

Reproduce results

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2025-09-30

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Analysis:

Here I focus on reproducing these results:

- Rothen ([Rothen et al. 2016](#))
- Ward ([Ward, n.d.](#)) from: <https://osf.io/p5xsd/files/osfstorage>
- Root ([Root et al. 2021](#))
- Van Petersen ([Van Petersen et al. 2020](#))

Rothen 2016

```
-- Column specification -----
cols(
  `Group` = col_character(),
  `ID` = col_character(),
  `Inducer` = col_character(),
  `X` = col_double(),
  `Y` = col_double(),
  `Cond` = col_character()
)
```

This is what we aim to replicate (Rothen et al. 2016):

Table 1 Summary statistics for the three different measures of consistency: either including all participants (top table) or excluding participants who place all their responses in the central horizontal band (300<y<500) or click on the same region of space for a given inducer (e.g., all days clicked on top right) generating high consistency but no sequence (bottom table)

Descriptive	DP	AUC	Mean (syn)	Mean (con)	SD (syn)	SD (con)	Sensitivity	Specificity	Cut-off	N syn / con
Optimal binary classification of all participants										
Area	1.57	0.76	1079	7031	1365	11149	88	70	1,596	33 / 37
Max. length	1.20	0.77	96	194	42	130	79	70	110	33 / 37
Perimeter (Euclidean sum)	1.18	0.77	202	415	87	284	76	73	221	33 / 37
Nearest neighbor	0.93	0.76	66	42	21	22	67	73	56	33 / 37
Optimal binary classification after removal by visual inspection										
Area	1.84	0.85	1164	8085	1403	11641	87	81	1,596	30 / 32
Perimeter (Euclidean sum)	1.46	0.82	207	453	90	287	77	81	236	30 / 32
Max. length	1.46	0.82	98	211	44	132	77	81	110	30 / 32
Nearest neighbor	1.08	0.79	66	40	21	22	67	78	55	30 / 32

DP discriminant power, AUC area under the curve, SD standard deviation, Max. maximum

Area (pixel^2):

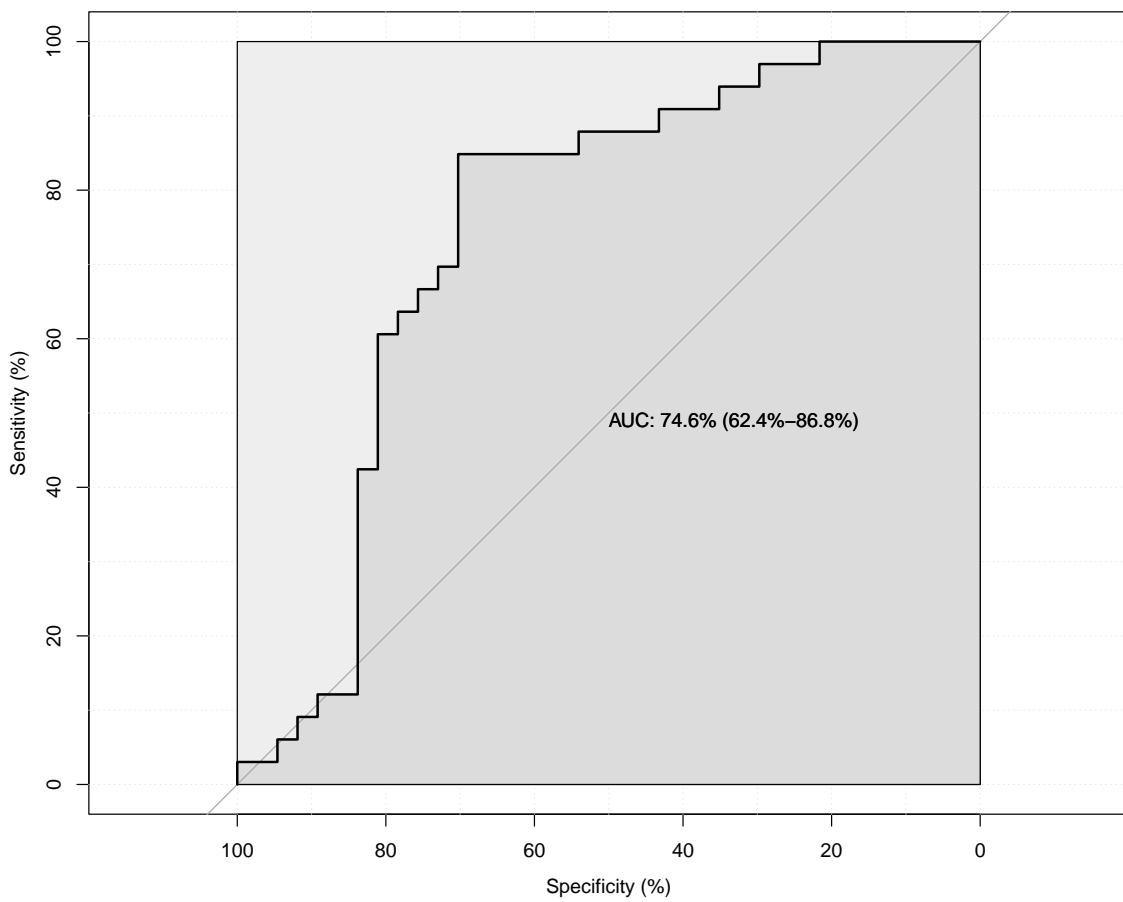
Definition: Calculating consistency Each stimulus is represented by three xy coordinates - (x1, y1), (x2, y2), (x3, y3) - from the three repetitions. For each stimulus, the area of the triangle bounded by the coordinates is calculated as follows:

