How Effect Size, Sample Size, and Power Interact with Each Other

Note and Disclaimer

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Effect Size

The following effect size numbers are from Jacob Cohen's *Statistical Power Analysis for the Behavioral Sciences*.

Effect Size	d	r
Small	0.2	0.1
Medium	0.5	0.3
Large	0.8	0.5

Sample Size

Sample size refers to the number of observations or individuals measured or included in a study.

Statistical Power

	H0 is True	H0 is False
Correct Action	Should Not Reject H0	Should Reject H0
A Test Rejects H0 (Positive)	α	$1-\beta$
A Test Doesn't Reject H0 (Negative)	$1-\alpha$	β

$1-\beta$ is also called power, or statistical power. It is the probability that, null hypothesis is false and we correctly reject the null hypothesis.

Keeping effect size the same:

Effect of Sample Size on Power

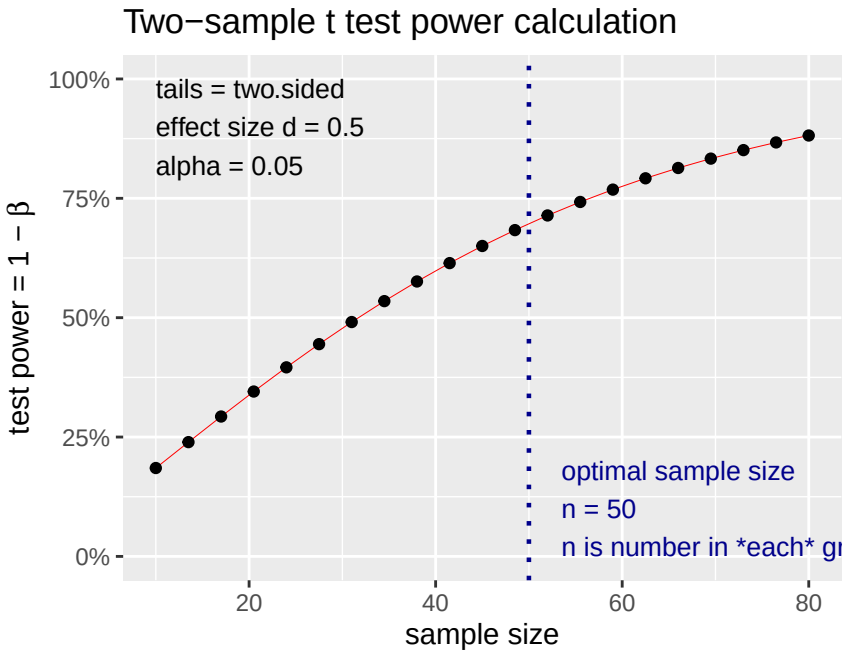
```
library(pwr)
```

```
## Warning: package 'pwr' was built under R version 4.1.3
```

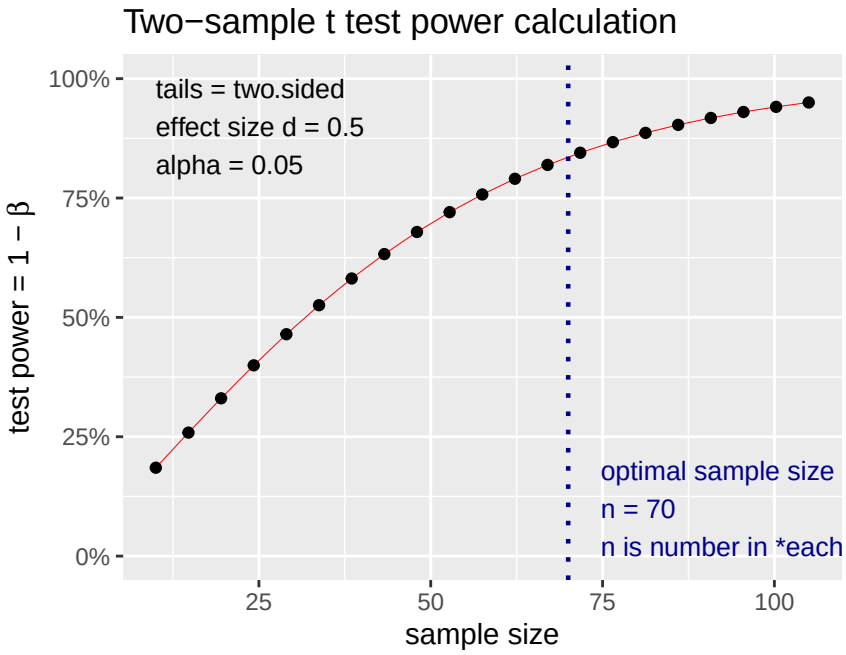
```
## Sample Size = 100
result_100<-pwr.t.test(n=50,
           d = 0.5,
           sig.level = 0.05,
           power = NULL,
           type = "two.sample",
           alternative="two.sided")

## Sample Size = 140
result_140<-pwr.t.test(n=70,
           d = 0.5,
           sig.level = 0.05,
           power = NULL,
           type = "two.sample",
           alternative="two.sided")
```

Keeping effect size the same: Effect of Sample Size on Power

```
## Sample Size = 100
plot(result_100)
```




```
## Sample Size = 140
plot(result_140)
```



Remark 1: For a given effect size, as sample size increases, the power also increases.

