11 juillet 2019

STATISTIQUES
comprendre les notions de bases pour bien choisir son test

Institute for **Advanced Biosciences**

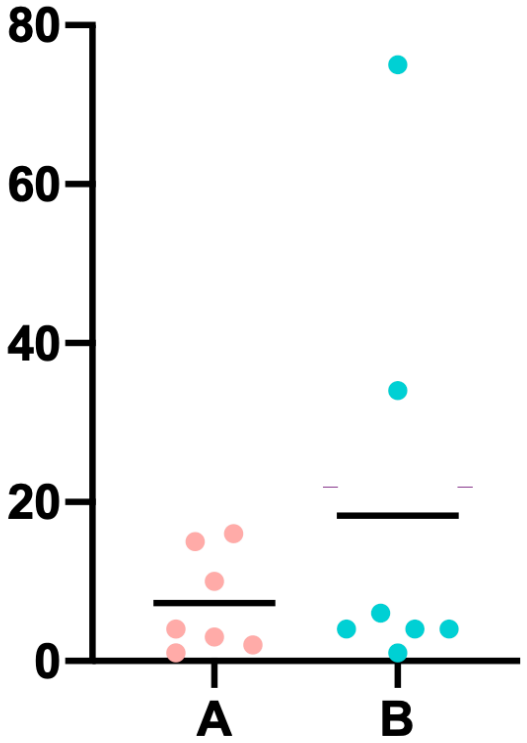
Emeline Lambert

Définitions

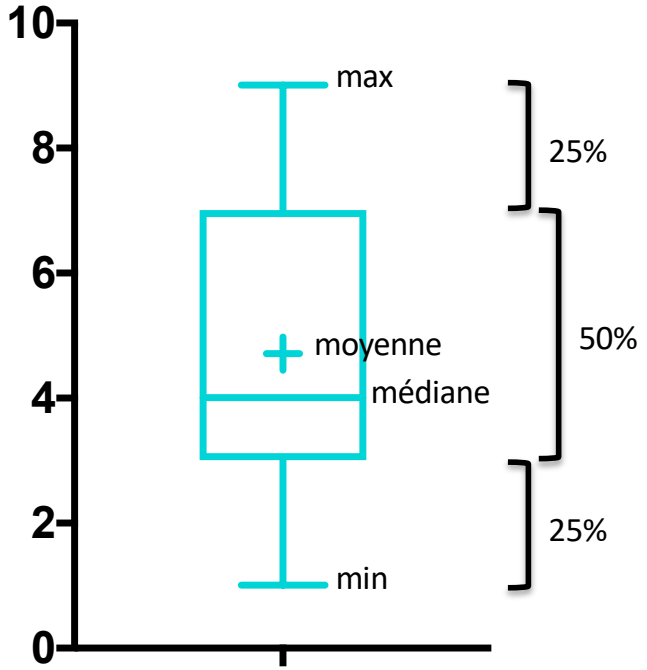
Objectif :

Est-ce que 2 groupes d'échantillons sont différent l'un de l'autre ?
Est-ce que 2 facteurs sont corrélés ?

Visualisation des données :