$$\text{Area} = (x_1y_2 + x_2y_3 + x_3y_1 - x_1y_3 - x_2y_1 - x_3y_2)/2$$

`summarise()` has grouped output by 'ID'. You can override using the `groups` argument.

Setting levels: control = Ctl, case = Syn

Setting direction: controls > cases



Feature	AUC	threshold	sensitivity	specificity	ppv	npv	ci_low	ci_high
triangle_area_GA611	74.611	1574.552	84.84848	70.27027	71.79487	83.87097	62.44444	86.77751

group	n	Mean	SD
Ctl	37	7030.922	11303.051
Syn	33	1311.875	1828.799

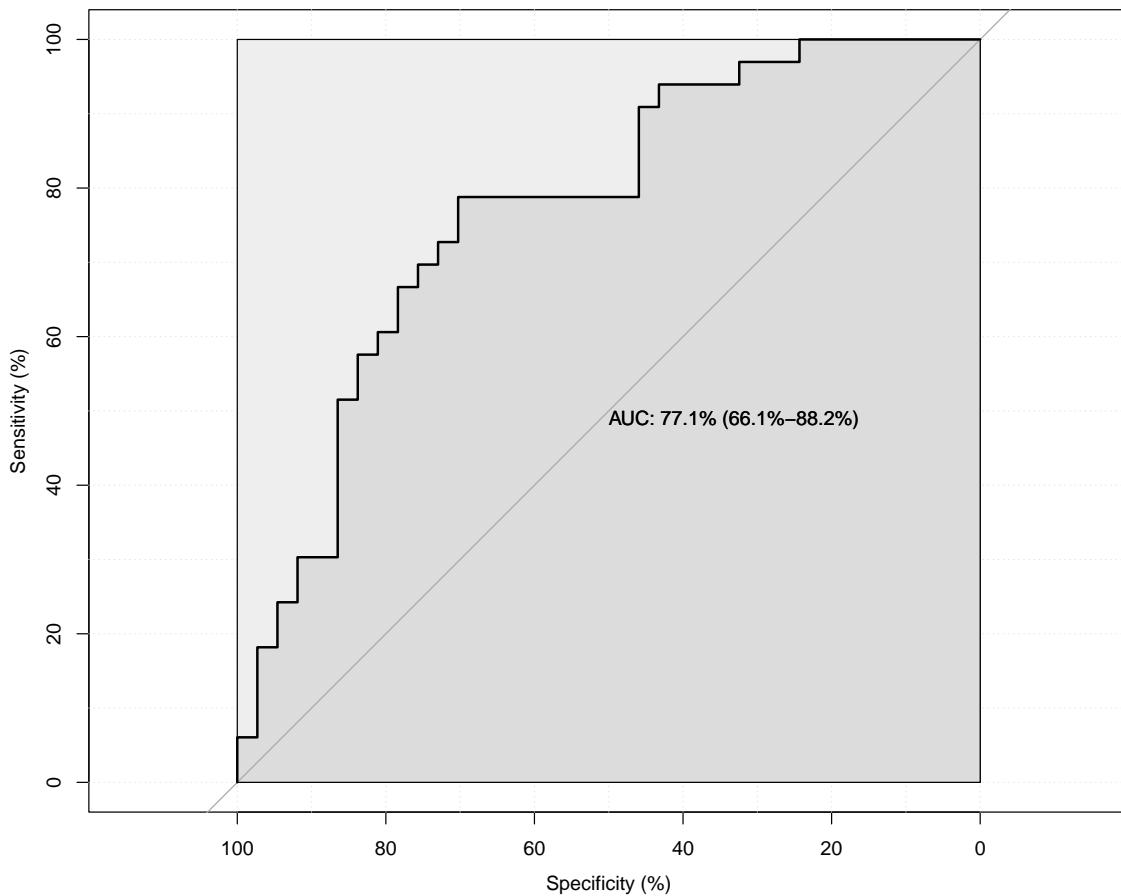
	Ctl	Syn
Ctl	26 (70.3%)	11 (29.7%)
Syn	5 (15.2%)	28 (84.8%)

Maximum length (pixel):

```
`summarise()` has grouped output by 'ID'. You can override using the `groups` argument.
```

```
Setting levels: control = Ctl, case = Syn
```

```
Setting direction: controls > cases
```



Feature	AUC	threshold	sensitivity	specificity	ppv	npv	ci_low	ci_high
triangle_maxLen77GA99	108.6739	78.78788	70.27027	70.27027	78.78788	66.0695	88.23026	

