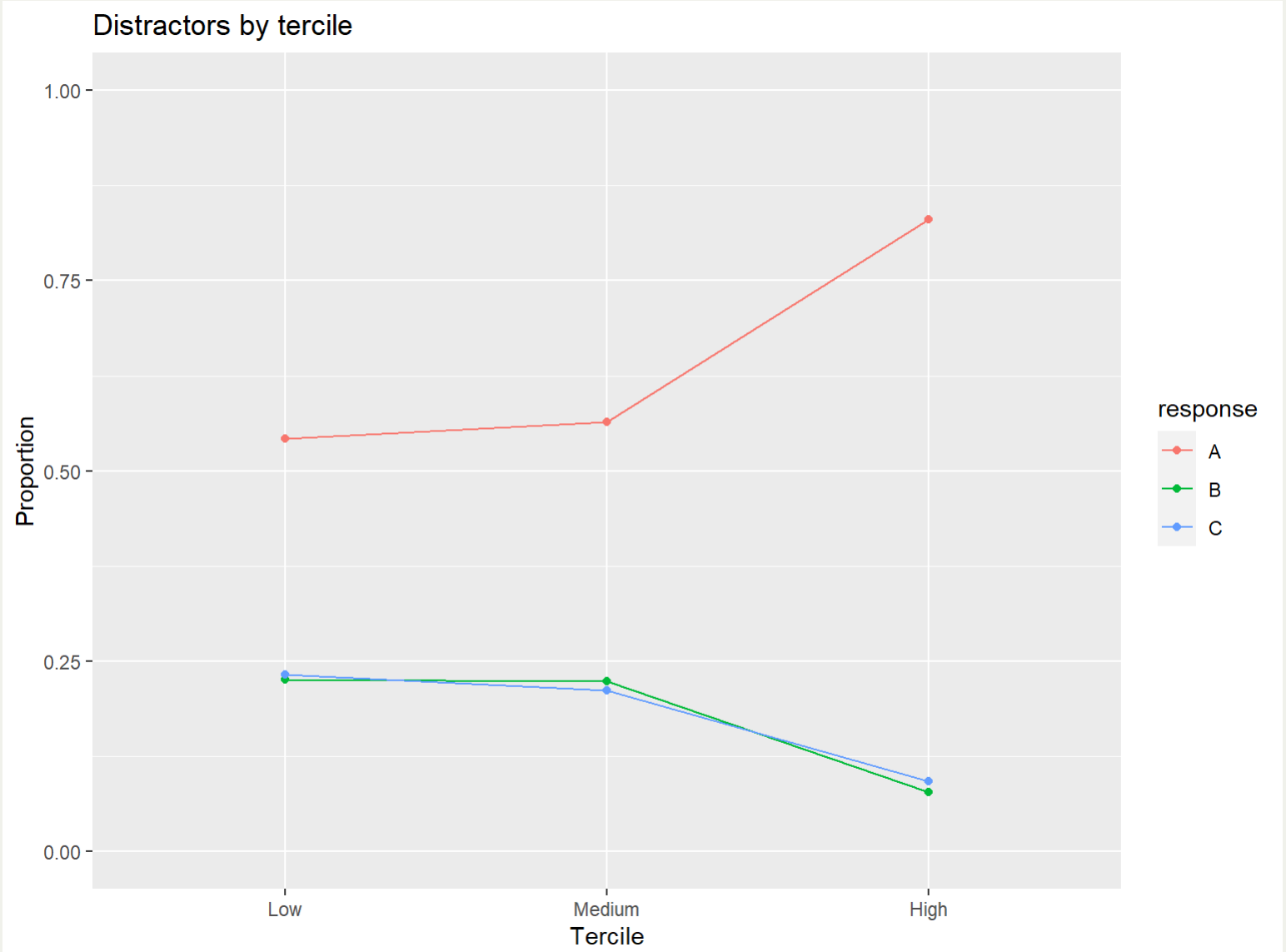


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    <td style="text-align:right;"> 1 </td>
    <td style="text-align:right;"> 0.65 </td>
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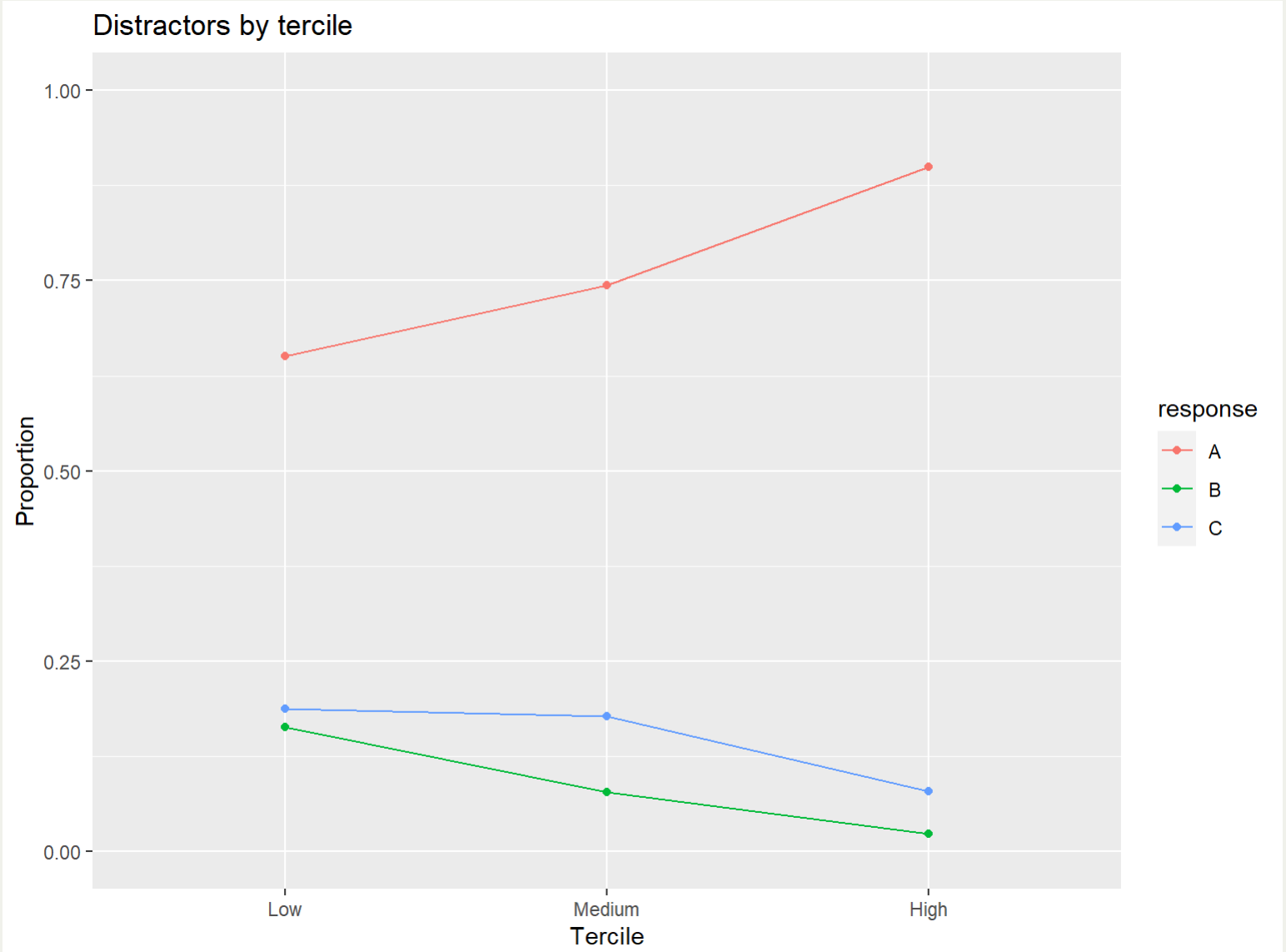