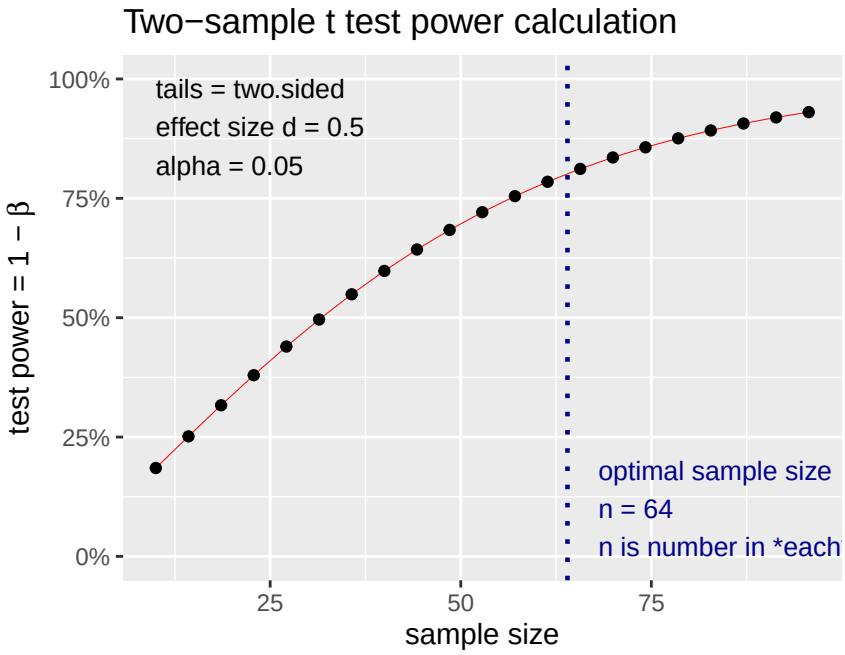
Keeping power the same:

Impact of Effect Size on Needed Sample Size

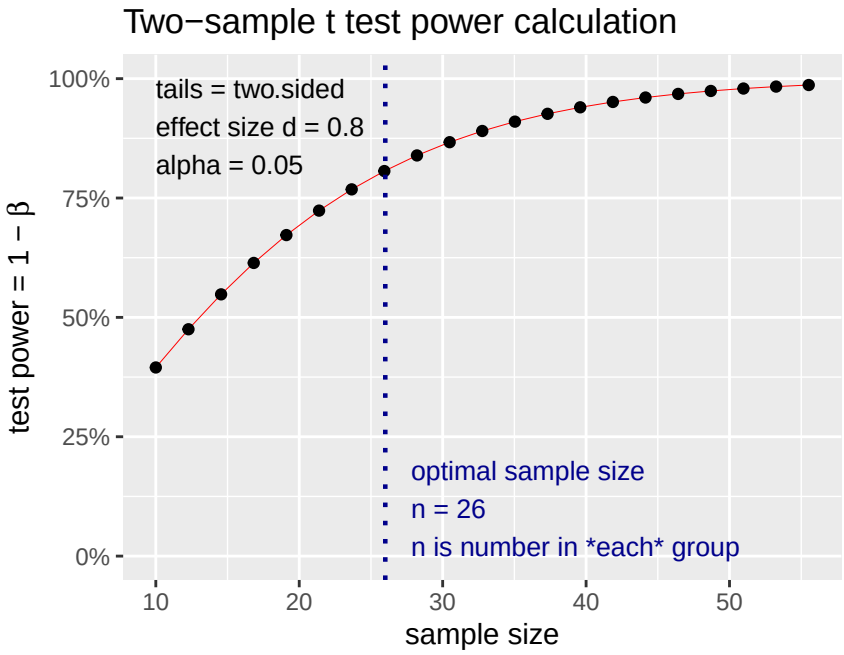
```
library(pwr)

## Effect Size = 0.5
result_0_5<-pwr.t.test(n=NULL,
           d = 0.5,
           sig.level = 0.05,
           power = 0.8,
           type = "two.sample",
           alternative="two.sided")

## Effect Size = 0.8
result_0_8<-pwr.t.test(n=NULL,
           d = 0.8,
           sig.level = 0.05,
           power = 0.8,
           type = "two.sample",
           alternative="two.sided")
```

***Keeping power the same:* Impact of Effect Size on Needed Sample Size**

```
## Effect Size = 0.5
plot(result_0_5)
```




```
## Effect Size = 0.8
plot(result_0_8)
```



Remark 2: For a given power, as effect size increases, the needed sample size decreases.