group	n	Mean	SD
Ctl	37	194.17590	131.86123
Syn	33	96.00616	48.50826

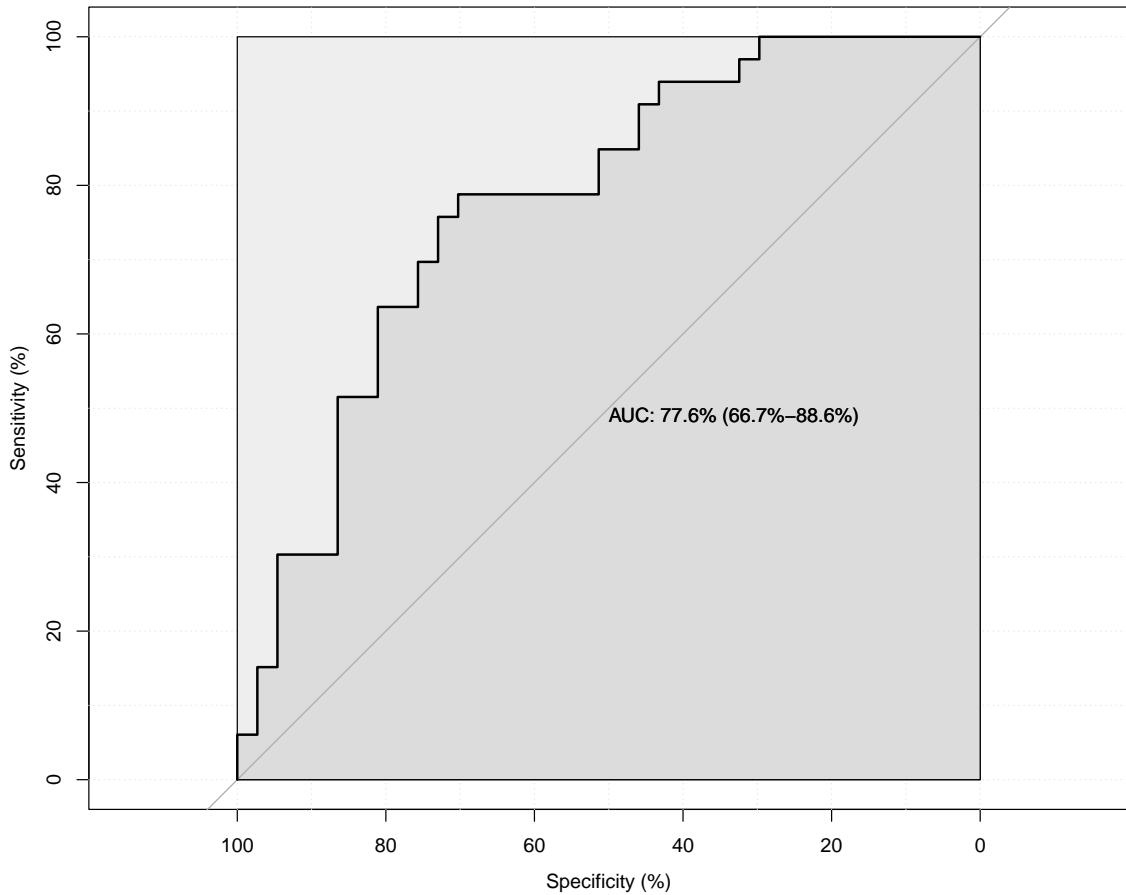
group	n	Mean	SD
	Ctl	Syn	
Ctl	26 (70.3%)	11 (29.7%)	
Syn	7 (21.2%)	26 (78.8%)	

Perimeter (pixel):

`summarise()` has grouped output by 'ID'. You can override using the `groups` argument.

Setting levels: control = Ctl, case = Syn

Setting direction: controls > cases



Feature	AUC	threshold	sensitivity	specificity	ppv	npv	ci_low	ci_high
triangle_perim_74413	233.8503	78.78788	70.27027	70.27027	78.78788	66.70604	88.57651	

group	n	Mean	SD
Ctl	37	414.9348	287.96720
Syn	33	200.9364	99.35026

	Ctl	Syn
Ctl	26 (70.3%)	11 (29.7%)
Syn	7 (21.2%)	26 (78.8%)

Comparison

Summary Rothen vs Repro

Descriptor	DP	AUC	Mean	Mean	SD	SD	Sensitivity	Specificity	Cut-off	
			(syn)	(con)	(syn)	(con)				
Rothen	Area	1.57	0.76	1079	7031	1365	11149	88	70	1,596
	Repro		0.75	1312	7031	1829	11303	85	70	1,575