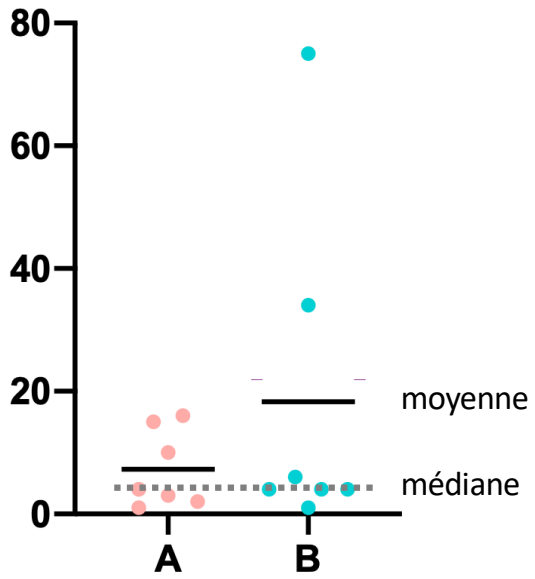
Scatter plot



Boite à moustache

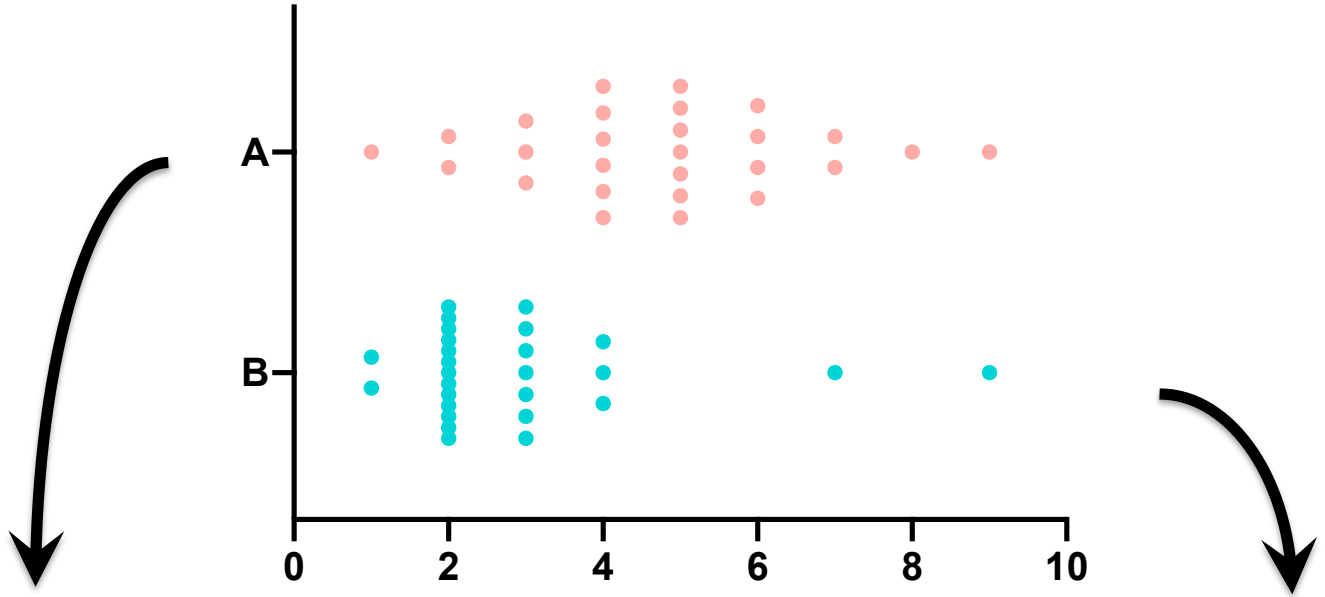
Définitions

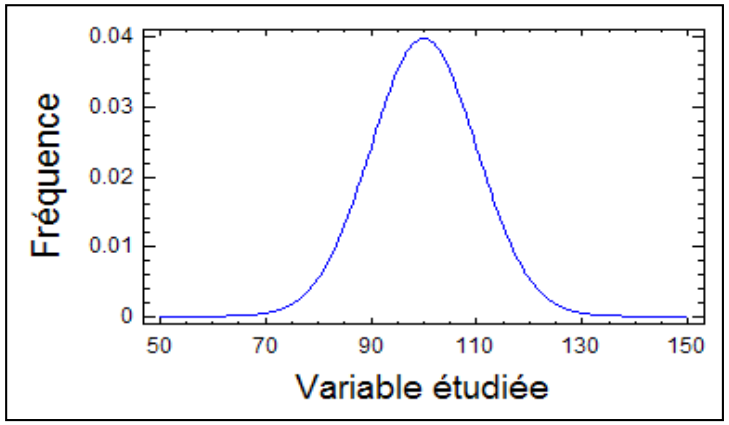
Que veut on comparer ? Moyennes ou Médianes ?



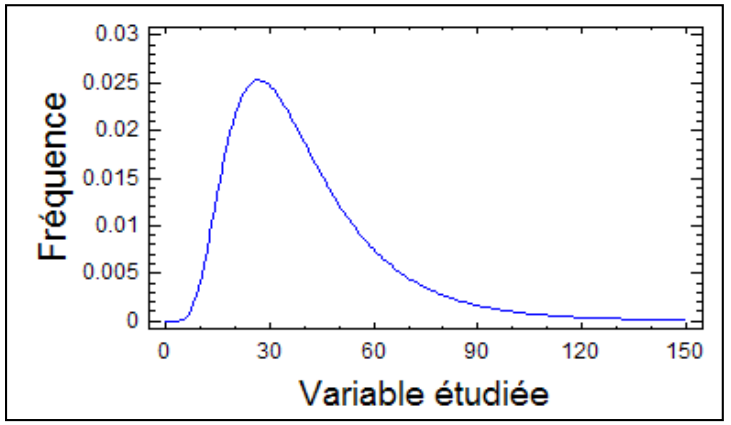
A	B	
1	1	
2	4	
3	4	
4	4	médiane
10	5	
15	37	
16	74	
7,3	18,4	moyenne