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    <td style="text-align:left;"> A </td>
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    <td style="text-align:right;"> 0.78 </td>
    <td style="text-align:right;"> 0.29 </td>
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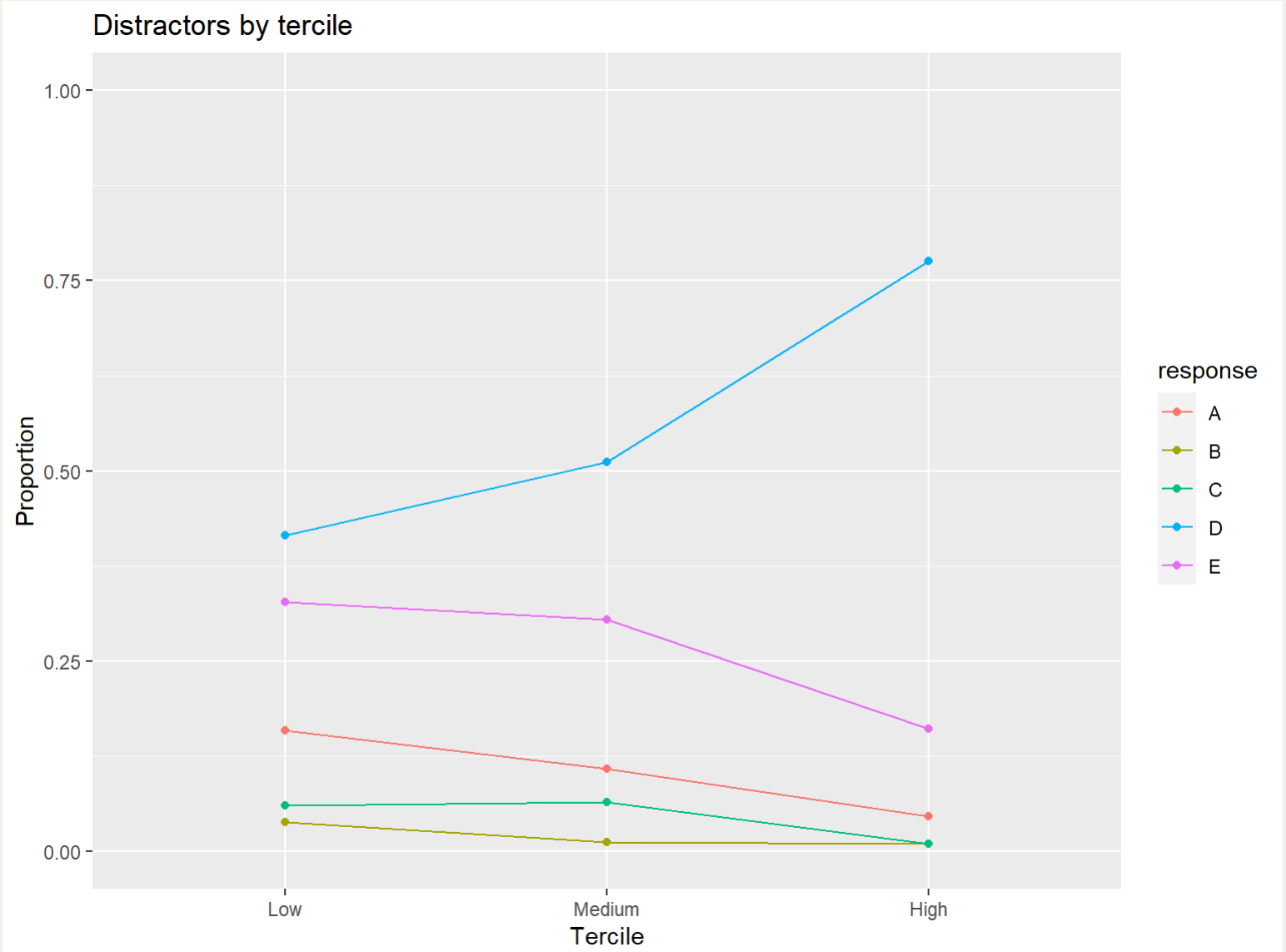
```

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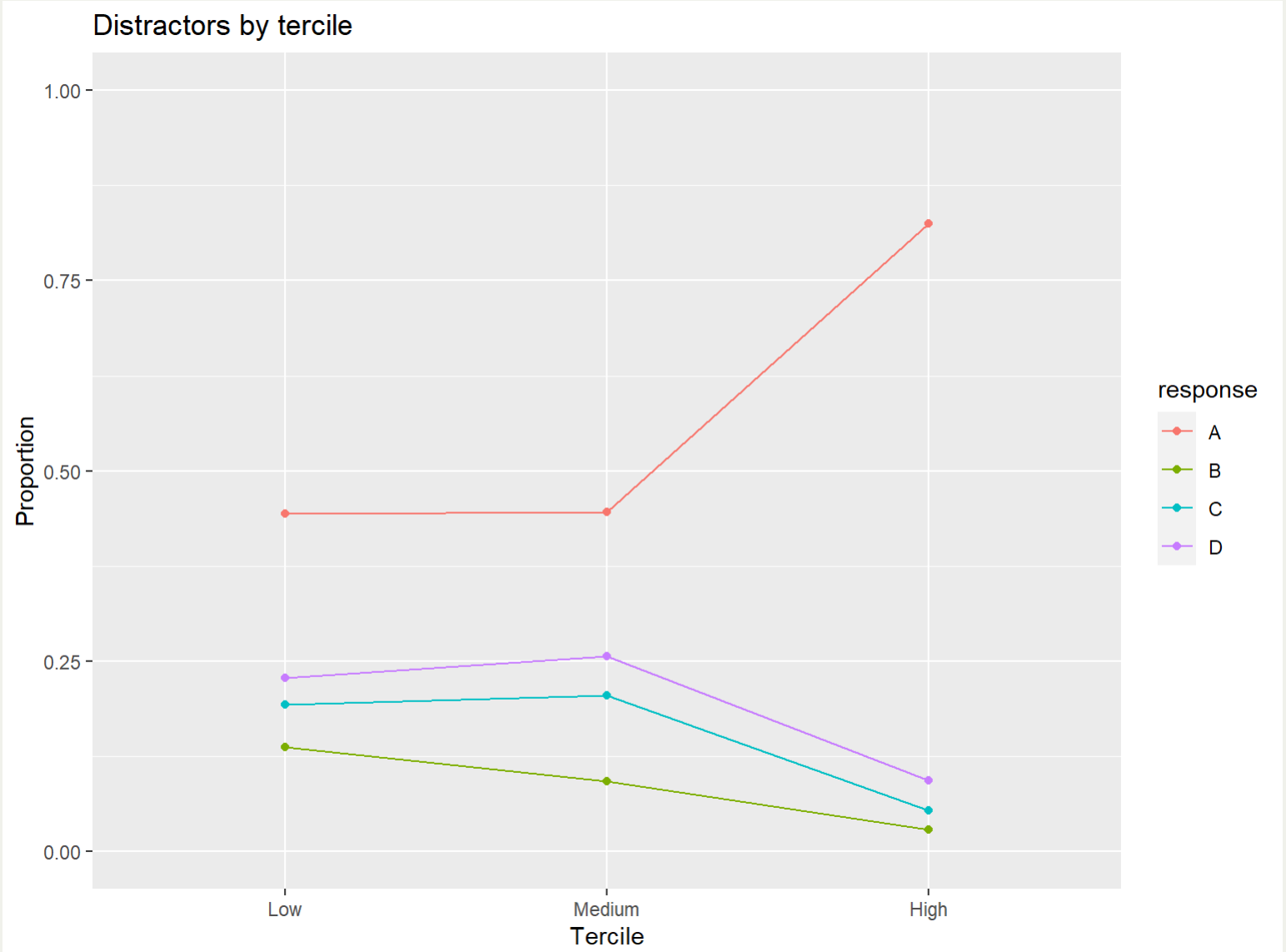


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   </tr>
  </thead>
 <tbody>
   <tr>
    <td style="text-align:left;"> A </td>
    <td style="text-align:right;"> 1 </td>
    <td style="text-align:right;"> 0.61 </td>
    <td style="text-align:right;"> 0.36 </td>
   </tr>
   <tr>
    <td style="text-align:left;"> B </td>
    <td style="text-align:right;"> 0 </td>
```
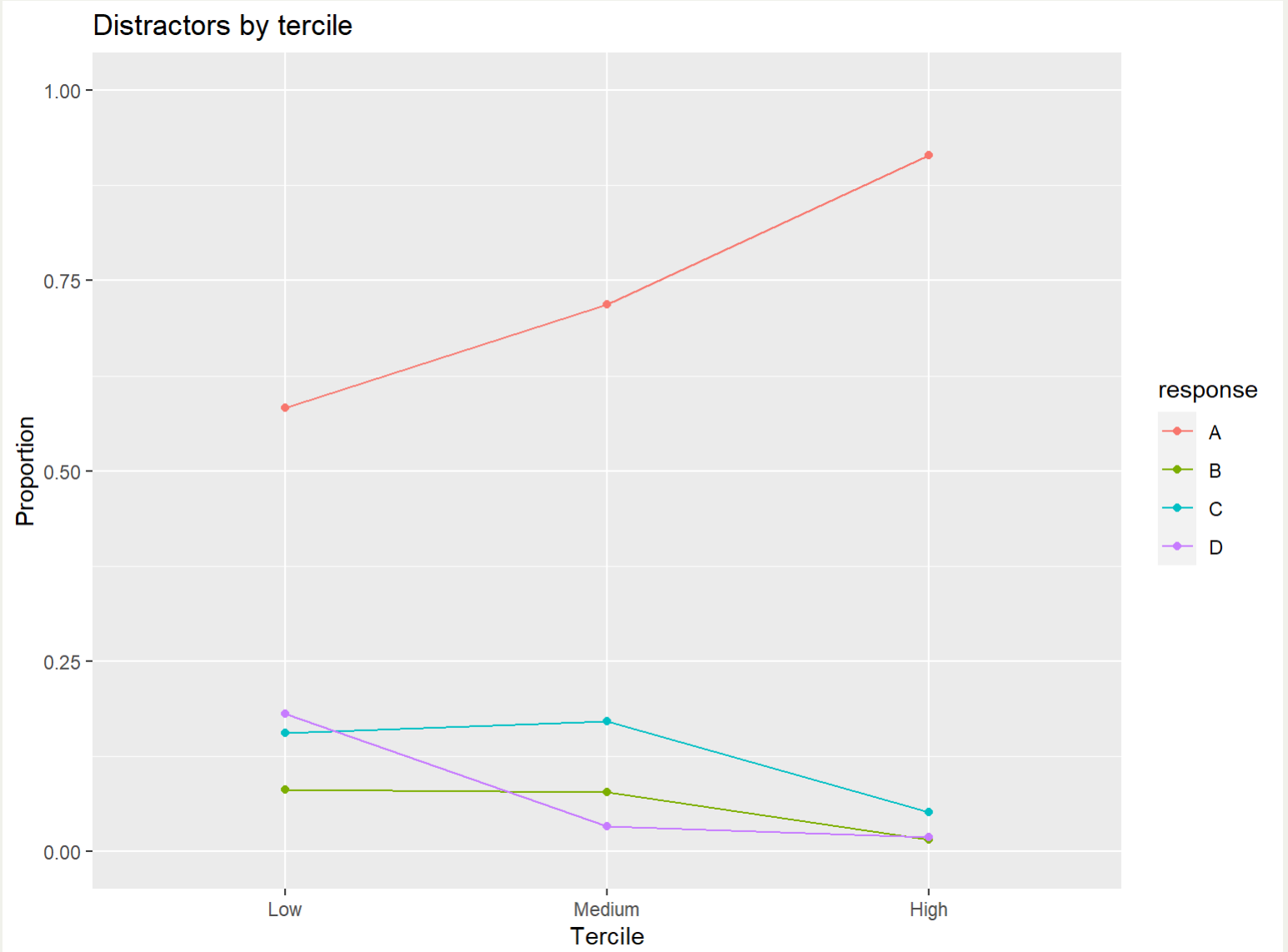
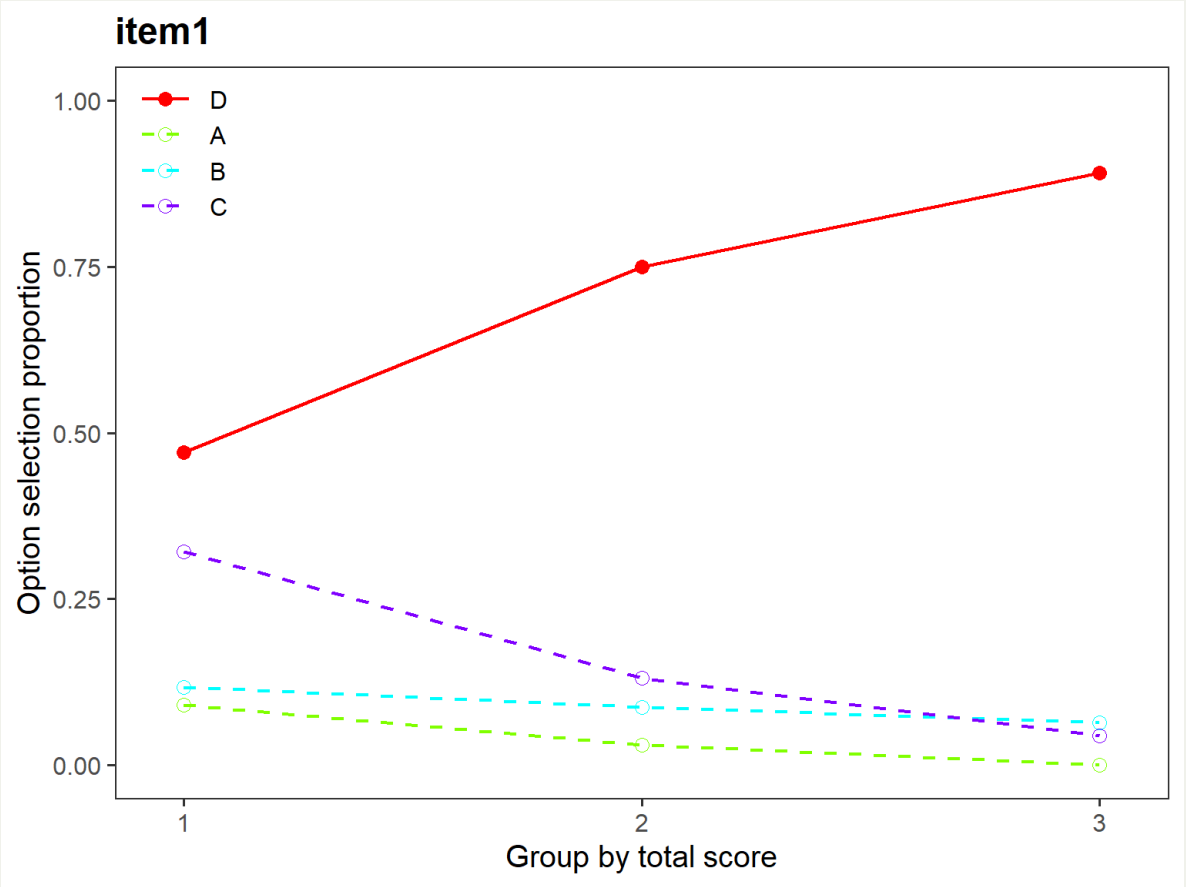




```
<table>
 <thead>
  <tr>
   <th style="text-align:left;"> Choice </th>
```

