



Scoring the implicit: The implicitMeasures package



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Introduction

Within the past decades, social sciences have been showing a growing interest for the implicit investigation of attitudes and preference. This was made possible by the advent of what are called implicit measures, among which the Implicit Association Test (IAT) [2] and the Single Category IAT (SC-IAT) [4] are the mostly common used ones [1]. Both tests result in a differential score (the so-called *D-score*) expressing respondents' bias in performing the categorization task between conditions. While the scoring of the SC-IAT is based on one single algorithm [4], six different algorithms are available for computing the IAT *D-score* [3].

implicitMeasures is an R package aimed at providing an easy to use tool to score both the IAT and the SC-IAT, and to easily compare the results obtained with the different *D-score* algorithms. The package basic functioning is illustrated.

The Implicit Association Test

The IAT is usually composed of seven blocks:

IAT structure			
Block	Function	Left response key	Right response key
B1	Practice	Object 1	Object 2
B2	Practice	Good	Bad
B3	Associative Practice Mapping A	Object 1 + Good	Object 2 + Bad
B4	Associative Test Mapping A	Object 1 + Good	Object 2 + Bad
B5	Practice	Object 2	Object 1
B6	Associative Practice Mapping B	Object 2 + Good	Object 1 + Bad
B7	Associative Test Mapping B	Object 2 + Good	Object 1 + Bad

The computation of the IAT *D-score* is rather easy but 6 different algorithms are available:

IAT <i>D-score</i> algorithms		
<i>D-score</i>	Error Replacement	Lower tail treatment
D1	Built-in	No
D2	Built-in	< 400 ms
D3	Mean + 2 <i>sd</i>	No
D4	Mean + 600 ms	No
D5	Mean + 2 <i>sd</i>	< 400 ms
D6	Mean + 600 ms	< 400 ms

Note: Trials with *rt* > 10,000 ms are discarded

The Single Category Implicit Association Test

Same assumption, same score computation as the IAT BUT just one target object:

SC-IAT structure			
Block	Function	Left response key	Right response key
B1	Associative Practice Mapping A	Object 1 + Good	Bad
B2	Associative Test Mapping A	Object 1 + Good	Bad
B3	Associative Practice Mapping B	Good	Object 1 + Bad
B4	Associative Test Mapping B	Good	Object 1 + Bad

The SC-IAT *D-score* is computed as the IAT *D-score* by considering just the responses in Blocks B2 and B4. Error responses are replaced by the average response time added with a penalty of 400 ms. Responses faster than 350 ms are discarded. The administration might include a Response Time Window (rtw) at 1,500 ms after which the stimulus disappears and the response is considered a non-response.