La distribution





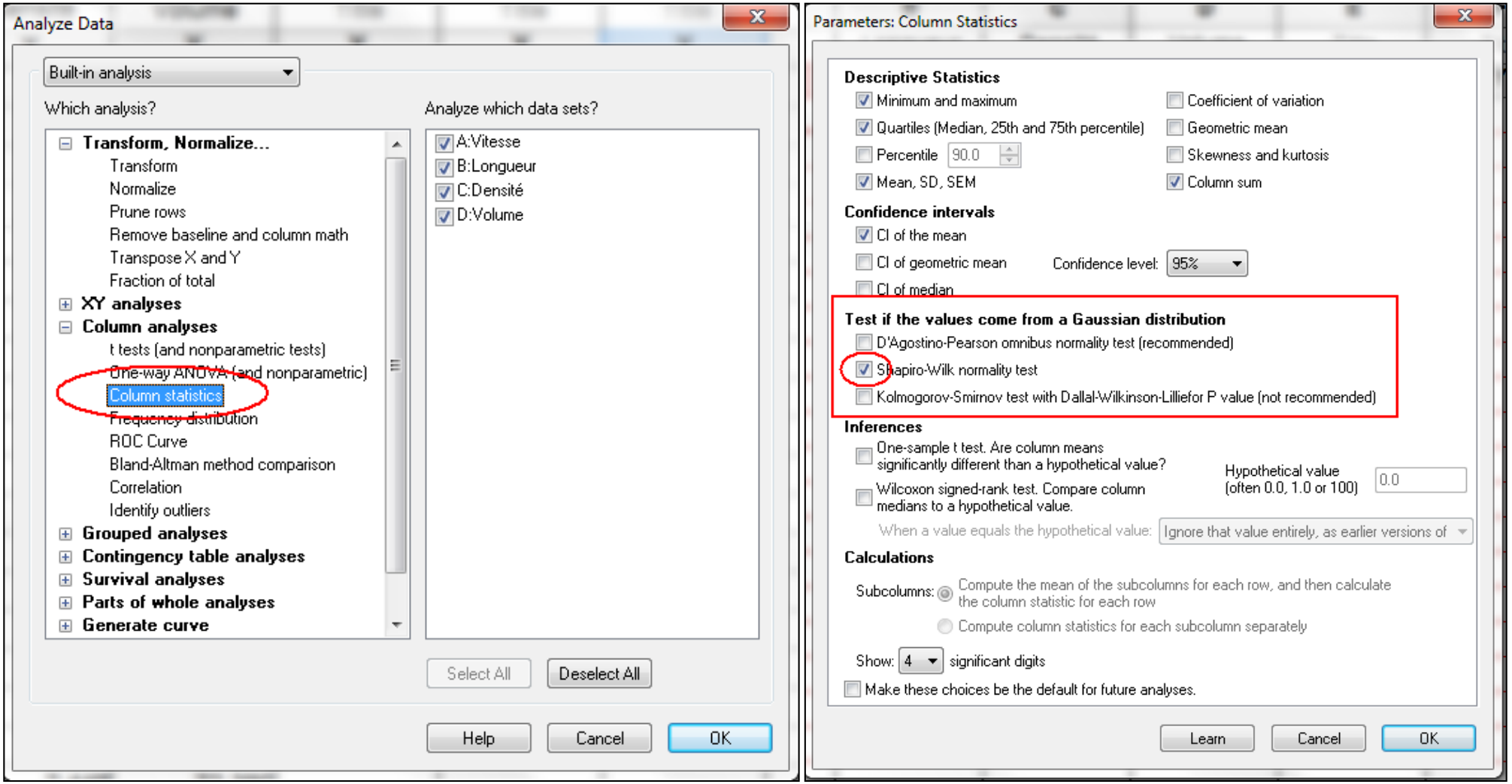
Normalité



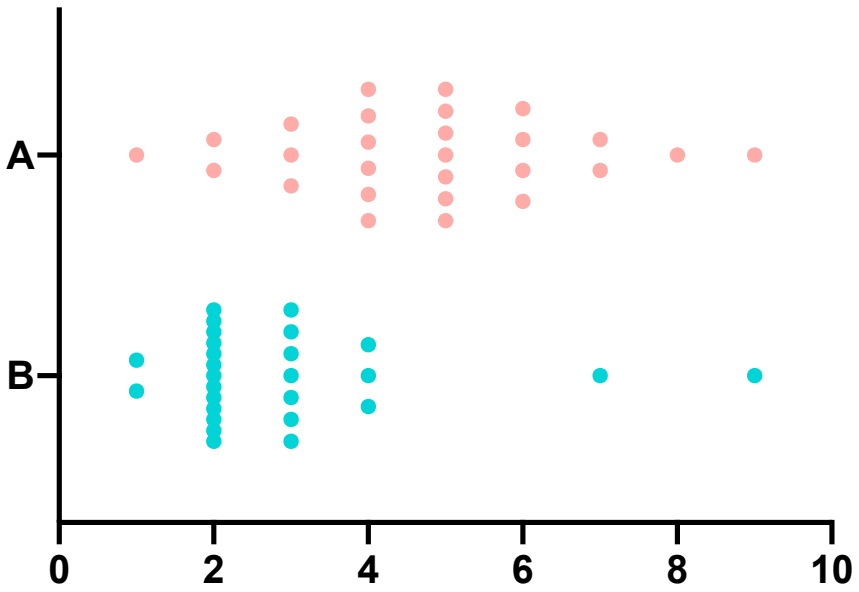
Non Normalité

La distribution

Test de normalité : test de Shapiro wilk



La distribution



Normality and Lognormality Tests Tabular results	A A Y	B B Y
Test for normal distribution		
Shapiro-Wilk test		
W	0.9720	0.6993
P value	0.6543	<0.0001
Passed normality test (alpha=0.05)?	Yes	No
P value summary	ns	****

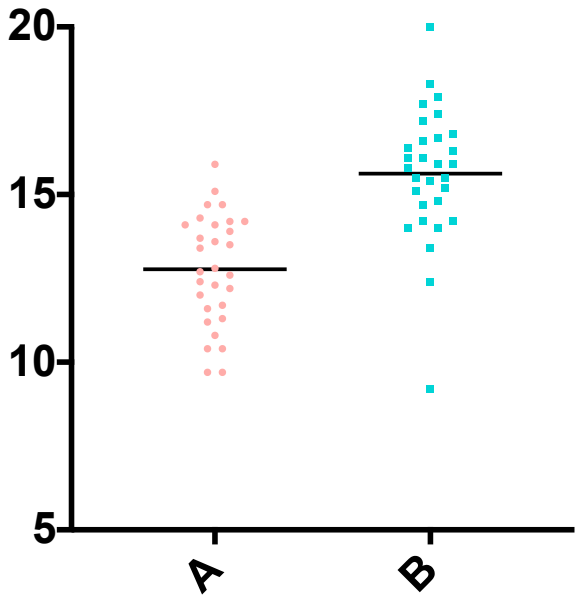
* Minimum n=7

Normalité
=
Comparaison de moyennes
Test paramétrique

Non Normalité
=
Comparaison de médianes
Test non paramétrique

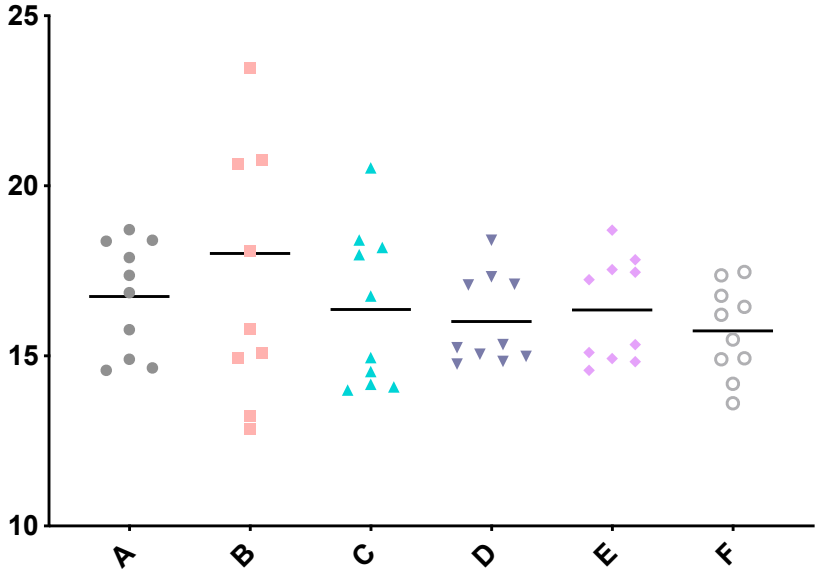
Tests de comparaison de moyennes

2 moyennes



T test
(test de student)

