

Parallel, Tau-Equivalent, and Congeneric Tests

```
# install.packages("here")
library(tidyverse)
library(modelsummary) # for summarizing data
```

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```

Parallel Tests

Here we simulate scores for two tests that are parallel:

```
set.seed(2237) # setting the seed ensure reproducibility
num_person <- 1000 # number of respondents
# True scores for Test 1
t1 <- rnorm(num_person, mean = 20, sd = 5)
# Error scores for Test 1
e1 <- rnorm(num_person, mean = 0, sd = 2)
# Observed scores for Test 1
x1 <- t1 + e1
# True scores for Test 2
t2 <- t1 # parallel tests have equal true scores
# Error scores for Test 2
e2 <- rnorm(num_person, mean = 0, sd = 2)
# Observed scores for Test 2
x2 <- t2 + e2

# Merge into a data frame
test_df <- data.frame(x1, x2)
# Get means and variances
mv <- datasummary(x1 + x2 ~ Mean + Var, data = test_df,
                  output = "data.frame")
# Correlation, adding means and variances
datasummary_correlation(test_df, add_columns = mv[-1])
```


	x1	x2	Mean	Var
x1	1	.	20.41	29.20
x2	0.87	1	20.31	30.27

```
Use 'xfun::attr2()' instead.
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```

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```

If we know the true scores, the reliability estimate for X3 is

```
# Reliability for x3
var(t2) / var(x2)
```

```
[1] 0.8473518
```

! Parallel Tests

- Means and Variances of observed scores are equal, theoretically
- Correlation = reliability

Tau-Equivalent Tests

Here we simulate scores for two tests that are tau-equivalent:

```
set.seed(2237) # setting the seed ensure reproducibility
num_person <- 1000 # number of respondents
# True scores for Test 1
t1 <- rnorm(num_person, mean = 20, sd = 5)
```

```
# Error scores for Test 1
e1 <- rnorm(num_person, mean = 0, sd = 2)
# Observed scores for Test 1
x1 <- t1 + e1
# True scores for Test 3
t3 <- t1 # parallel tests have equal true scores
# Error scores for Test 3
e3 <- rnorm(num_person, mean = 0, sd = 4)
# Observed scores for Test 3
x3 <- t3 + e3
```

If we know the true scores, the reliability estimate for X3 is

```
# Reliability for x3
var(t3) / var(x3)
```

```
[1] 0.5957004
```

```
# Merge into a data frame
test_df <- data.frame(x1, x3)
# Get means and variances
mv <- datasummary(x1 + x3 ~ Mean + Var, data = test_df,
                  output = "data.frame")
# Correlation, adding means and variances
datasummary_correlation(test_df, add_columns = mv[-1])
```

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	x1	x3	Mean	Var
x1	1	.	20.41	29.20
x3	0.74	1	20.27	43.06

! Tau-Equivalent Tests

- Means of observed scores are equal, theoretically, but variances are different
- Correlation $\neq$ reliability

Essentially Tau-Equivalent Tests

```
# True scores for Test 4
t4 <- 5 + t1 # essentially tau-equivalent tests
# Error scores for Test 4 (larger error SDs)
e4 <- rnorm(num_person, mean = 0, sd = 4)
# Observed scores for Test 4
x4 <- t4 + e4
```

```
# Merge into a data frame
test_df2 <- data.frame(x1, x4)
# Get means and variances
mv <- datasummary(x1 + x4 ~ Mean + Var, data = test_df2,
                  output = "data.frame")
# Correlation, adding means and variances
datasummary_correlation(test_df2, add_columns = mv[-1])
```

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	x1	x4	Mean	Var
x1	1	.	20.41	29.20
x4	0.72	1	25.41	41.50

Use 'xfun::attr2()' instead.
See `help("Deprecated")`

If we know the true scores, the reliability estimate for X4 is

```
# Reliability for x4
var(t4) / var(x4)
```

```
[1] 0.6180122
```

! Essentially Tau-Equivalent Tests

- Means and Variances of observed scores are different
- Correlation $\neq$ reliability

Congeneric Tests

```
# True scores for Test 5
t5 <- 2 + 0.8 * t1
# Error scores for Test 5 (larger error SDs)
e5 <- rnorm(num_person, mean = 0, sd = 3)
# Observed scores for Test 5
x5 <- t5 + e5
```

```
# Merge into a data frame
test_df3 <- data.frame(x1, x5)
# Get means and variances
mv <- datasummary(x1 + x5 ~ Mean + Var, data = test_df3,
                  output = "data.frame")
# Correlation, adding means and variances
datasummary_correlation(test_df3, add_columns = mv[-1])
```


	x1	x5	Mean	Var
x1	1	.	20.41	29.20
x5	0.73	1	18.27	24.23

```
Use 'xfun::attr2()' instead.
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See help("Deprecated")
```

```
Warning in attr(x, "format"): 'xfun::attr()' is deprecated.
Use 'xfun::attr2()' instead.
See help("Deprecated")
```

If we know the true scores, the reliability estimate for X5 is

```
# Reliability for x5
var(t5) / var(x5)
```

```
[1] 0.6773983
```

! Congeneric Tests

- Means and Variances of observed scores are different
- Correlation $\neq$ reliability
- Need more than two tests to be distinguishable from essentially tau-equivalent tests