IAT example

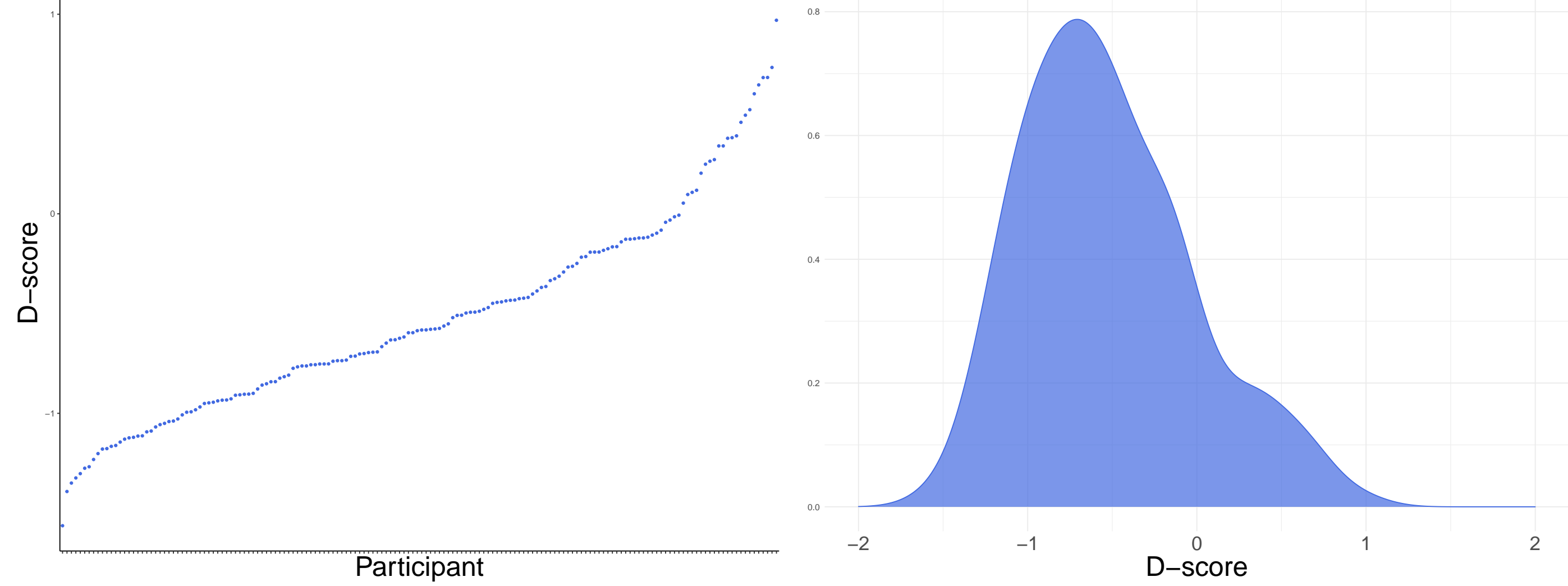
The examples are based on the toy data set included in implicitMeasures package.

```
data("raw_data") # load toy data
iat_data <- clean_iat(raw_data, # raw data set
  sbj_id = "Participant", # Respondents' IDs
  block_id = "blockcode", # Blocks labels
  mapA_practice = "practice.iat.Milkbad", # Label B3
  mapA_test = "test.iat.Milkbad", # Label B4
  mapB_practice = "practice.iat.Milkgood", # Label B6
  mapB_test = "test.iat.Milkgood", # Label B7
  latency_id = "latency", # Response times
  accuracy_id = "correct", # Accuracy responses)
```