A partir de 3 moyennes



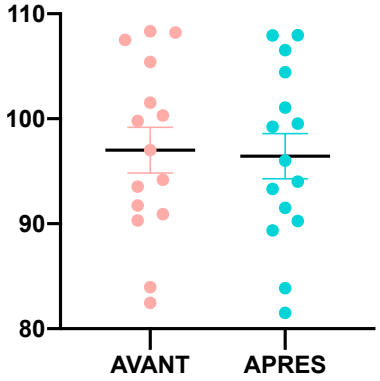
ANOVA

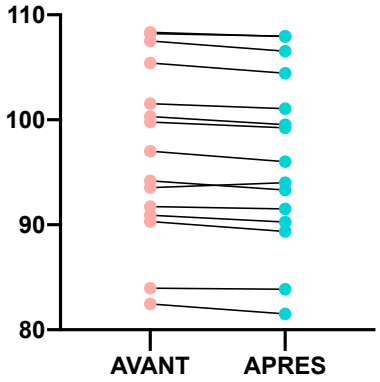
Tests de comparaison de moyennes

Données appariées – pairées :
Valeurs prises 2 fois sur les mêmes individus

Exemple :
Comparaison de la taille d'une tumeur avant/après traitement

AVANT TRAITEMENT	APRES TRAITEMENT
82	82
84	84
90	89
91	90
92	92
94	94
94	93
97	96
100	99
100	100
102	101
105	104
108	107
108	108
108	108
97	**96**





Unpaired t test

P value	0,8512
P value summary	ns
Significantly different (P < 0.05)?	No

Paired t test

P value	0,0001
P value summary	***
Significantly different (P < 0.05)?	Yes

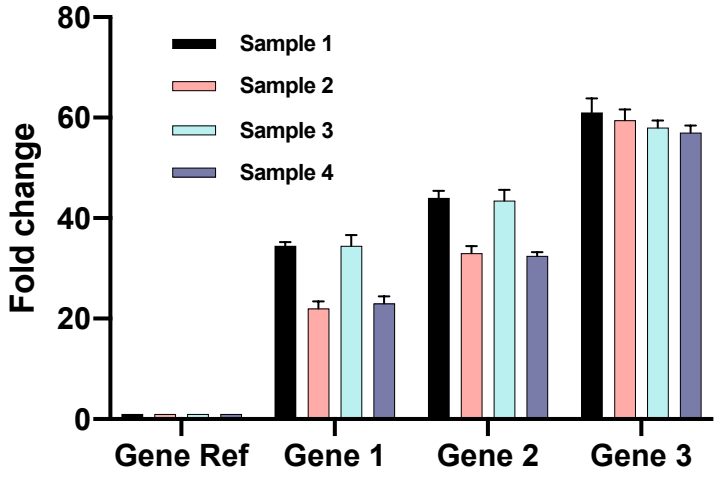
Comparaison multiple

A partir de 3 moyennes à comparer : test ANOVA

Exemple :

Comparaison d'expression de gènes en qPCR

Table format: Grouped		Group A		Group B		Group C		Group D	
		sample 1		Sample 2		sample 3		Sample 4	
		A:Y1	A:Y2	B:Y1	B:Y2	C:Y1	C:Y2	D:Y1	D:Y2
1	**Gene Ref**	1	1	1	1	1	1	1	1
2	**Gene 1**	34	35	23	21	33	36	22	24
3	**Gene 2**	43	45	34	32	45	42	33	32
4	**Gene 3**	59	63	61	58	57	59	56	58



2way ANOVA ANOVA results					
1	Table Analyzed	Data 1			
2					
3	**Two-way ANOVA**	Ordinary			
4	Alpha	0.05			
5					
6	**Source of Variation**	**% of total variation**	**P value**	**P value summary**	**Significant?**
7	Interaction	1.742	<0.0001	****	Yes