Çeldirici Analiz

```
1  key3 <- as.vector(key$key)
2
3  ShinyItemAnalysis::plotDistractorAnalysis(Data = hci_items,        key = key3,
4        num.groups = 3,
5        item = 1)
```

```
$item1
```



Puanlama

```r
hci_scored <- CTT::score(items = hci_items,
      key = key3,
      output.scored = TRUE,
     rel = TRUE)
str(hci_scored)
```

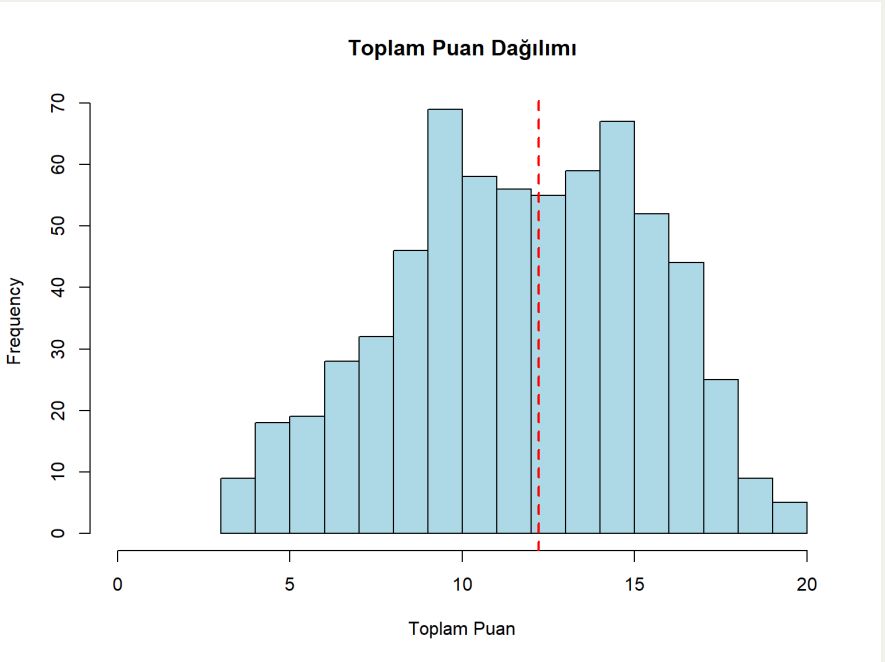
```
List of 3
 $ score      : Named num [1:651] 16 19 17 20 19 20 20 14 18 17 ...
  ..- attr(*, "names")= chr [1:651] "P1" "P2" "P3" "P4" ...
 $ reliability:List of 9
  ..$ nItem         : int 20
  ..$ nPerson       : int 651
  ..$ alpha         : num 0.715
  ..$ scaleMean     : num 12.2
  ..$ scaleSD       : num 3.64
  ..$ alphaIfDeleted: num [1:20(1d)] 0.704 0.71 0.701 0.715 0.705 ...
  ..$ pBis          : num [1:20(1d)] 0.288 0.221 0.35 0.173 0.277 ...
  ..$ bis           : num [1:20(1d)] 0.37 0.295 0.525 0.218 0.344 ...
  ..$ itemMean      : Named num [1:20] 0.699 0.753 0.848 0.404 0.442 ...
  .. ..- attr(*, "names")= chr [1:20] "item1" "item2" "item3" "item4" ...
  ..- attr(*, "class")= chr "reliability"
 $ scored     : num [1:651, 1:20] 1 1 1 1 1 1 1 0 1 1
```

