

1 rempsyc: Convenience functions for psychology

2 Rémi Thériault  ¹

3 ¹ Department of Psychology, Université du Québec à Montréal, Québec, Canada

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4 Summary

5 {rempsyc} is an R package of convenience functions that make the analysis-to-publication
6 workflow faster, easier, and less error-prone. It enables nice APA tables exportable to Word
7 (via {flextable}) and easily customizable APA-compliant plots (via {ggplot2}). It makes it easy
8 to run statistical tests, check assumptions, and automate various tasks common in psychology
9 research.

10 Statement of need

11 There are many reasons to use R ([R Core Team, 2022](#)) for analyzing and reporting data from
12 research studies, such as being compatible with the ideals of open science ([Quintana, 2020](#)).
13 However, R has a major downside for novices: its steep learning curve due to its programmatic
14 interface, in contrast to perhaps more user-friendly point-and-click software. Of course, this
15 flexibility is also a strength, as the R community can and does come together to produce
16 packages that make using R increasingly easier and more user-friendly (e.g., the *easystats*
17 ecosystem [Lüdtke et al., 2019/2023](#)). The {rempsyc} package (Really Easy Methods for
18 Psychology) contributes to this momentum by providing convenience functions that remove as
19 much friction as possible between your script and your manuscript (in particular, if you are
20 using Microsoft Word).

21 There are mainly three things that go into a manuscript: text, tables, and figures. {rempsyc}
22 does not generate publication-ready text summarizing analyses; for this, see the {report}
23 package ([Makowski et al., 2021/2023](#)). Instead, {rempsyc} focuses on the production of
24 publication-ready tables and figures. Below, I go over a few quick examples of those.

25 Examples Features

26 Publication-Ready Tables

27 Many researchers using R still copy-paste the values from the R console to their manuscript, or
28 retype them manually. Yet, this approach increases the risks of copy-paste and retyping errors
29 so common in psychology. This problem is not trivial given that according to some estimates,
30 up to 50% of articles in psychology have at least one statistical error ([Nuijten et al., 2016](#)).
31 Ideally, one should be able to format the table directly in R, and to export it to Word directly.

32 Formatting your table properly in R is already a time-consuming task, but fortunately several
33 packages take care of this step (e.g., the {broom} or {report} packages, [Makowski et al.,](#)
34 [2021/2023](#); [Robinson et al., 2022](#), and there are several others). Exporting these formatted
35 tables to Microsoft Word remains a challenge however. Some packages do export to Word (e.g.,
36 [Stanley & Spence, 2018](#)), but their formatting is often rigid especially when using analyzes or
37 table formats that are not supported by default.

38 {rempsysc} solves this problem by allowing maximum flexibility: you manually create the data
 39 frame exactly the way you want, and then only use the magical function, `nice_table()`, on
 40 the resulting data frame. `nice_table()` works on any data frame, even non-statistical ones
 41 like `mtcars`.

42 One of its main benefit however is the automatic formatting of statistical symbols and its
 43 integration with other packages. We can for example create a {broom} table and then apply
 44 `nice_table()` on it. It suits particularly well the pipe workflow.

```
45 library(rempsysc)
46
47 lm(mpg ~ cyl + wt * hp, mtcars) |>
48   broom::tidy(conf.int = TRUE) |>
49   nice_table(broom = "lm")
```

Term	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>	95% CI
(Intercept)	49.49	3.66	13.51	< .001	[41.97, 57.01]
cyl	-0.37	0.51	-0.72	.479	[-1.41, 0.68]
wt	-7.63	1.52	-5.01	< .001	[-10.75, -4.51]
hp	-0.11	0.03	-3.64	.001	[-0.17, -0.05]
wt × hp	0.03	0.01	3.23	.003	[0.01, 0.04]

50
 51 We can do the same with a {report} table.

```
52 stats.table <- lm(mpg ~ cyl + wt * hp, mtcars) |>
53   report::report() |>
54   as.data.frame()
55
56 nice_table(stats.table)
```

Parameter	Fit	b	95% CI (b)	t	df	p	β	95% CI (β)
(Intercept)		49.49	[41.97, 57.01]	13.51	27	< .001	-0.18	[-0.36, -0.01]
cyl		-0.37	[-1.41, 0.68]	-0.72	27	.479	-0.11	[-0.42, 0.20]
wt		-7.63	[-10.75, -4.51]	-5.01	27	< .001	-0.62	[-0.85, -0.40]
hp		-0.11	[-0.17, -0.05]	-3.64	27	.001	-0.29	[-0.53, -0.04]
wt \times hp		0.03	[0.01, 0.04]	3.23	27	.003	0.29	[0.11, 0.47]
AIC	147.01							
AICc	150.37							
BIC	155.80							
R2	0.89							
R2 (adj.)	0.87							
Sigma	2.17							