Rothen	Max. length	1.20	0.77	96	194	42	130	79	70	110
	Repro		0.77	96	194	49	132	79	70	109
Rothen	Perimeter (Euclidean sum)	1.18	0.77	202	415	87	284	76	73	221
	Repro		0.78	201	415	99	288	79	70	234
	Nearest neighbor	0.93	0.76	66	42	21	22	67	73	56

Original table:

Summary Statistics Table

Description	DP	AUC	Mean (syn)	Mean (con)	SD (syn)	SD (con)	Sensitivity	Specificity	Cut-off	N syn / con
Area	1.57	0.76	1079	7031	1365	11149	88	70	1,596	33 / 37
Max. length	1.20	0.77	96	194	42	130	79	70	110	33 / 37
Perimeter (Euclidean sum)	1.18	0.77	202	415	87	284	76	73	221	33 / 37
Nearest neighbor	0.93	0.76	66	42	21	22	67	73	56	33 / 37
Area	1.84	0.85	1164	8085	1403	11641	87	81	1,596	30 / 32
Perimeter (Euclidean sum)	1.46	0.82	207	453	90	287	77	81	236	30 / 32
Max. length	1.46	0.82	98	211	44	132	77	81	110	30 / 32
Nearest neighbor	1.08	0.79	66	40	21	22	67	78	55	30 / 32