Puanlama

```r
scores <- hci_scored$score
summary(scores)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
   3.00   10.00   12.00   12.21   15.00   20.00 
```

```r
hist(x = scores,
     xlab = "Toplam Puan",
     main = "Toplam Puan Dağılımı",
     col = "lightblue",
     breaks = 15,
     xlim = c(0, 20))
abline(v = mean(scores), col = "red", lwd = 2, lty = 2)
```



Puanlama

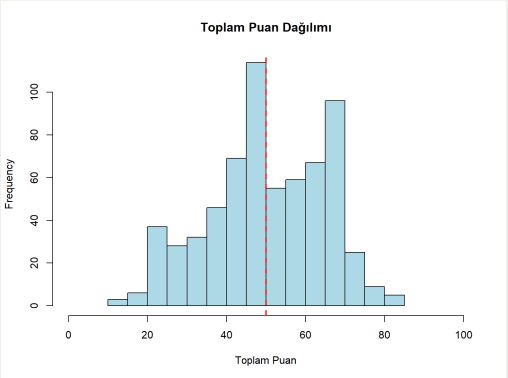
```
1 hci_scored$reliability
```

```
Number of Items
20

Number of Examinees
651

Coefficient Alpha
0.715
```

Puanlama -Dönüşüm

- Toplam puanları (20 üzerinden) 50 ortalama ve 10 standart sapmaya sahip olacak şekilde yeniden ölçeklendirmek istediğimizi varsayalım (tıpkı T puanları gibi). Bu tür bir dönüşümü gerçekleştirmek için **CTT** paketindeki `score.transform()` kullanabiliriz

```r
scores_scaled <- CTT::score.transform(scores = scores,
                  mu.new = 50,
                  sd.new = 15)


hist(x = scores_scaled$new.scores,
     xlab = "Toplam Puan",
     main = "Toplam Puan Dağılımı",
     col = "lightblue",
     xlim = c(0, 100))

abline(v = mean(scores_scaled$new.scores), col = "red", lwd = 2, lty = 2)
```

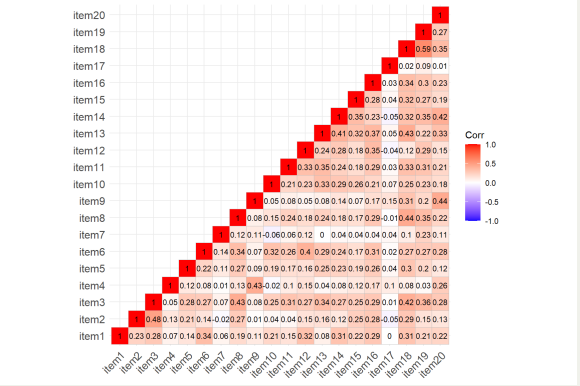


Madde analizleri

- İlk olarak, **psych** paketinden `tetrachoric()` fonksiyonunu kullanarak maddeler arasındaki korelasyonları kontrol edilir ve ardından `ggcorrplot()` kullanarak korelasyonları görselleştireceğiz.

```
cormat_hci <- psych::tetrachoric(x = hci_scored$scored)$rho
```

```
ggcorrplot::ggcorrplot(corr = cormat_hci,
                       type = "lower",
                       show.diag = TRUE,
                       lab = TRUE,
                       lab_size = 3)
```



- Korelasyon matrisi grafiği, veri kümesinde 7. ve 17. maddeler gibi birkaç sorunlu madde olduğunu göstermektedir.

Madde analizi

```
hci_items_scored <- hci_scored$scored
hci_itemanalysis <- CTT::itemAnalysis(items = hci_items_scored, pBisFlag =

hci_itemanalysis
```

```
Number of Items
20

Number of Examinees
651

Coefficient Alpha
0.715
```

Madde analizi sonuçları, hci maddelerinin iç tutarlılığının 0.72 civarında olduğunu görülmektedir.

Madde analizi

```
1 hci_itemanalysis$itemReport
```

	itemName	itemMean	pBis	bis	alphaIfDeleted	lowPBis	lowBis
1	item1	0.6989247	0.28841909	0.37990903	0.7041972		
2	item2	0.7526882	0.22061343	0.30125951	0.7099362		
3	item3	0.8479263	0.35004183	0.53420292	0.7006955		
4	item4	0.4039939	0.17298662	0.21914922	0.7150766	X	
5	item5	0.4423963	0.27678377	0.34822354	0.7053505		
6	item6	0.3625192	0.34188468	0.43826145	0.6991489		
7	item7	0.5468510	0.10093796	0.12682596	0.7219621	X	X
8	item8	0.7050691	0.32521530	0.42986414	0.7009218		
9	item9	0.4331797	0.21296787	0.26829359	0.7114344		
10	item10	0.6482335	0.26435677	0.34018971	0.7064185		
11	item11	0.7788018	0.28511163	0.39841785	0.7046640		
12	item12	0.5729647	0.31559335	0.39797842	0.7015908		
13	item13	0.6082949	0.36121767	0.45898953	0.6972122		
14	item14	0.7588326	0.33855783	0.46465921	0.7001197		
15	item15	0.4439324	0.30056400	0.37806512	0.7030488		
16	item16	0.6067588	0.38222680	0.48549208	0.6951640		
17	item17	0.2964670	0.04340407	0.05732028	0.7253267	X	X
18	item18	0.7972350	0.41712069	0.59412579	0.6943156		
19	item19	0.7849462	0.36650603	0.51528308	0.6981434		
20	item20	0.7219662	0.33955329	0.45348132	0.6997382		

Madde analizi

```r
hci_itemanalysis2 <- CTT::itemAnalysis(items = hci_items_scored[, -c(7, 17)],
       pBisFlag = .2,
       bisFlag = .2)
hci_itemanalysis2
```

```
Number of Items
18

Number of Examinees
651

Coefficient Alpha
0.733
```

Güncellenen madde analizi sonuçları, hci testinin iç tutarlılığının 0.73'e yükseldiğini göstermektedir

Madde analizi

```
1 hci_itemanalysis2$itemReport
```

	itemName	itemMean	pBis	bis	alphaIfDeleted	lowPBis	lowBis
1	item1	0.6989247	0.2948723	0.3884093	0.7228366		
2	item2	0.7526882	0.2352250	0.3212124	0.7278005		
3	item3	0.8479263	0.3584801	0.5470807	0.7187943		
4	item4	0.4039939	0.1703088	0.2157568	0.7347497		X
5	item5	0.4423963	0.2737195	0.3443684	0.7251008		
6	item6	0.3625192	0.3401596	0.4360500	0.7186537		
7	item8	0.7050691	0.3283374	0.4339909	0.7198352		
8	item9	0.4331797	0.1987390	0.2503683	0.7322322		X
9	item10	0.6482335	0.2751882	0.3541283	0.7247489		
10	item11	0.7788018	0.2894657	0.4045023	0.7232886		
11	item12	0.5729647	0.3206200	0.4043173	0.7205367		
12	item13	0.6082949	0.3715534	0.4721228	0.7155900		
13	item14	0.7588326	0.3533586	0.4849728	0.7179002		
14	item15	0.4439324	0.3061087	0.3850396	0.7219610		
15	item16	0.6067588	0.3916629	0.4974776	0.7136207		
16	item18	0.7972350	0.4246352	0.6048291	0.7125853		
17	item19	0.7849462	0.3547787	0.4987953	0.7180327		
18	item20	0.7219662	0.3423104	0.4571635	0.7186383		

Her ne kadar 4. ve 9. maddeler düşük nokta-çiftserili korelasyon gösterdikleri için işaretlenmiş olsalar da, çiftserili korelasyon değerleri çok düşük değildir.