Au moins un des échantillons est différent des autres

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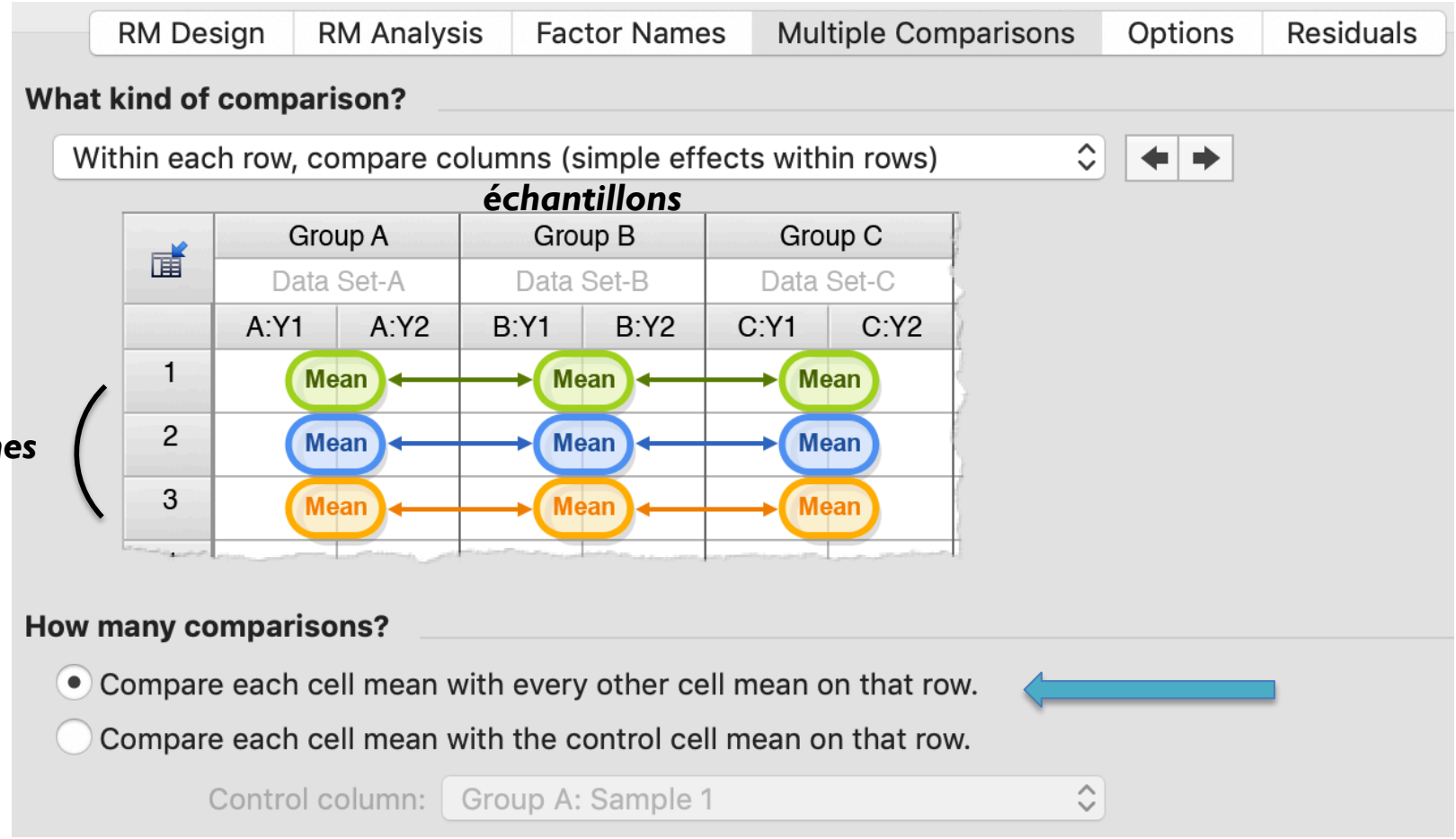
Comparaison multiple

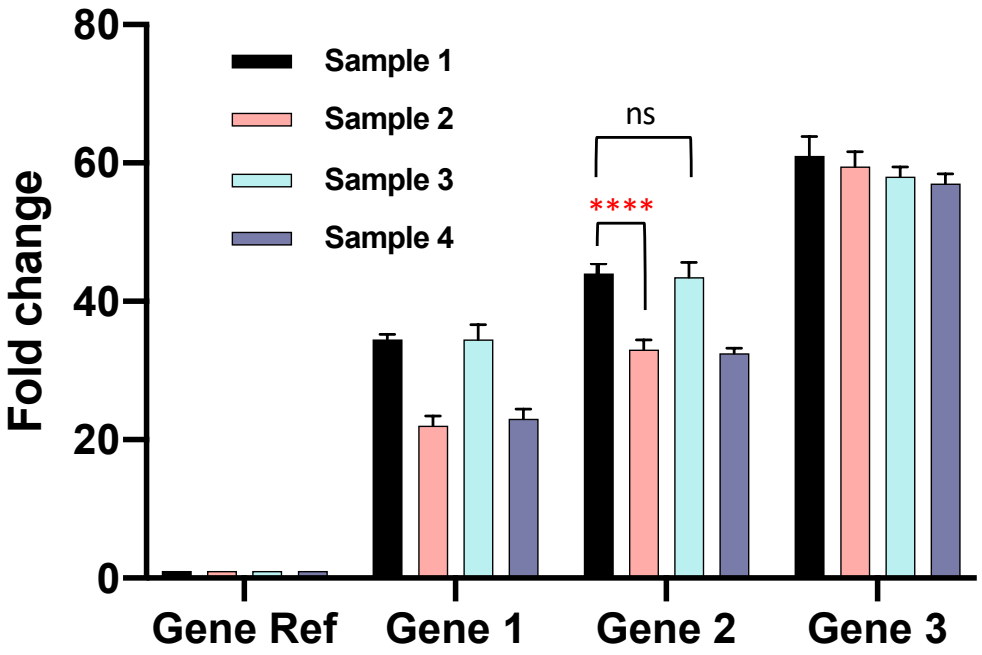
Quel échantillon est différent ?