57

58 The {report} package provides quite comprehensive tables, so one may request an abbreviated
59 table with the 'short' argument. For convenience, it is also possible to highlight significant
60 results for better visual discrimination, using the 'highlight' argument.[1] Once satisfied
61 with the table, we can add a title and note.

```
62 my_table <- nice_table(  
63   stats.table, short = TRUE, highlight = 0.001,  
64   title = c("Table 1", "A Pretty Regression Model"),  
65   note = c("The data was extracted from the 1974 Motor Trend US magazine.",  
66            "Greyed rows represent statistically significant differences, p < .001.")  
67 my_table
```

Table 1

A Pretty Regression Model

Parameter	<i>b</i>	<i>t</i>	<i>df</i>	<i>p</i>	β	95% CI (β)
(Intercept)	49.49	13.51	27	< .001	-0.18	[-0.36, -0.01]
cyl	-0.37	-0.72	27	.479	-0.11	[-0.42, 0.20]
wt	-7.63	-5.01	27	< .001	-0.62	[-0.85, -0.40]
hp	-0.11	-3.64	27	.001	-0.29	[-0.53, -0.04]
wt \times hp	0.03	3.23	27	.003	0.29	[0.11, 0.47]

Note. The data was extracted from the 1974 Motor Trend US magazine.

Greyed rows represent statistically significant differences, $p < .001$.

One can then easily save the resulting table to Word with `flextable::save_as_docx()`, specifying the object name and desired path.

```
flextable::save_as_docx(my_table, path = "nice_tablehere.docx")
```

Additionally, tables created with `nice_table()` are `{flextable}` objects (Gohel & Skintzos, 2022), and can be modified as such.[2]

Formattting Results of Analyses

`{rempsys}` also provides its own set of functions to prepare statistical tables before they can be fed to `nice_table()` and saved to Word.

t tests

```
nice_t_test(data = mtcars,
            response = c("mpg", "disp", "drat"),
            group = "am",
            warning = FALSE) |>
  nice_table()
```

Dependent Variable	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>	95% CI
mpg	-3.77	18.33	.001	-1.48	[-2.27, -0.67]
disp	4.20	29.26	< .001	1.45	[0.64, 2.23]
drat	-5.65	27.20	< .001	-2.00	[-2.86, -1.12]

84 Contrasts

```
85 nice_contrasts(data = mtcars,
86               response = c("mpg", "disp"),
87               group = "cyl",
88               covariates = "hp") |>
89   nice_table(highlight = .001)
```

Dependent Variable	Comparison	<i>df</i>	<i>t</i>	<i>p</i>	<i>d</i>	95% CI
mpg	4 - 8	28	3.66	.001	3.59	[2.70, 4.45]
	6 - 8	28	1.29	.207	1.44	[0.78, 1.97]
	4 - 6	28	3.64	.001	2.15	[1.36, 3.15]
disp	4 - 8	28	-6.04	<.001	-4.80	[-5.79, -3.82]
	6 - 8	28	-4.86	<.001	-3.29	[-4.27, -2.27]
	4 - 6	28	-2.70	.012	-1.51	[-2.26, -0.90]

90

91 Regressions

```
92 model1 <- lm(mpg ~ cyl + wt * hp, mtcars)
93 model2 <- lm(qsec ~ disp + drat * carb, mtcars)
94
95 nice_lm(list(model1, model2)) |>
96   nice_table(highlight = TRUE)
```

Dependent Variable	Predictor	<i>df</i>	<i>b</i>	<i>t</i>	<i>p</i>	<i>sr</i> ²	95% CI
mpg	cyl	27	-0.37	-0.72	.479	.00	[0.00, 0.01]
	wt	27	-7.63	-5.01	<.001	.11	[0.01, 0.20]
	hp	27	-0.11	-3.64	.001	.06	[0.00, 0.12]
	wt × hp	27	0.03	3.23	.003	.04	[0.00, 0.10]
qsec	disp	27	-0.01	-1.97	.059	.07	[0.00, 0.20]
	drat	27	0.23	0.20	.845	.00	[0.00, 0.01]
	carb	27	1.15	0.72	.479	.01	[0.00, 0.06]
	drat × carb	27	-0.48	-1.08	.289	.02	[0.00, 0.09]