Ölçmenin Standart hatası

- Test düzeyinde önemli bir istatistik, aşağıdaki şekilde hesaplanabilen ölçmenin standart ölçüm hatasıdır (SEM):
  - $$SEM = \sigma\sqrt{(1 - r_{xx})}$$
- Burada σ test puanlarının standart sapması ve r_{xx} testin güvenilirliğidir.
- SEM ve güven aralıklarını hesaplamak için, madde verilerini girdi olarak alan ve toplam puan için SEM ve güven aralıklarını hesaplayan özel bir fonksiyon oluşturma

```r
sem.ctt <- function(x, ci.level = 0.95) {
  require("CTT")
  rxx <- CTT::itemAnalysis(items = x)$alpha
  scores <- rowSums(x, na.rm = TRUE)
  sigma <- sd(scores, na.rm = TRUE)
  sem <- sigma*sqrt((1-rxx))
  z <- qnorm(1-(1-ci.level)/2)
  output <- data.frame(lower_CI = scores - (sem*z),
                       observed = scores,
                       upper_CI = scores + (sem*z))
  return(output)
}
```

```r

sem_hci <- sem.ctt(x = hci_items_scored, ci.level = 0.95)
head(sem_hci)
```

```
  lower_CI observed upper_CI
1  12.1947       16  19.8053
2  15.1947       19  22.8053
3  13.1947       17  20.8053
4  16.1947       20  23.8053
5  15.1947       19  22.8053
6  16.1947       20  23.8053
```

DIF

- DIF madde düzeyindeki yanlılığı tespit etmek için kullanılır.
- **difR** paketi (Magis et al. 2010), DIF gösteren iki kategorili maddeleri tespit etmek için çeşitli yöntemler sağlar. Aşağıdaki örnekte, puanlanan hci maddelerini DIF açısından analiz etmek için Mantel-Haenszel (MH) ve lojistik regresyon yöntemlerini kullanacağız. Cinsiyet veya ana dil olarak İngilizce konuşulmasına bağlı olarak DIF sergileyen hci maddelerini belirlemek için grup değişkenleri olarak "sex" ve "eng_first_lang" kullanacağız.

```
  item1 item2 item3 item4 item5 item6 item7 item8 item9 item10 item11 item12 item13 item14 item15 item16
1     1     1     1     1     1     0     0     1     1      1      1      1      1      1      0      1
2     1     1     1     1     1     1     0     1     1      1      1      1      1      1      1      1
3     1     1     1     1     0     1     0     1     1      1      1      1      1      1      0      1
4     1     1     1     1     1     1     1     1     1      1      1      1      1      1      1      1
5     1     1     1     1     1     1     1     1     1      1      1      1      1      1      0      1
6     1     1     1     1     1     1     1     1     1      1      1      1      1      1      1      1
  item17 item18 item19 item20 gender eng_first_lang
1      0      1      1      1      F            yes
2      1      1      1      1      F            yes
3      1      1      1      1      M            yes
4      1      1      1      1      M            yes
5      1      1      1      1      M            yes
6      1      1      1      1      F            yes
```

DIF

```
table(hci_scored$gender)
```

```
  F   M 
405 246 
```

```
table(hci_scored$eng_first_lang)
```

```
 no yes 
143 508 
```

DIF

```r
hci_items <- dplyr::select(hci_scored, starts_with("item"))
gender <- hci_scored$gender
language <- hci_scored$eng_first_lang
```

```r
# 1) Run the DIF analysis based on gender
gender_MH <- difR::difMH(Data = hci_items,
                         group = gender,
                         focal.name = "F",
                         match = "score",
                         purify = TRUE)
print(gender_MH)
```

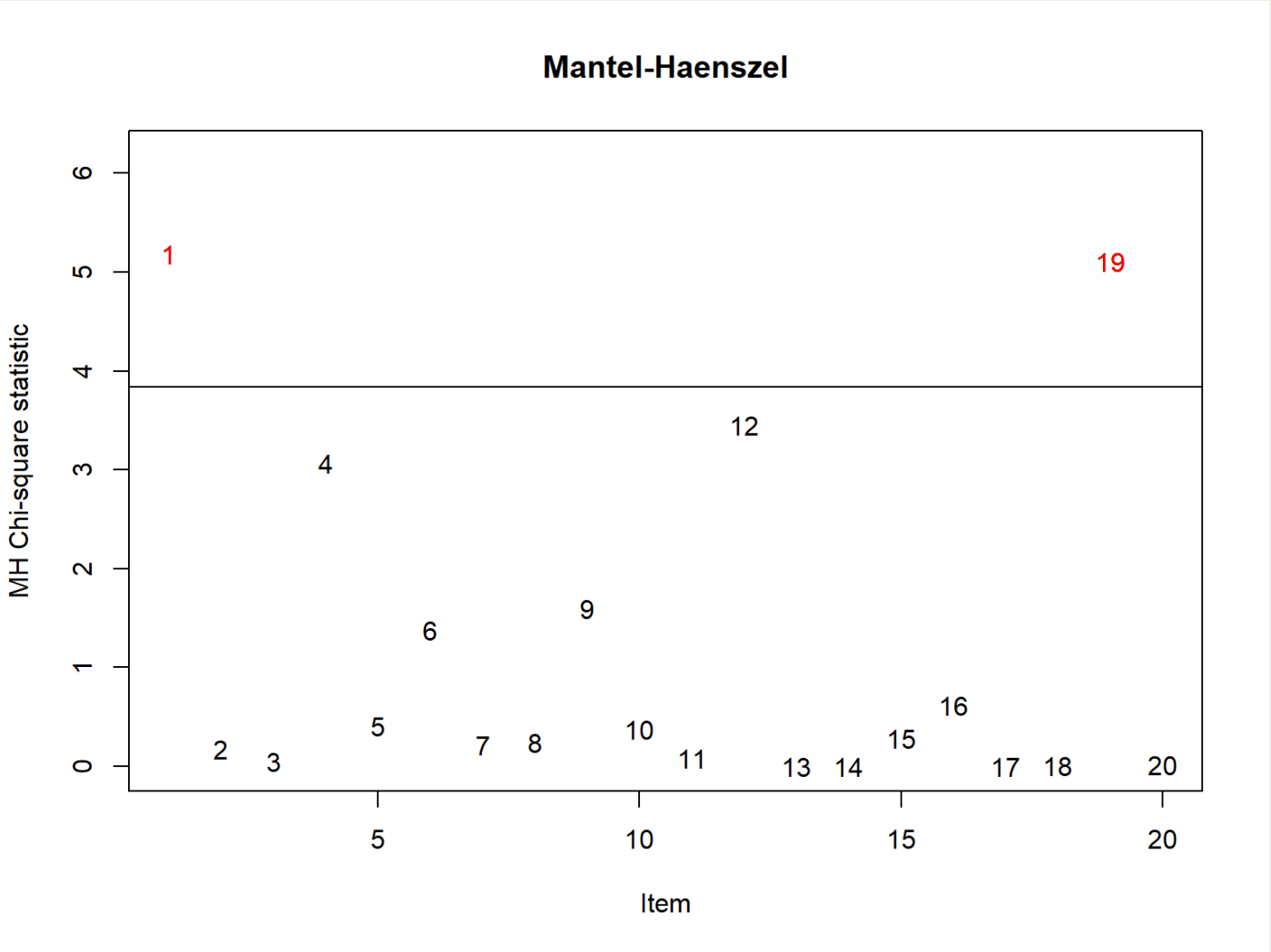
```
Detection of Differential Item Functioning using Mantel-Haenszel method
with continuity correction and with item purification

Results based on asymptotic inference

Convergence reached after 2 iterations

Matching variable: test score

No set of anchor items was provided
```

```
No p-value adjustment for multiple comparisons

Mantel-Haenszel Chi-square statistic:
```

DIF

```
1  plot(gender_MH)
```

```
The plot was not captured!
```



DIF

- Çıktı iki bölümden oluşmaktadır. İlk bölümde maddeler için MH ki-kare istatistikleri ve bunlara karşılık gelen p değerleri gösterilmektedir.
- İki maddenin (madde 1 ve 19) p değerleri .05'ten küçük olduğu için kız ve erkek öğrenciler arasında DIF gösterdiği gerekçesiyle $\alpha = .05$ değerinde işaretlendiğini görüyoruz. Bu maddeler ayrıca "DIF maddesi olarak tespit edilen maddeler" altında listelenmiştir.
- Çıktının ikinci kısmı, ETS delta sınıflandırması kullanılarak etki büyüklüğünü göstermektedir. İki madde (madde 1 ve 19) "B: Orta Derecede DIF" olarak sınıflandırılırken, geri kalan maddeler "A: İhmal Edilebilir DIF" olarak sınıflandırılmıştır. "C: Büyük DIF" işaretine sahip hiçbir madde yoktur. Grafik ayrıca MH ki-kare testine göre işaretlenmiş iki maddeyi de göstermektedir. Bu maddeler eşik ki-kare değeri için yatay çizginin üzerinde görünmektedir ($\alpha = .05$ anlamlılık düzeyi için $\chi^2 = 3.84$). ## DIF

```
lang_MH <- difR::difMH(Data = hci_items,
                       group = language,
                       focal.name = "no",
                       match = "score",
```