Reproduced table:

group	Mean	SD	group	Mean	SD	Feature	AUC	threshold	sensitivity	specificity	ppv	npv	ci_low	ci_high
2	33	1311.875	28.799	37	7030.912	303t05	angle_74611674.532	848470.270271.79487870274486177751						
2	33	96.00618650826	37	194.1751	8612	angle_mak1998.6739	787880.270270.27027787680695							
2	33	200.936435026	37	414.9387.9672	angle_p7e611236.8578	787880.270270.27027787687068457651								

Supplementary

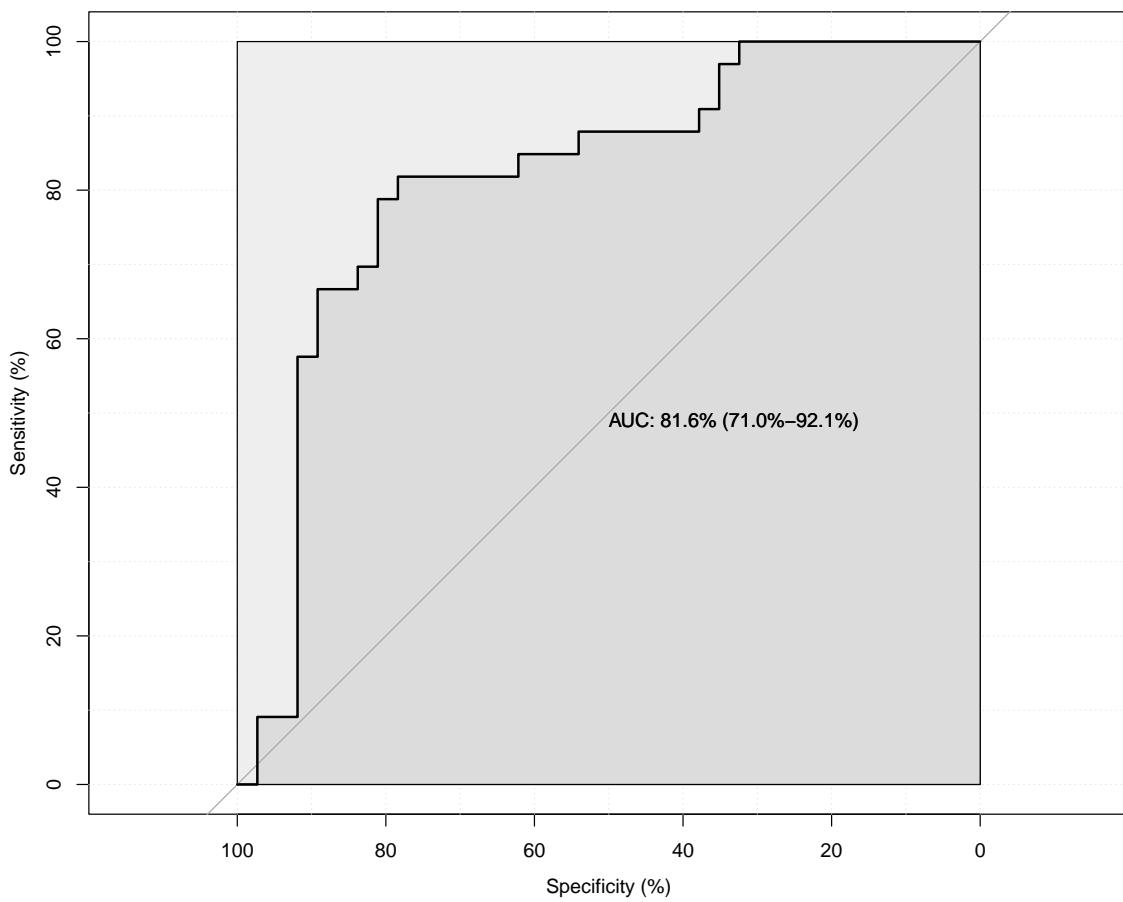
Test with Area (zs)