97

98 Simple Slopes

```

99 model1 <- lm(mpg ~ gear * wt, mtcars)
100 model2 <- lm(displ ~ gear * wt, mtcars)
101 my.models <- list(model1, model2)
102
103 nice_lm_slopes(my.models, predictor = "gear", moderator = "wt") |>
104   nice_table()

```

Dependent Variable	Predictor (+/-1 SD)	df	b	t	p	sr ²	95% CI
mpg	gear (LOW-wt)	28	7.54	2.01	.054	.03	[0.00, 0.09]
	gear (MEAN-wt)	28	5.62	1.94	.062	.03	[0.00, 0.08]
	gear (HIGH-wt)	28	3.69	1.80	.083	.02	[0.00, 0.08]
displ	gear (LOW-wt)	28	50.51	0.67	.511	.00	[0.00, 0.02]
	gear (MEAN-wt)	28	35.80	0.61	.545	.00	[0.00, 0.02]
	gear (HIGH-wt)	28	21.08	0.51	.616	.00	[0.00, 0.02]

106 Correlation Matrices

107 It is also possible to export a colour-coded correlation matrix to Microsoft Excel. The
 108 `cormatrix_excel()` function has several benefits over conventional approaches. The base R
 109 `cor()` function for example does not use rounded values and the console is impractical for
 110 large matrices. One may manually round values and export it to a .csv file, which is an
 111 improvement but still unsatisfying.

112 The `{apaTables}` package (Stanley & Spence, 2018) allows exporting the correlation matrix
 113 to Word in an APA format, and in many cases this is very satisfying for APA requirements.
 114 However, the Word format is not suitable for large matrices, as it will often spread beyond the
 115 document's margin limits.

116 Another approach is to export to an image, like the `{correlation}` package does (Makowski
 117 et al., 2020).^[3] For very small matrices, this works extremely well, and the colour is an
 118 immense help to quickly identify which correlations are strong or weak, positive or negative,
 119 and significant or non-significant. Again, however, this does not work so well for large matrices
 120 because labels might overlap or navigating the large figure becomes difficult.

121 When the goal is more exploratory, rather than reporting, and we have large matrices, it can
 122 be more useful to export it to Excel. In `{rempsyc}`, we combine the idea of using a coloured
 123 correlation matrix from the `{correlation}` package with the idea of exporting to Excel using
 124 `{openxlsx2}` (Barbone & Garbuszus, 2023).

125 We also provide some usability improvements, like freezing the first row and column so as to
 126 be able to easily see which variables correlates with which other variable, regardless of how far
 127 or deep those variables are located within the matrix.

128 The colour represents the strength of the correlation, whereas the stars represent how significant
 129 the *p* value is.^[4] The exact *p* values are provided in a second tab for reference purposes, so all
 130 information is readily available in a convenient format.

```

131 cormatrix_excel(data = infert,
132                 filename = "cormatrix1",

```

```
133 select = c("age", "parity", "induced", "case", "spontaneous",
134           "stratum", "pooled.stratum"))
```

	A	B	C	D	E	F	G	H	I
1	Parameter	age	parity	induced	case	spontaneous	stratum	pooled.stratum	
2	age	1.0	.08	-.10	.0	-.08	-.21 ***	-.17 *	
3	parity	.08	1.0	.45 ***	.01	.31 ***	-.31 ***	.12	
4	induced	-.10	.45 ***	1.0	.02	-.27 ***	-.10	.16 *	
5	case	.0	.01	.02	1.0	.36 ***	.0	.0	
6	spontaneous	-.08	.31 ***	-.27 ***	.36 ***	1.0	.06	.21 ***	
7	stratum	-.21 ***	-.31 ***	-.10	.0	.06	1.0	.75 ***	
8	pooled.stratum	-.17 *	.12	.16 *	.0	.21 ***	.75 ***	1.0	
9									

	A	B	C	D	E	F	G	H	I
1	Parameter	age	parity	induced	case	spontaneous	stratum	pooled.stratum	
2	age	.0	.194	.113	.956	.186	.001	.006	
3	parity	.194	.0	.0	.889	.0	.0	.059	
4	induced	.113	.0	.0	.789	.0	.113	.010	
5	case	.956	.889	.789	.0	.0	.952	.939	
6	spontaneous	.186	.0	.0	.0	.0	.341	.001	
7	stratum	.001	.0	.113	.952	.341	.0	.0	
8	pooled.stratum	.006	.059	.010	.939	.001	.0	.0	
9									

137 Publication-Ready Figures

138 Preparing figures according to APA style, having them look good, and being able to save
 139 them in high-resolution with the proper ratios is often challenging. Working with {ggplot2}
 140 (Wickham, 2016) provides tremendous flexibility, but an unintended consequence is that doing
 141 even trivial operations can at times be daunting.