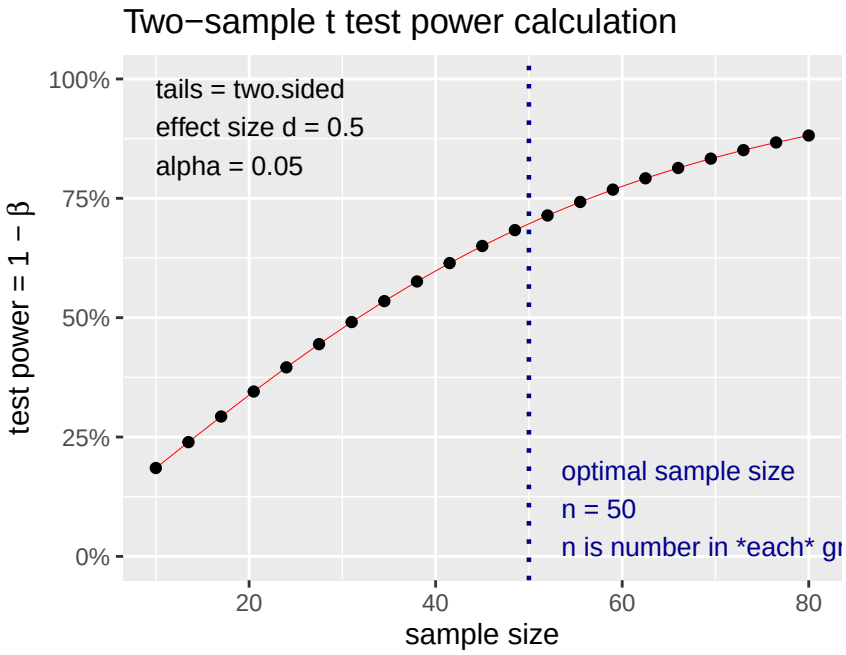
Keeping sample size the same:

Impact of Effect Size on Power

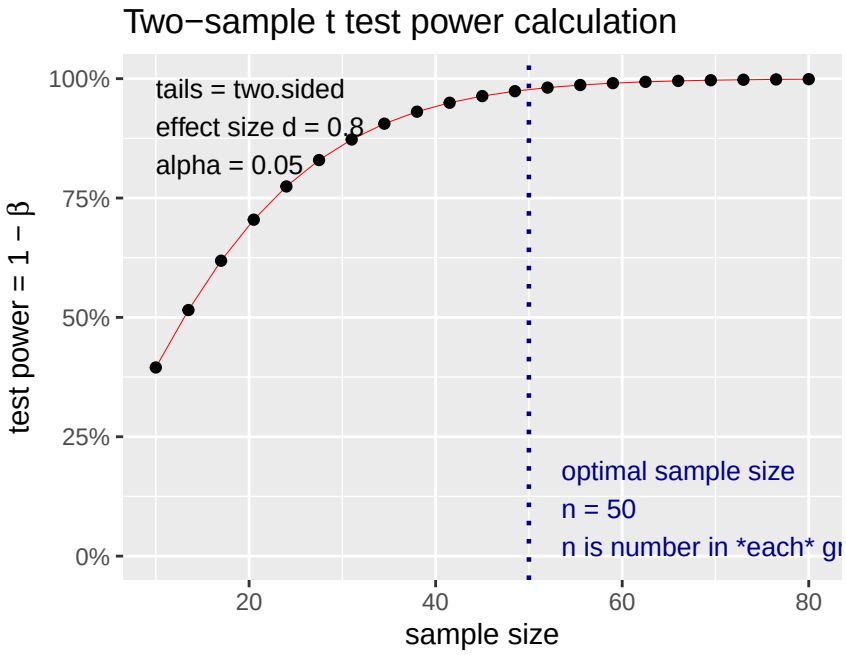
```
library(pwr)

## Effect Size = 0.5
result_0_5<-pwr.t.test(n=50,
           d = 0.5,
           sig.level = 0.05,
           power = NULL,
           type = "two.sample",
           alternative="two.sided")

## Effect Size = 0.8
result_0_8<-pwr.t.test(n=50,
           d = 0.8,
           sig.level = 0.05,
           power = NULL,
           type = "two.sample",
           alternative="two.sided")
```

Keeping sample size the same: Impact of Effect Size on Power

```
## Effect Size = 0.5
plot(result_0_5)
```




```
## Effect Size = 0.8
plot(result_0_8)
```



Remark 3: For a given sample size, as effect size increases, the power also increases.

Remark 1: For a given effect size, as sample size increases, the power also increases.

Remark 2: For a given power, as effect size increases, the needed sample size decreases.

Remark 3: For a given sample size, as effect size increases, the power also increases.