Now use individual z-score transformed pixel. Give rise to better results.

```
`summarise()` has grouped output by 'ID'. You can override using the `groups` argument.
```

```
Setting levels: control = Ctl, case = Syn
```

```
Setting direction: controls > cases
```



Feature	AUC	threshold	sensitivity	specificity	ppv	npv	ci_low	ci_high
triangle_area_G	81.5725	0.076886	81.81818	78.37838	77.14286	82.85714	71.01422	92.13074

group	n	Mean	SD
Ctl	37	0.2263572	0.2525547
Syn	33	0.0472247	0.0576979

	Ctl	Syn
Ctl	29 (78.4%)	8 (21.6%)
Syn	6 (18.2%)	27 (81.8%)

System info:

```
R version 4.5.1 (2025-06-13)
Platform: aarch64-apple-darwin20
Running under: macOS Tahoe 26.0

Matrix products: default
BLAS:      /Library/Frameworks/R.framework/Versions/4.5-arm64/Resources/lib/libRblas.0.dylib
LAPACK:   /Library/Frameworks/R.framework/Versions/4.5-arm64/Resources/lib/libRlapack.dylib

locale:
[1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8

time zone: Europe/Zurich
tzcode source: internal

attached base packages:
[1] stats      graphics   grDevices utils      datasets   methods    base

other attached packages:
[1] pROC_1.19.0.1   papaja_0.1.3     tinylabels_0.2.5 dplyr_1.1.4
[5] tidyrr_1.3.1    readxl_1.4.5     readr_2.1.5

loaded via a namespace (and not attached):
[1] crayon_1.5.3      vctrs_0.6.5       cli_3.6.5        knitr_1.50
[5] rlang_1.1.6       xfun_0.52        purrr_1.1.0      generics_0.1.4
[9] jsonlite_2.0.0    glue_1.8.0       htmltools_0.5.8.1 hms_1.1.3
[13] rmarkdown_2.29    cellranger_1.1.0 evaluate_1.0.3    tibble_3.3.0
[17] tzdb_0.5.0       fastmap_1.2.0    yaml_2.3.10      lifecycle_1.0.4
[21] compiler_4.5.1    Rcpp_1.0.14      pkgconfig_2.0.3   rstudioapi_0.17.1
[25] digest_0.6.37    R6_2.6.1        tidyselect_1.2.1  pillar_1.10.2
[29] magrittr_2.0.3    tools_4.5.1
```

Root, Nicholas, Michiko Asano, Helena Melero, Chai-Youn Kim, Anton V. Sidoroff-Dorso, Argiro Vatakis, Kazuhiko Yokosawa, Vilayanur Ramachandran, and Romke Rouw. 2021. “Do the Colors of Your Letters Depend on Your Language? Language-Dependent and Universal Influences on Grapheme-Color Synesthesia in Seven Languages.” *Consciousness and Cognition* 95 (October): 103192. <https://doi.org/10.1016/j.concog.2021.103192>.

Rothen, Nicolas, Kristin Jünemann, Andy D. Mealor, Vera Burckhardt, and Jamie Ward. 2016. “The Sensitivity and Specificity of a Diagnostic Test of Sequence-Space Synesthesia.” *Behavior Research Methods* 48 (4): 1476–81. <https://doi.org/10.3758/s13428-015-0656-2>.

Van Petersen, Eline, Mareike Altgassen, Rob Van Lier, and Tessa M. Van Leeuwen. 2020. “Enhanced Spatial Navigation Skills in Sequence-Space Synesthetes.” *Cortex* 130 (September): 49–63. <https://doi.org/10.1016/j.cortex.2020.04.034>.

Ward, Jamie. n.d. “Optimizing a Measure of Consistency for Sequence-Space Synesthesia.” <https://doi.org/10.31234/osf.io/5cnr7>.