Comparaison multiple

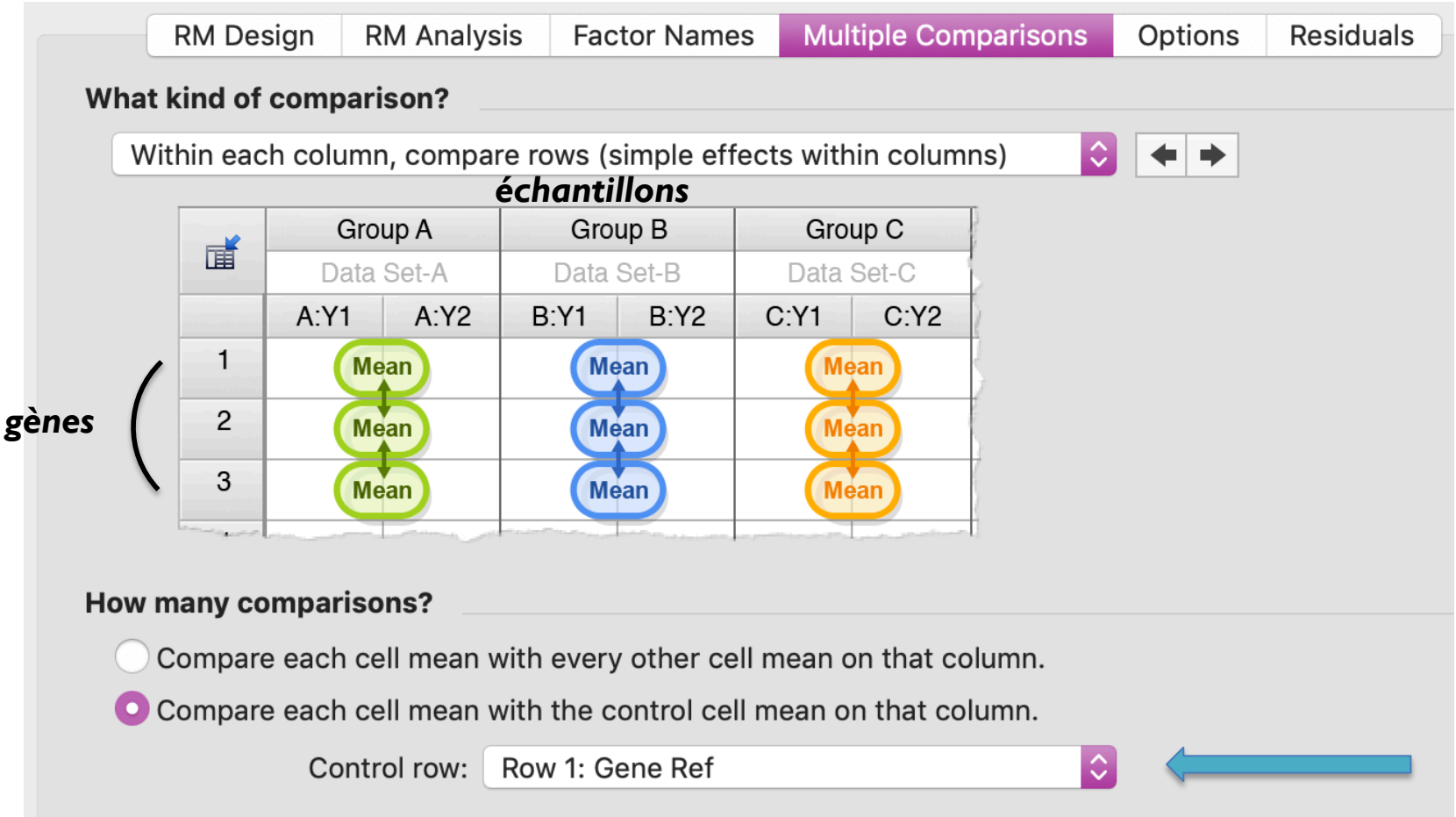
Quel échantillon est différent ?

Tukey's multiple comparisons test	Mean Diff,	Significant?	Summary	Adjusted P Value
Gene 1				
Sample 1 vs. **Sample 2**	12,5	Yes	****	<0,0001
Sample 1 vs. **Sample 3**	0	No	ns	>0,9999
Sample 1 vs. **Sample 4**	11,5	Yes	****	<0,0001
Sample 2 vs. **Sample 3**	-12,5	Yes	****	<0,0001
Sample 2 vs. **Sample 4**	-1	No	ns	0,9028
Sample 3 vs. **Sample 4**	11,5	Yes	****	<0,0001
Gene 2				
Sample 1 vs. **Sample 2**	11	Yes	****	<0,0001
Sample 1 vs. **Sample 3**	0,5	No	ns	0,9859
Sample 1 vs. **Sample 4**	11,5	Yes	****	<0,0001
Sample 2 vs. **Sample 3**	-10,5	Yes	****	<0,0001
Sample 2 vs. **Sample 4**	0,5	No	ns	0,9859
Sample 3 vs. **Sample 4**	11	Yes	****	<0,0001
Gene 3				
Sample 1 vs. **Sample 2**	1,5	No	ns	0,7396
Sample 1 vs. **Sample 3**	3	No	ns	0,2138
Sample 1 vs. **Sample 4**	4	No	ns	0,0649
Sample 2 vs. **Sample 3**	1,5	No	ns	0,7396
Sample 2 vs. **Sample 4**	2,5	No	ns	0,3545
Sample 3 vs. **Sample 4**	1	No	ns	0,9028



Comparaison multiple

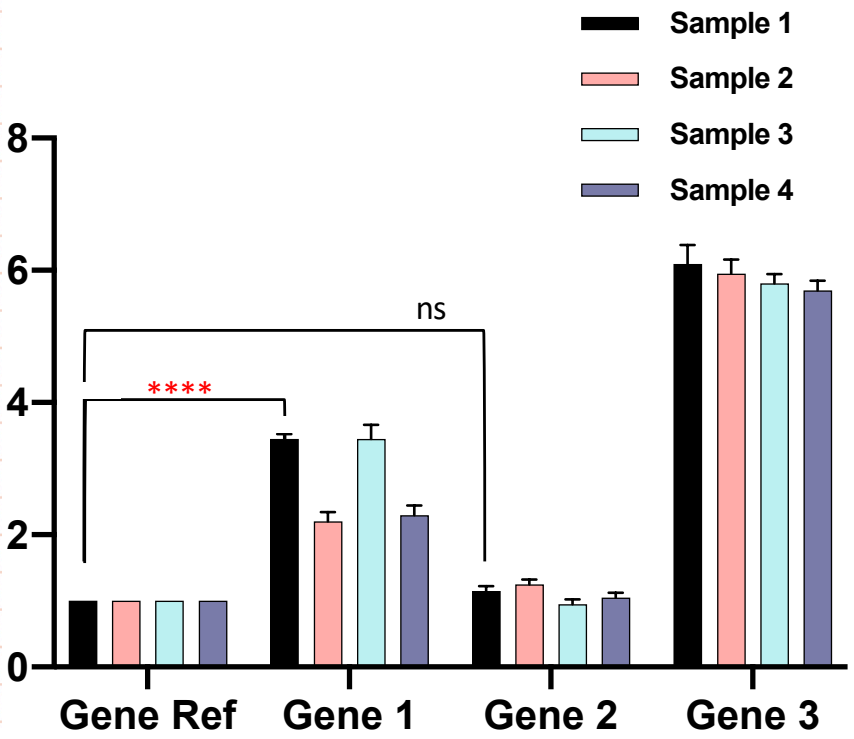
Quel gène est différent ?