Function **clean_iat()** results in a list, in which the first object is a data frame with class **iat_clean**. This data set can be passed to function **computed()**:

```
iat_dscore <- computed(iat_cleandata[[1]], # iat_clean object
  Dscore = "d2") # D-score algorithm
```

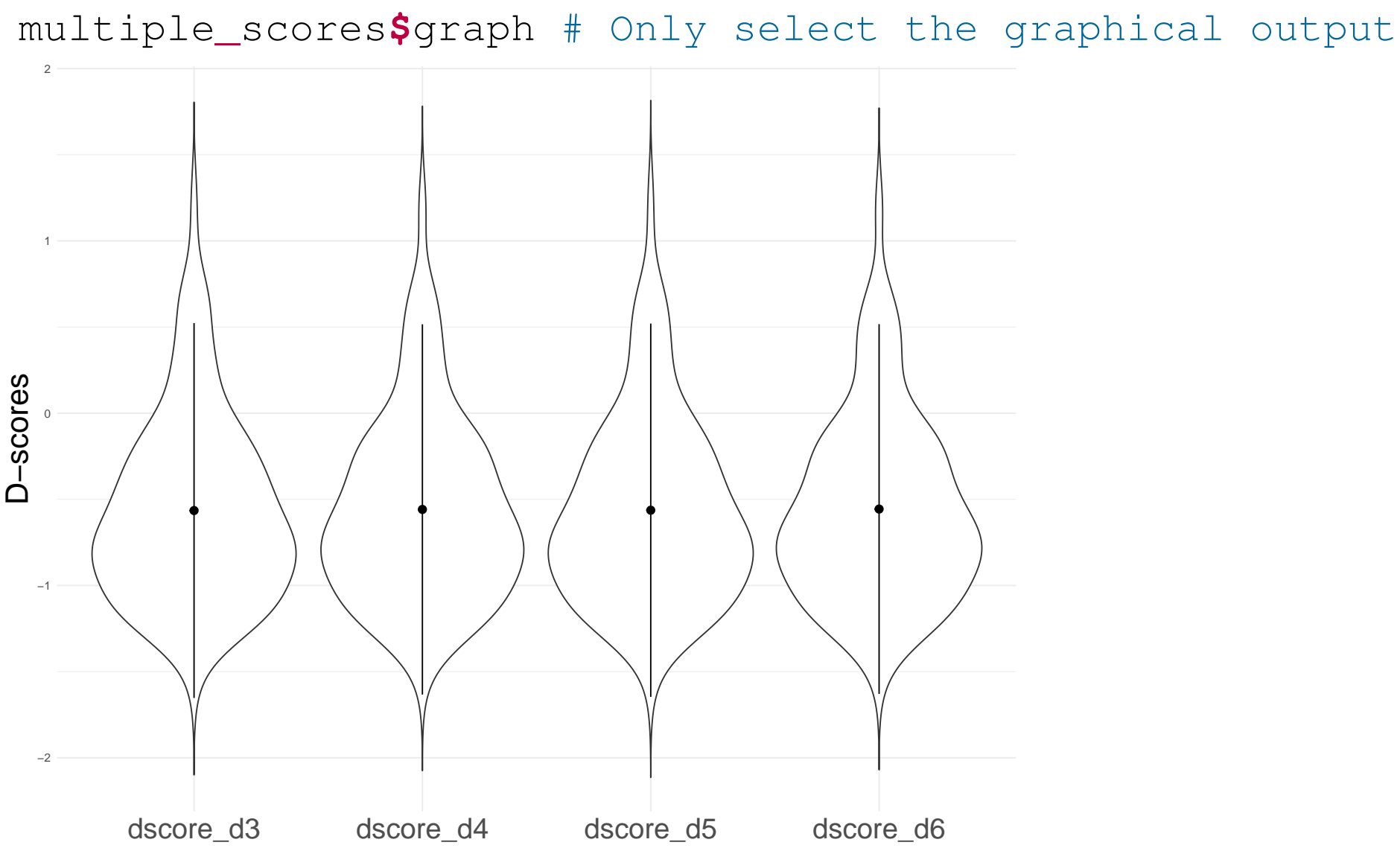
The object **iat_dscore** is an object of class **dscore**. This object can be passed to functions **descript d()** (i.e., print a table of descriptive statistics of the results, even in \LaTeX), **IATrel()** (i.e., compute the IAT reliability), and to functions for obtaining graphical representation of the results, either at the individual respondent level with function **dplot()** or at the sample level with function **ddistr()**:



The object with class **iat_clean** can also be passed to function **multi_dscore()**, which simultaneously computes multiple *D-score* algorithms:

```
multiple_scores <- multi_dscore(iat_cleandata[[1]],
  ds = 'error-inflation') # Which algorithm?
```

Function **multiple_scores()** results in a list containing a data set with a number of columns equal to the number of computed algorithms plus a column for respondents' IDs and a graph with the distribution resulting from the different algorithms:



SC-IAT example

The raw_data toy data set contains data from two distinct data SC-IATs. Data from both SC-IATs can be simultaneously cleaned and prepared for the computation by using **clean_sciat()** function:

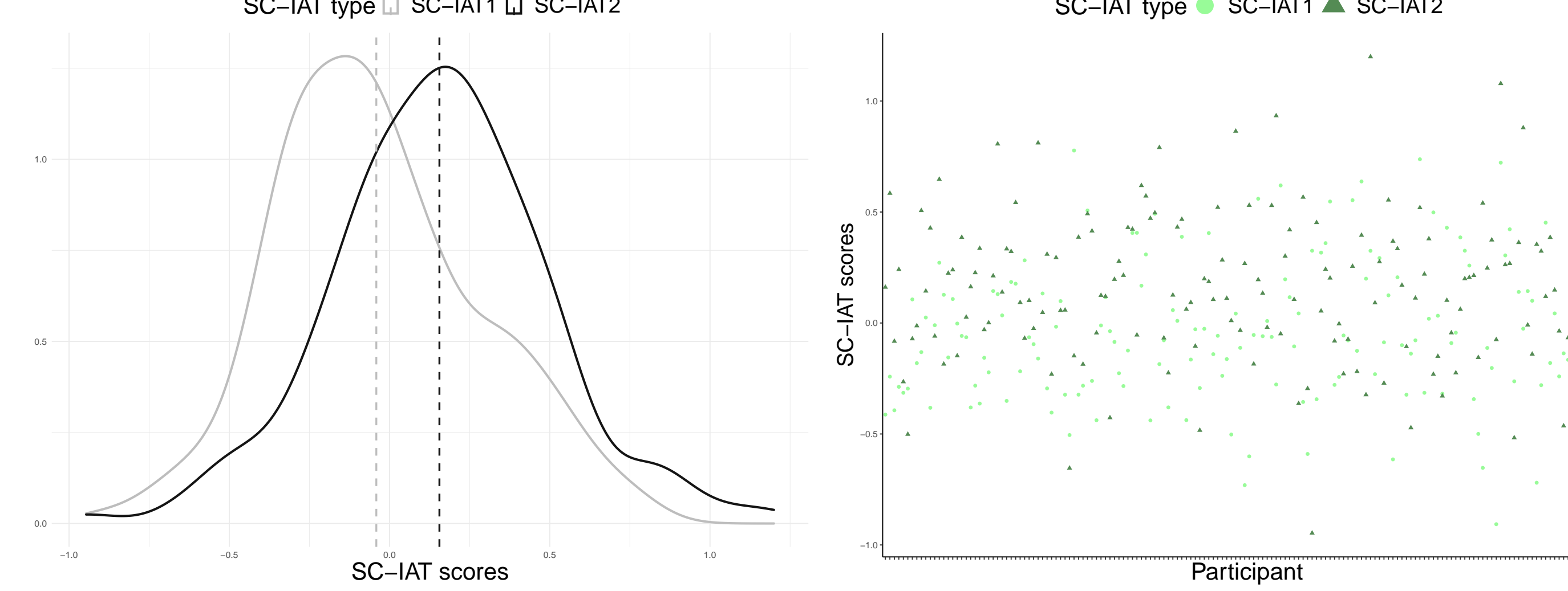
```
data("raw_data") # load toy data
sciat_data <- clean_sciat(raw_data, # raw data set
  sbj_id = "Participant", # Column with respondents' IDs
  block_id = "blockcode", # Column with blocks labels
  latency_id = "latency", # Column with latency responses
  accuracy_id = "correct", # Column with accuracy responses
  block_sciat_1 = c("test.sc_dark.Darkbad", # 1st SC-IAT block label
    "test.sc_dark.Darkgood"),
  block_sciat_2 = c("test.sc_milk.Milkbad", # 2nd SC-IAT block label
    "test.sc_milk.Milkgood"),
  trial_id = "trialcode", # Column with trial labels
  trial_eliminate = c("reminder",
    "reminder1")) # Trials to eliminate
```

The object resulting from **clean_sciat()** is a list containing two data sets of class **sciat_clean**, one for each SC-IAT. These data sets can be individually passed to **Dsciat()** for the computation of the SC-IAT *D-score*:

```
d_sciat1 <- Dsciat(sciat_data[[1]], # 1st SC-IAT data
  mappingA = "test.sc_dark.Darkbad", # Mapping A Label
  mappingB = "test.sc_dark.Darkgood", # Mapping B Label
  non_response = "alert") # Label for responses over rtw
d_sciat2 <- Dsciat(sciat_data[[2]], # 2nd SC-IAT data
  mappingA = "test.sc_milk.Milkbad", # Mapping A Label
  mappingB = "test.sc_milk.Milkgood", # Mapping B Label
  non_response = "alert") # Label for responses over rtw
```

The objects obtained from **Dsciat()** function have class **dsciat** and they can be passed to functions **descript d()**, **dplot()**, and **ddistr()**, as the objects obtained from **computed()** function.

Results obtained from multiple SC-IATs can be plotted together by using **multi_dsciat()**:



multi_dsciat() Default settings **multi_dsciat()** Customized plot

Last but not least: All graphical functions are based on ggplot2 [5] and can be further modified by the users!

References

[1] Ottavia M Epifania, Egidio Robusto, and Pasquale Anselmi. Implicit social cognition through years: The Implicit Association Test at age 21. 2020.

[2] Anthony G Greenwald, Debbie E McGhee, and Jordan L K Schwartz. Measuring Individual Differences in Implicit Cognition: The Implicit Association Test. *Journal of Personality and Social Psychology*, 74(6):1464–1480, 1998.

[3] Anthony G Greenwald, Brian A Nosek, and Mahzarin R Banaji. Understanding and Using the Implicit Association Test: I. An Improved Scoring Algorithm. *Journal of Personality and Social Psychology*, 85(2):197–216, 2003.

[4] Andrew Karpinski and Ross B. Steinman. The Single Category Implicit Association Test as a measure of implicit social cognition. *Journal of Personality and Social Psychology*, 91(1):16–32, 2006.

[5] Hadley Wickham. *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York, 2016.