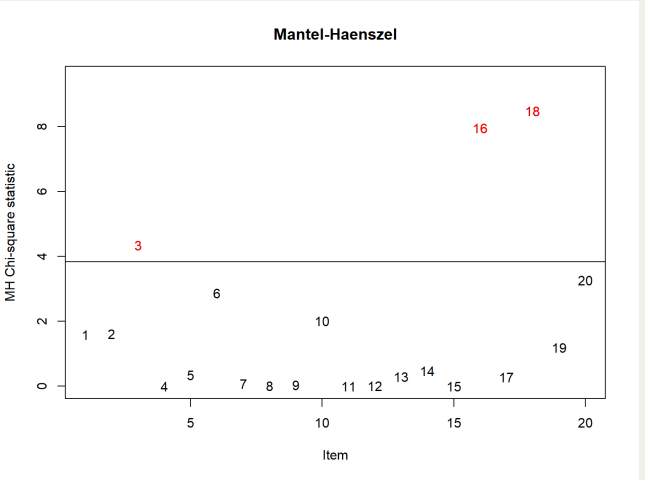
```r
                        purify = TRUE)
print(lang_MH)
```

```
Detection of Differential Item Functioning using Mantel-Haenszel method
with continuity correction and with item purification

Results based on asymptotic inference

Convergence reached after 2 iterations

Matching variable: test score

No set of anchor items was provided

No p-value adjustment for multiple comparisons

Mantel-Haenszel Chi-square statistic:

       Stat.  P-value
item1  1.5933 0.2069
item2  1.6164 0.2036
item3  4.3557 0.0369  *
item4  0.0003 0.9870
item5  0.3458 0.5565
```

DIF

```
1  plot(lang_MH)
```

```
The plot was not captured!
```



- Sonuçlar, üç maddenin (madde 3, 16 ve 18) dile dayalı DIF içerdiği için işaretlendiğini göstermektedir. ETS delta sınıflandırması kullanılarak elde edilen etki büyüklüğü, madde 3'ün "B: Orta DIF" olarak sınıflandırıldığını, madde 16 ve 18'in ise "C: Büyük DIF" olarak sınıflandırıldığını göstermektedir. Bu maddelere ek olarak, 6. ve 20. maddeler "B: Orta DIF" olarak sınıflandırılmıştır. Dolayısıyla, bu maddelerin içeriğinin diğer işaretli maddelerle birlikte incelenmesi ve dile dayalı DIF'in neden ortaya çıktığının belirlenmesi faydalı olacaktır.

DIF

```r
# 1) Run the DIF analysis based on gender
gender_LR <- difR::difLogistic(Data = hci_items,
                               group = gender,
                               focal.name = "F",
                               match = "score",
                               type = "both",
                               purify = TRUE)
print(gender_LR)
```

```
Detection of both types of Differential Item Functioning
using Logistic regression method, with item purification
and with LRT DIF statistic

Convergence reached after 1 iteration

Matching variable: test score

No set of anchor items was provided

No p-value adjustment for multiple comparisons

Logistic regression DIF statistic:
```

DIF

```
1 plot(gender_LR)
```

```
The plot was not captured!
```

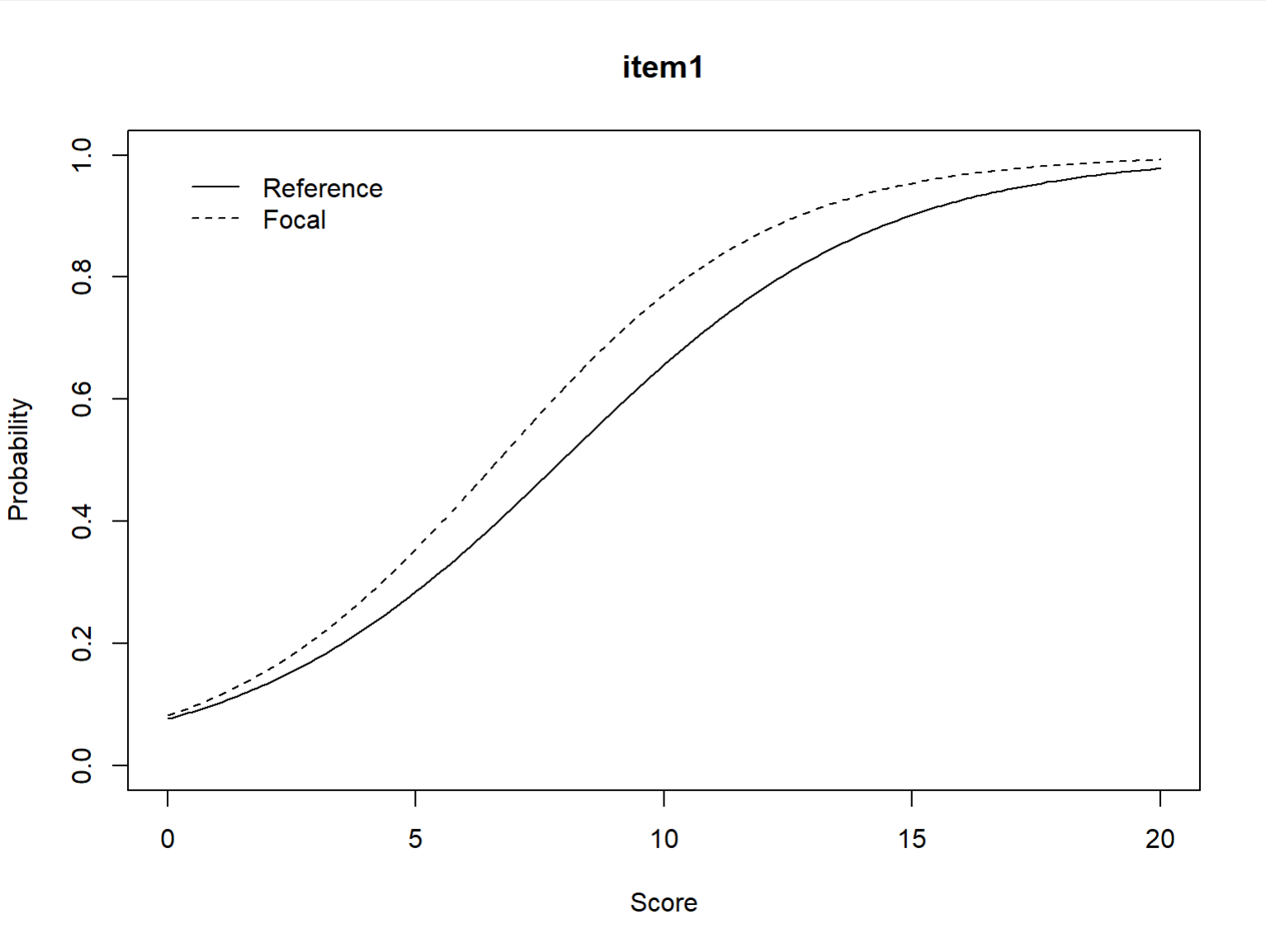
difMH()`fonksiyonundan elde edilen çıktıya benzer şekilde,` difLogistic()` fonksiyonundan elde edilen çıktı da iki bölümden oluşur. Çıktının üst kısmı, öğeler için olabilirlik oranı test istatistiklerini ve karşılık gelen p değerlerini gösterir. LR yöntemi, 1. ve 19. maddelere ek olarak, $\alpha = .05$ anlamlılık düzeyinde 12. ve 20. maddeler olmak üzere iki DIF'li madde daha tespit etmiştir. Çıktının ikinci kısmı, sözde R-kare farkları kullanılarak hesaplanan etki büyüklüklerini göstermektedir. Sonuçlar, her iki etki büyüklüğü ölçütüne (ZT ve JG) dayalı olarak tüm maddeler için etki büyüklüğünün "A: İhmal Edilebilir DIF" olduğunu göstermektedir. Grafikte, dört DIF maddesinin (madde 1, 12, 19 ve 20) eşik olabilirlik oranı istatistiği ($\alpha = .05$ anlamlılık düzeyi için 5.9915) için yatay çizginin üzerinde olduğunu görüyoruz.

Aynı `plot()` fonksiyonu, olabilirlik oranı istatistiğine dayalı olarak işaretlenmiş maddeler için ayrı grafikler oluşturmak için de kullanılabilir. Çizim, x ekseninin toplam test puanları olduğu ve y ekseninin doğru cevap olasılığını (yani 0 üzerinden

1 alma) gösterdiği ayrı madde karakteristik eğrileri oluşturur. Bu grafik, DIF türünün tek tip mi yoksa tek tip olmayan mı olduğunu ve iki gruptan hangisinin (yani referans ve odak) diğer gruba göre avantajlı olduğunu gösterebilir. Aşağıdaki örnekte, 1. ve 19. maddeler için madde karakteristik eğrileri oluşturacağız. Öğeyi `item` bağımsız değişkenini kullanarak ve çizim türünü `plot = "itemCurve"` kullanarak belirtiriz.

