

		1 ÉCHANTILLON 1 MESURE	1 ÉCHANTILLON 2 MESURES	2 ÉCHANTILLONS 1 MESURE	k ÉCHANTILLONS 1 MESURE
VARIABLES	NOMINALES	Chapitre 6 <ul style="list-style-type: none"> • Test sur une proportion 	<ul style="list-style-type: none"> • Test de McNemar 	Chapitre 7 <ul style="list-style-type: none"> • Test de l'égalité de deux proportions • Test d'indépendance du χ^2 (table de dimension $r \times 2$) 	<ul style="list-style-type: none"> • Test d'indépendance du χ^2 (table de dimension $r \times k$)
	ORDINALES	Chapitre 8.3 <ul style="list-style-type: none"> • Test de Wilcoxon sur un échantillon 	Chapitre 9.2 <ul style="list-style-type: none"> • Test de Wilcoxon sur mesures paires 	Chapitre 10.2 <ul style="list-style-type: none"> • Test de Mann-Whitney 	Chapitre 11.3 <ul style="list-style-type: none"> • Test de Kruskal-Wallis
	NUMÉRIQUES	Chapitre 8.2 <ul style="list-style-type: none"> • Test Shapiro-Wilk Chapitre 8.1 <ul style="list-style-type: none"> • Test de Student sur un échantillon 	Chapitre 9.1 <ul style="list-style-type: none"> • Test de Student à mesures répétées 	Chapitre 10.1 <ul style="list-style-type: none"> • Test de l'homogénéité des variances • Test de Student à deux groupes indépendants • Test de Welch 	Chapitre 11.2 <ul style="list-style-type: none"> • Analyse de variance à un facteur de classification • Comparaisons multiples

En général si $p < \alpha$, on rejette H_0

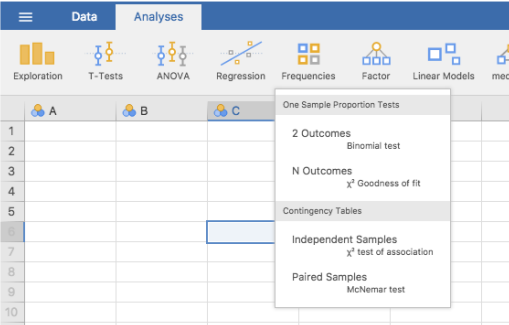
Test sur une proportion (Données brutes)

Saisie des données

	Réponse	B	C
1	Juste		
2	Juste		
3	Faux		
4	Juste		
5	Juste		
6	Juste		
7	Juste		
8	Juste		
9			

Choix du test

Analyses → Frequencies → 2 Outcomes (Binomial test)



Choix des options

Proportion Test (2 Outcomes)

B

C

→

Réponse

☐ Values are counts

Test value 0.5

Additional Statistics

☐ Confidence intervals

Interval 95 %

Hypothesis

☐ ≠ Test value

☒ > Test value

☐ < Test value

> Bayesian Statistics

Résultat

```
##
## PROPORTION TEST (2 OUTCOMES)
##
## Binomial Test
##
##      Level  Count  Total  Proportion  p
##
## Réponse  Faux    1     8      0.125    0.996
##           Juste    7     8      0.875    0.035
##
## Note. Ha is proportion > 0.5
```

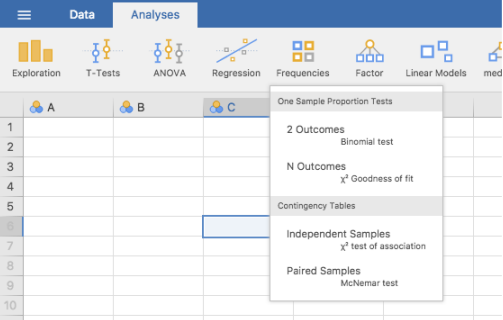
Test sur une proportion (Données regroupées)

Saisie des données

	Effectifs	B	C
1	1		
2	7		
3			
4			
5			

Choix du test

Analyses → Frequencies → 2 Outcomes (Binomial test)



Choix des options

Proportion Test (2 Outcomes)

B

C

→

Effectifs

☒ Values are counts

Test value 0.5

Additional Statistics

☐ Confidence intervals

Interval 95 %

Hypothesis

☐ ≠ Test value

☒ > Test value

☐ < Test value

> Bayesian Statistics

Résultat

```
##
## PROPORTION TEST (2 OUTCOMES)
##
## Binomial Test
##
##      Level  Count  Total  Proportion  p
##
## Effectifs  1      1     8      0.125    0.996
##           2      7     8      0.875    0.035
##
## Note. Ha is proportion > 0.5
```