142 This is why {rempsyc} setups a few default plot types, ready to be saved to your preferred
 143 format (.pdf, .tiff, or .png).

144 Violin Plots

```
145 nice_violin(data = ToothGrowth,
146             group = "dose",
147             response = "len",
148             xlabels = c("Low", "Medium", "High"),
149             comp1 = 1,
150             comp2 = 3,
151             has.d = TRUE,
152             d.y = 30)
```



153

154 For an example of such use in publication, see Thériault et al. (2021).

155 One can easily save the resulting figure with `ggplot2::ggsave()`, specifying the desired file
156 name, extension, and resolution.

```
157 ggplot2::ggsave('nice_violinplotthere.pdf', width = 7, height = 7,  
158                  unit = 'in', dpi = 300)
```

159 Recommended dimensions for saving {rempsyc} figures is 7 inches wide and 7 inches high
160 at 300 dpi, which makes sure that the resolution is high enough even if saving to non-vector
161 graphics formats like .png. That said, scalable vector graphics formats like .pdf or .eps are
162 still recommended for high-resolution submissions to scientific journals.

163 Scatter Plots

164 Figures are {ggplot2} objects (Wickham, 2016), and can be modified as such.

```
165 nice_scatter(data = mtcars,  
166              predictor = "wt",  
167              response = "mpg",  
168              group = "cyl",  
169              has.confband = TRUE)
```



170


```

171 nice_scatter(data = mtcars,
172               predictor = "wt",
173               response = "mpg",
174               has.confband = TRUE,
175               has.r = TRUE,
176               has.p = TRUE) +
177   ggplot2::geom_hline(yintercept = mean(mtcars$mpg), colour = "black",
178                       linewidth = 1.4, linetype = "dashed") +
179   ggplot2::annotate("text", x = 3.5, y = 22, size = 7,
180                       label = paste("Mean mpg =", round(mean(mtcars$mpg), 2)))

```



```

181
182 For an example of such use in publication, see Krol et al. (2020).

```

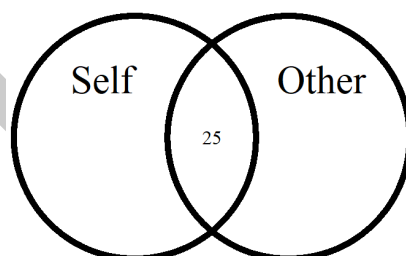
183 Overlapping Circles

184 For psychologists using the Inclusion of Other in the the Self Scale (Aron et al., 1992), it can
 185 be useful to interpolate the original discrete scores (1 to 7) into a group average representation
 186 of the conceptual self-other overlap.

```

187 overlap_circle(3.5)

```



```

188
189 For an example of such use in publication, see Thériault et al. (2021).

```

190 Testing assumptions

191 When comes time to test assumptions of a linear model, the best option is the `check_model()`
192 function from *easystats*' `{performance}` package, which allows direct visual evaluation of
193 assumptions (Lüdtke, Ben-Shachar, et al., 2021). Indeed, visual assessment of diagnostic
194 plots is recommended over statistical tests since they are overpowered in large samples and
195 underpowered in small samples (Kozak & Piepho, 2018).

196 That said, if for whatever reason one wants to check objective assumption tests for a linear
197 model, *rempsysc* makes this easy with the `nice_assumptions()` function, which provide p
198 values for normality (Shapiro–Wilk), homoscedasticity (Breusch–Pagan) and autocorrelation of
199 residuals (Durbin–Watson) in one call.