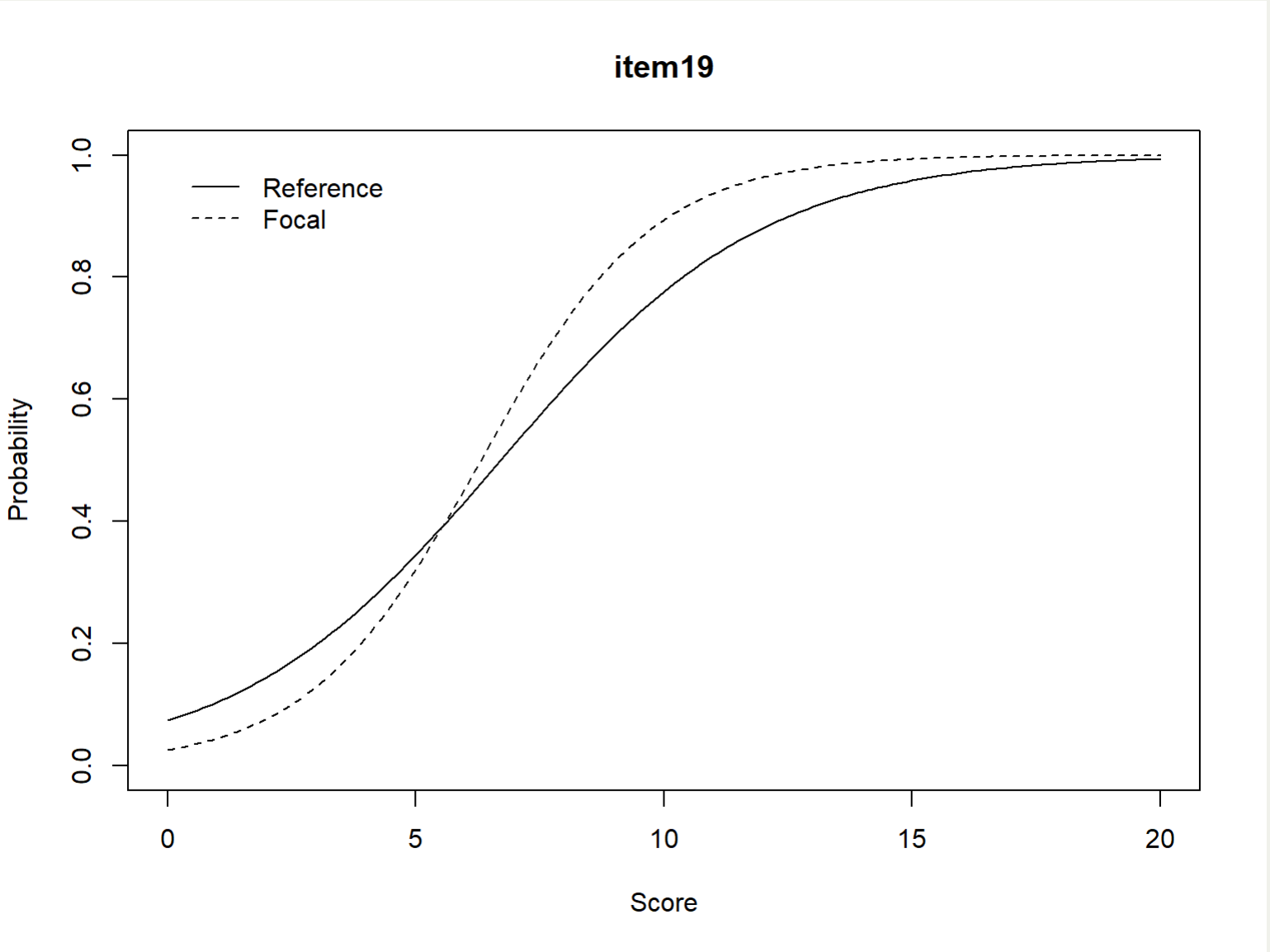
DIF

```
plot(gender_LR, item = 1, plot = "itemCurve")
```



The plot was not captured!

```
1 plot(gender_LR, item = 19, plot = "itemCurve")
```



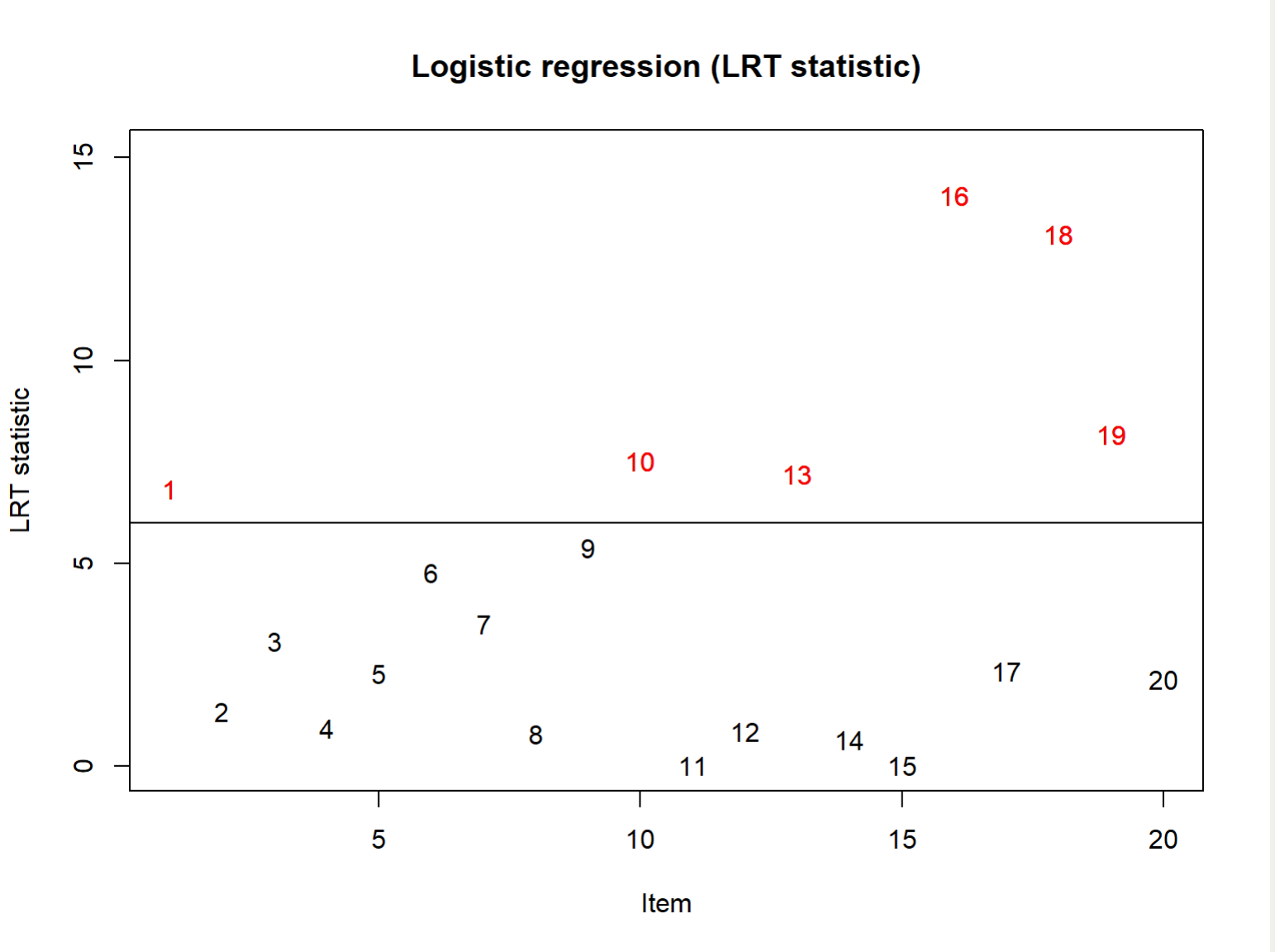
The plot was not captured!