Comparaison multiple

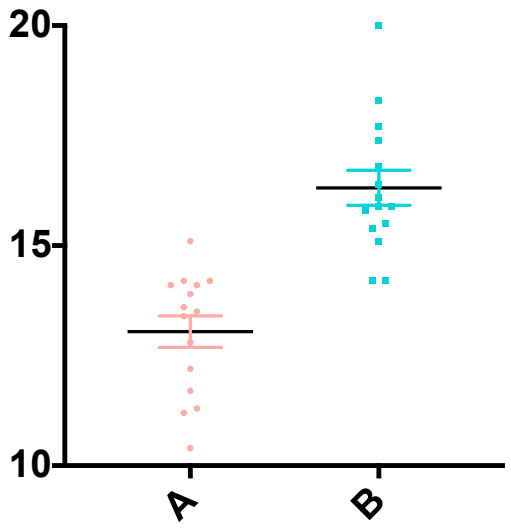
Quel gène est différent ?

Dunnett's multiple comparisons test	Mean Diff,	Significant?	Summary	Adjusted P Value
Sample 1				
Gene Ref vs. **Gene 1**	-2,45	Yes	****	<0,0001
Gene Ref vs. **Gene 2**	-0,15	No	ns	0,5403
Gene Ref vs. **Gene 3**	-5,1	Yes	****	<0,0001
Sample 2				
Gene Ref vs. **Gene 1**	-1,2	Yes	****	<0,0001
Gene Ref vs. **Gene 2**	-0,25	No	ns	0,176
Gene Ref vs. **Gene 3**	-4,95	Yes	****	<0,0001
Sample 3				
Gene Ref vs. **Gene 1**	-2,45	Yes	****	<0,0001
Gene Ref vs. **Gene 2**	0,05	No	ns	0,9633
Gene Ref vs. **Gene 3**	-4,8	Yes	****	<0,0001
Sample 4				
Gene Ref vs. **Gene 1**	-1,3	Yes	****	<0,0001
Gene Ref vs. **Gene 2**	-0,05	No	ns	0,9633
Gene Ref vs. **Gene 3**	-4,7	Yes	****	<0,0001



Interprétation du test

A	B
13,5	15,5
14,1	17,4
12,8	15,9
13,4	20
11,7	15,4
11,3	15,8
15,1	14,2
11,2	15,9
13,6	14,2
14,1	16,4
13,9	18,3
10,4	15,1
14,2	16,1
12,2	17,7
14,2	16,8
13	16



Test d'hypothèse nulle Ho

=

On suppose l'égalité

Unpaired t test	
P value	<0.0001
P value summary	****
Significantly different (P < 0.05)?	Yes

P-value :

Probabilité que les moyennes comparées soient égales

Risque α :

Seuil de la p-value - Risque que l'on accepte de prendre de se tromper

Souvent le risque α est de 5% :

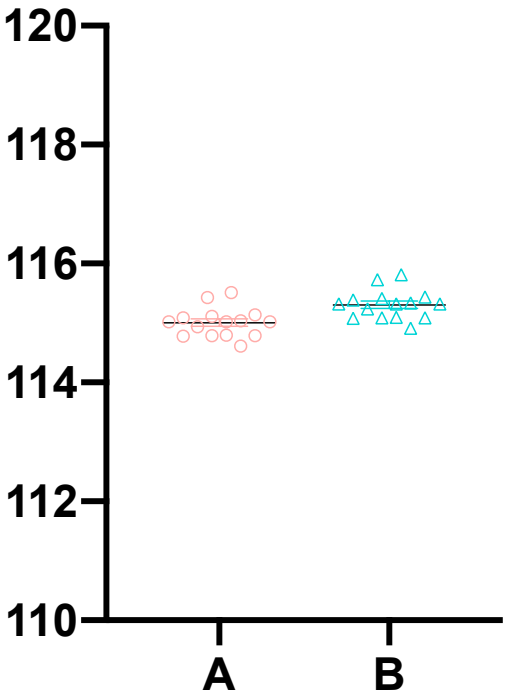
J'accepte de me tromper 5 fois sur 100 en affirmant que la différence n'est pas due au hasard

α va permettre d'interpréter la p-value et de prendre une décision :

Si p-value < α : on rejette l'hypothèse que les moyennes soient égales

on parle de **différence significative**

Interprétation du test



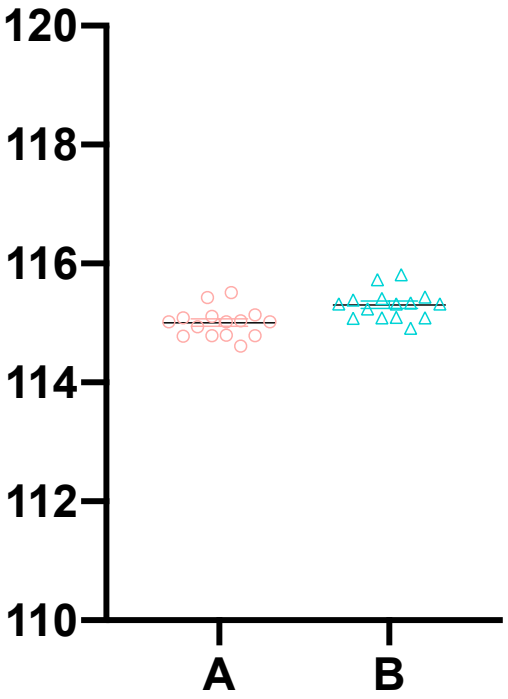
Unpaired t test	
P value	<0.0001
P value summary	****
Significantly different (P < 0.05)?	Yes

~~Nous pouvons conclure que les moyennes sont très différentes~~

Nous pouvons conclure que les moyennes sont très probablement différentes

How big is the difference ?