200 Categorical Predictors

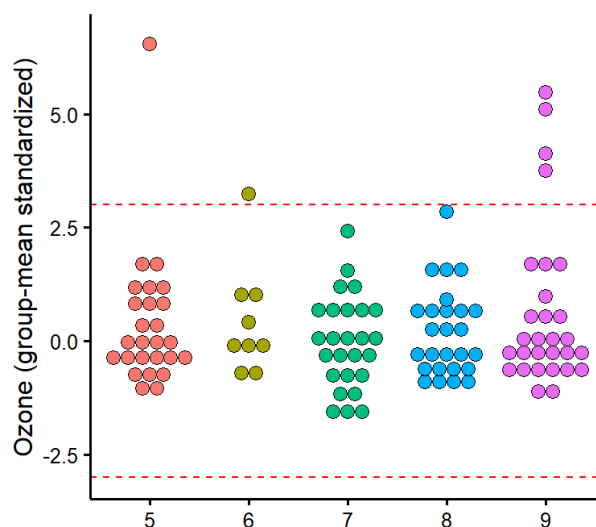
201 `nice_normality()` makes it easy to visually check normality in the case of categorical predictors
202 (i.e., when using groups), through a combination of quantile-quantile plots, density plots, and
203 histograms.

```
204 nice_normality(data = iris,  
205               variable = "Sepal.Length",  
206               group = "Species",  
207               shapiro = TRUE,  
208               histogram = TRUE,  
209               title = "Density (Sepal Length)")
```



210
211 Similarly for univariate outliers using the median absolute deviation (MAD, Leys et al., 2013).

```
212 plot_outliers(airquality,  
213               group = "Month",  
214               response = "Ozone")
```



215

216 Univariate outliers based on the MAD can also be simply requested with `find_mad()[5]`

217 `find_mad(airquality, names(airquality), criteria = 3)`

218

219 `## 8 outlier(s) based on 3 median absolute deviations for variable(s):`

220 `## Ozone, Solar.R, Wind, Temp, Month, Day`

221 `##`

222 `## Outliers per variable:`

223 `##`

224 `## $Ozone`

225 `## Row Ozone_mad`

226 `## 1 30 3.218284`

227 `## 2 62 3.989131`

228 `## 3 99 3.488081`

229 `## 4 101 3.025573`

230 `## 5 117 5.261028`

231 `## 6 121 3.333911`

232 `##`

233 `## $Wind`

234 `## Row Wind_mad`

235 `## 1 9 3.049871`

236 `## 2 48 3.225825`

237 Homoscedasticity can also be checked numerically with `nice_var()` or visually with
238 `nice_varplot()`.

239 `nice_var(data = iris,`
240 `variable = names(iris[1:4]),`
241 `group = "Species") |>`
242 `nice_table()`

243 `nice_varplot(data = iris,`
244 `variable = "Sepal.Length",`
245 `group = "Species")`

246 Utility functions

247 Finally, with the idea of making the analysis workflow easier in mind, `{rempsyc}` also provides
248 a few other utility functions. `nice_na()` allows reporting item-level missing values per scale,

as well as participant's maximum number of missing items by scale, as per recommendations (Parent, 2013).

`extract_duplicates()` creates a data frame of only observations with a duplicated ID or participant number, so they can be investigated more thoroughly. `best_duplicate()` allows to follow-up on this investigation and only keep the "best" duplicate, meaning those with the fewer number of missing values, and in case of ties, the first one.

`nice_reverse()` permits the automatic reverse-coding of scores so common for psychology questionnaires, provided the minimum and maximum score values are known.

There are other functions that the reader can explore at their leisure on the package official website. However, hopefully, this overview has given the reader a gentle introduction to this package.

Licensing and Availability

The `{rempsyc}` package is licensed under the GNU General Public License (GPL v3.0). It is available on CRAN, and can be installed using `install.packages("rempsyc")`. The full tutorial website can be accessed at: <https://rempsyc.remi-theriault.com/>. All code is open-source and hosted on GitHub, and bugs can be reported at <https://github.com/rempsyc/rempsyc/issues/>.

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- 320 [1] This argument can be used logically, as 'TRUE' or 'FALSE', but can also be provided with
321 a numeric value representing the cut-off threshold for the *p* value
- 322 [2] A great resource for this is the {flextable} e-book: [https://ardata-fr.github.io/](https://ardata-fr.github.io/flextable-book/)
323 [flextable-book/](https://ardata-fr.github.io/flextable-book/)
- 324 [3] Exporting the correlation matrix to an image through the {correlation} package also requires
325 the {see} package (Lüdtke, Patil, et al., 2021)
- 326 [4] For convenience, colours are only used when the corresponding *p* value is at least smaller
327 than .05
- 328 [5] Once one has identified outliers, it is also possible to winsorize them with the
329 `winsorize_mad()` function.
- 330