DIF

```r
# 2) Run the DIF analysis based on language
lang_LR <- difR::difLogistic(Data = hci_items,
                             group = language,
                             focal.name = "no",
                             match = "score",
                             type = "both",
                             purify = TRUE)

print(lang_LR)
```

```
Detection of both types of Differential Item Functioning
using Logistic regression method, with item purification
and with LRT DIF statistic

Convergence reached after 4 iterations

Matching variable: test score

No set of anchor items was provided

No p-value adjustment for multiple comparisons

Logistic regression DIF statistic:
```

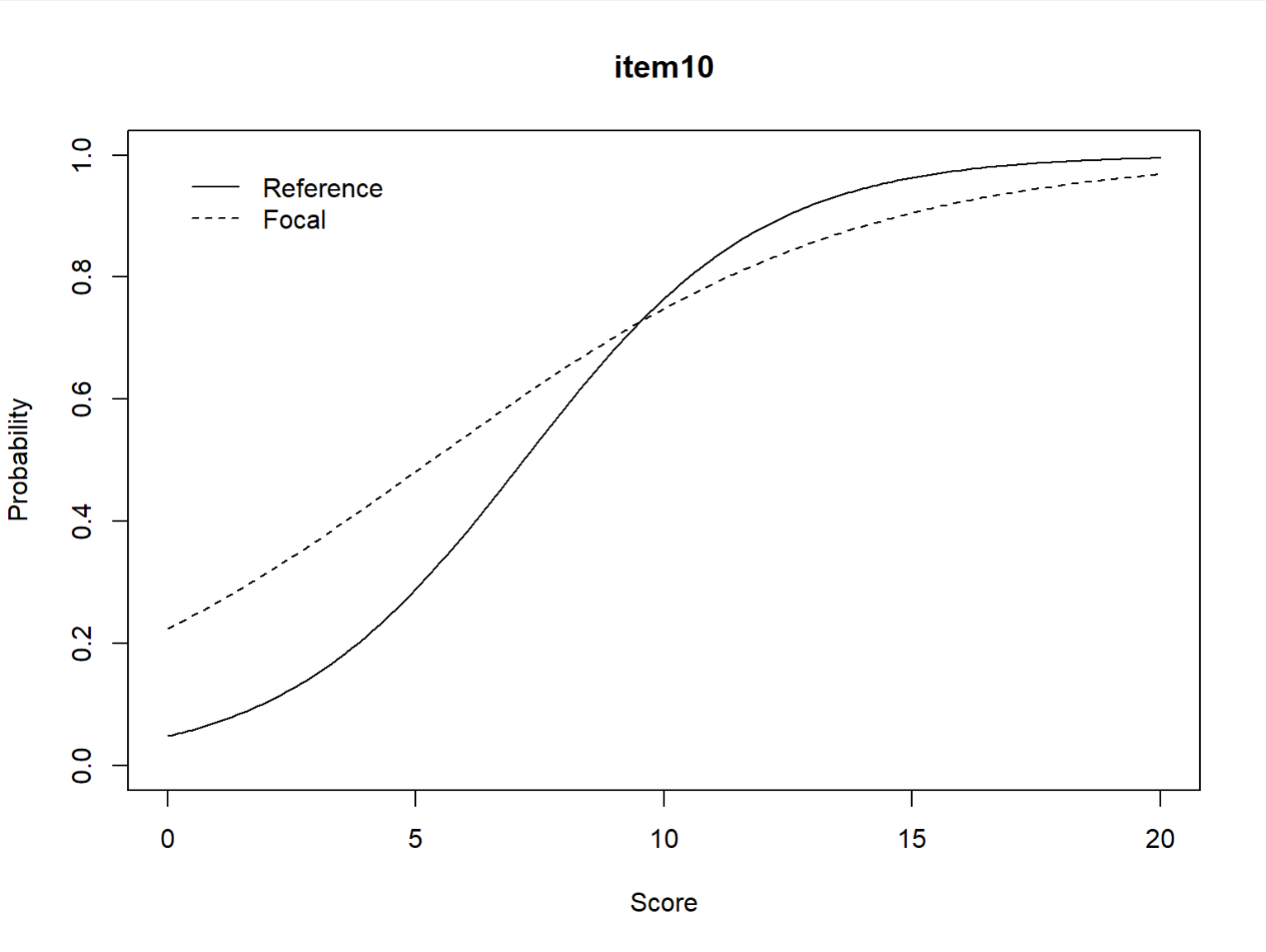
```
1 plot(lang_LR)
```



The plot was not captured!

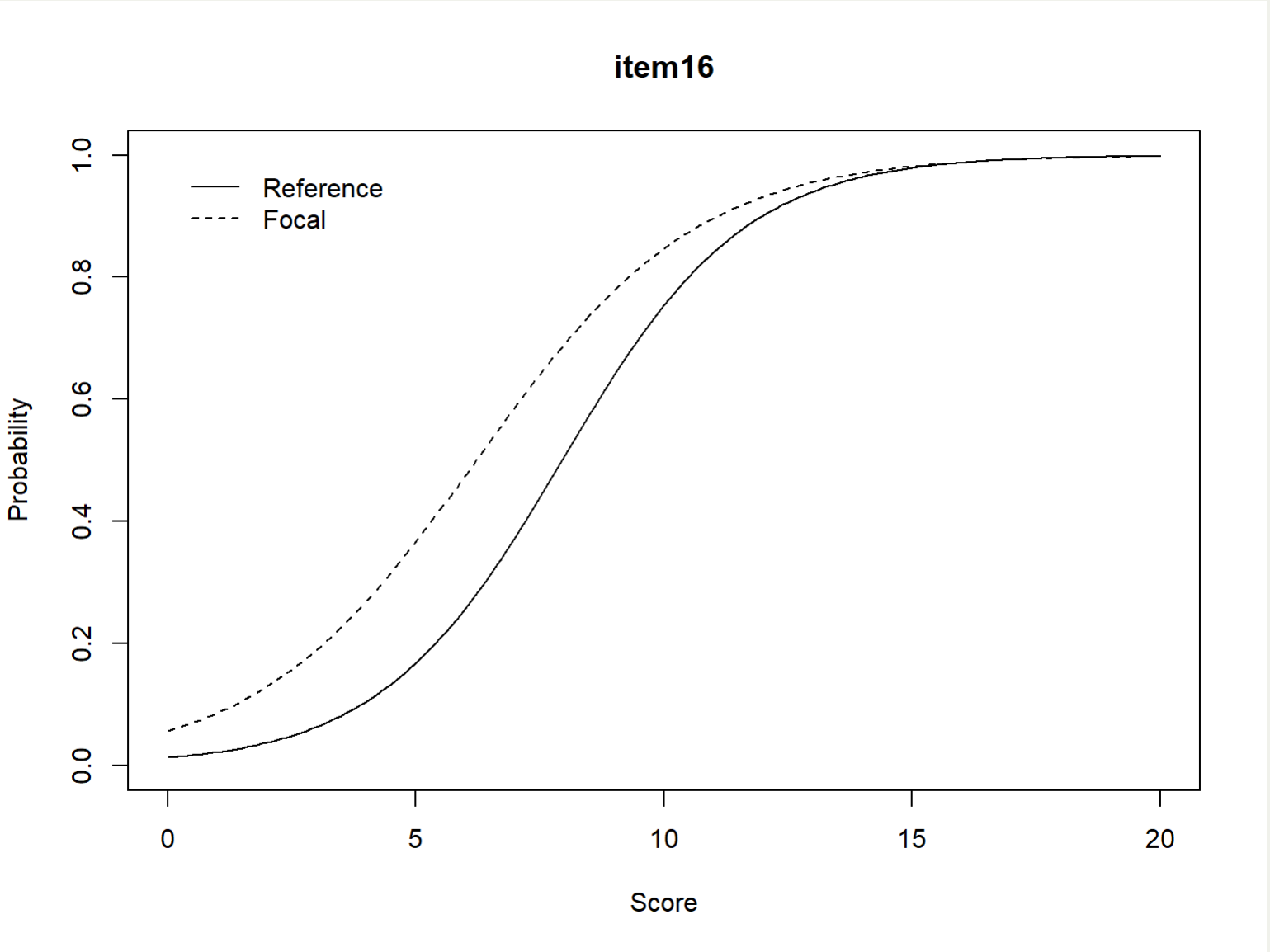
LR yöntemi, dil temelli DIF içeren altı madde tespit etmiştir: 1, 10, 13, 16, 18 ve 19. maddeler. Ancak bu maddelerin tümü, her iki etki büyüklüğü ölçütüne (ZT ve JG) göre “A: İhmal Edilebilir DIF” etki büyüklüğüne sahiptir. Son olarak, DIF içerdiği için işaretlenen maddelerden ikisine bir göz atalım. Şekillerde, 16. maddenin odak grup lehine tekdüze bir DIF’e sahip olduğunu, 10. maddenin ise tekdüze olmayan bir DIF’e sahip olduğunu görebiliriz (yani hangi grubun tercih edildiği testteki toplam puana bağlıdır).

```
plot(lang_LR, item = 10, plot = "itemCurve")
```



The plot was not captured!

```
1 plot(lang_LR, item = 16, plot = "itemCurve")
```



The plot was not captured!

References

Magis, David, Sébastien Béland, Francis Tuerlinckx, and Paul De Boeck. 2010. “A General Framework and an r Package for the Detection of Dichotomous Differential Item Functioning.” *Behavior Research Methods* 42 (3): 847–62.