Interprétation du test



Unpaired t test	
P value	<0.0001
P value summary	****
Significantly different (P < 0.05)?	Yes

How big is the difference?	
Mean of column A	13.05
Mean of column B	16.31
Difference between means (B - A) ± SEM	3.267 ± 0.5343
95% confidence interval	2.172 to 4.361
R squared (eta squared)	0.5717

SEM = Standard Error of Mean

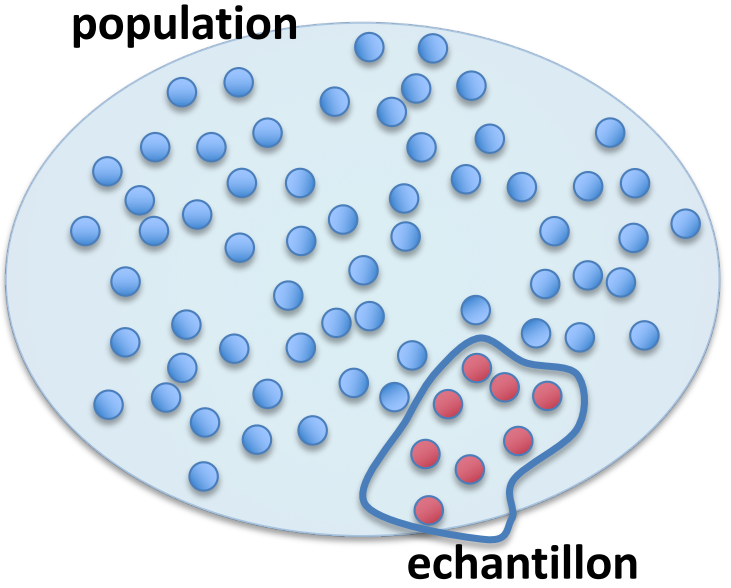
IC à 95% = Intervalle de confiance

Interprétation du test

SEM = Standard Error of Mean

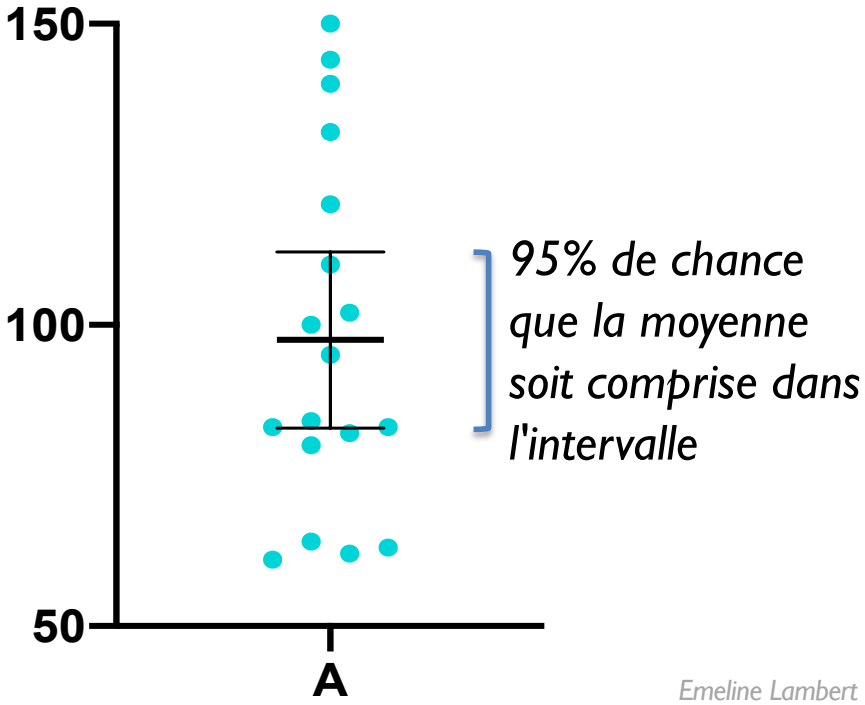
Souvent confondu avec l'Ecart type
(qui représente la variabilité/dispersion des données)

$$SEM = \frac{ecart - type}{\sqrt{effectif}}$$



IC $_{95\%}$ = Intervalle de Confiance à 95%

IC 95% = Moyenne +/- 2 SEM
Il y a 95% de chance que la moyenne de population soit comprise dans l'intervalle :
Moyenne d'échantillon +/- 2 SEM



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Conclusion du test

Unpaired t test	
P value	<0.0001
P value summary	****
Significantly different (P < 0.05)?	Yes
One- or two-tailed P value?	Two-tailed
t, df	t=6.114, df=28
How big is the difference?	
Mean of column A	13.05
Mean of column B	16.31
Difference between means (B - A)	3.267 ± 0.5343
95% confidence interval	2.172 to 4.361

Je peux conclure qu'il y a
très certainement une différence

Mais je ne peux pas conclure
si cette différence est grande ou pas

Je peux conclure que la
différence entre les moyennes
est sans doute comprise dans
l'intervale de confiance

Arbre des tests