Saisie des données

	Talons	Galant	Effectifs
1	Hauts	Oui	37
2	Hauts	Non	23
3	Plats	Oui	56
4	Plats	Non	4

Analyses → Frequencies → Independent Samples (χ^2 test of association)

The screenshot displays the JASP software interface. The top navigation bar includes a hamburger menu icon, the 'Data' tab, and the 'Analyses' tab. Below the navigation bar, a row of analysis icons is visible: 'Exploration' (three vertical bars), 'T-Tests' (two groups of circles), 'ANOVA' (two groups of circles), 'Regression' (a line with a slope), 'Frequencies' (a 2x2 grid of squares), 'Factor' (a hierarchical tree diagram), 'Linear Models' (two squares), and a partially visible 'me' icon. Below these icons is a data table with three columns labeled A, B, and C, and ten rows numbered 1 to 10. The 'ANOVA' icon is highlighted, and a dropdown menu is open, listing the following options: 'One Sample Proportion Tests', '2 Outcomes' (with 'Binomial test' as a sub-option), 'N Outcomes' (with 'χ² Goodness of fit' as a sub-option), 'Contingency Tables', 'Independent Samples' (with 'χ² test of association' as a sub-option), and 'Paired Samples' (with 'McNemar test' as a sub-option).

Contingency Tables

→

Rows

→ Galant

Columns

→ Talons

Counts (optional)

→ Effectifs

Layers

→

▼ Statistics

Tests

☐ χ^2
☒ χ^2 continuity correction
☐ Likelihood ratio
☐ Fisher's exact test

Comparative Measures (2x2 only)

☐ Log odds ratio
☐ Odds ratio
☐ Relative risk
☒ Confidence intervals
 Interval %

Nominal

☐ Contingency coefficient
☐ Phi and Cramer's V

Ordinal

☐ Gamma
☐ Kendall's tau-b

```
##
## CONTINGENCY TABLES
##
## Contingency Tables
##
```

	Galant	Hauts	Plats	Total
Non	23	4	27	
Oui	37	56	93	
Total	60	60	120	




```
##
##
##
##
```

χ^2 Tests

	Value	df	p
χ^2 continuity correction	15.5	1	< .001
N	120		

```
##
##
```

Saisie des données

	 Salaire	 B	 C
1	24		
2	27		
3	31		
4	21		
5	19		
6	26		
7	28		
8	22		
9	15		
10	25		
11			
12			

Analyses → T-Tests → One Sample T-Test

The screenshot shows the 'Data Science Dashboard' with the 'Analyses' tab selected. A dropdown menu is open under the 'Exploration' icon, displaying the following options:

- Independent Samples T-Test
- Paired Samples T-Test
- One Sample T-Test

One Sample T-Test

→

B

C

→

Dependent Variables

Salaire

Tests

☒ Student's

☐ Bayes factor

Prior 0.707

☐ Mann-Whitney U

Hypothesis

Test value 28

☐ ≠ Test value
 ☐ > Test value
 ☒ < Test value

Additional Statistics

☐ Mean difference
 ☐ Effect size
 ☐ Confidence interval

Interval 95 %

☐ Descriptives
 ☐ Descriptives plots




Assumption Checks

☐ Normality

```
##
## ONE SAMPLE T-TEST
##
## One Sample T-Test
##
## _____
##                statistic    df      p
## _____
## Salaire      Student's t      -2.83    9.00    0.010
## _____
## Note. H0: population mean < 28
```

Test de Wilcoxon sur un échantillon

Saisie des données

	 Poids	 B	 C
1	576		
2	491		
3	485		
4	499		
5	606		
6	493		
7	506		
8	585		
9			
10			

Choix du test

Analyses → T-Tests → One Sample T-Test

The screenshot shows the 'Analyses' menu in SPSS. The 'Analyses' menu is open, displaying a list of statistical analysis options. The 'T-Tests' option is highlighted, and a submenu is visible, listing 'Independent Samples T-Test', 'Paired Samples T-Test', and 'One Sample T-Test'. The background shows the 'Data' menu and other analysis options like 'Exploration', 'ANOVA', 'Regression', 'Frequencies', 'Factor', 'Linear Models', and 'medmod'.

Choix des options

One Sample T-Test

B

C

→

Dependent Variables

Poids

Tests

☐ Student's

☐ Bayes factor

Prior

☒ Mann-Whitney U

Hypothesis

Test value

☐ ≠ Test value

☒ > Test value

☐ < Test value

Additional Statistics

☐ Mean difference

☐ Effect size

☐ Confidence interval

Interval %

☐ Descriptives

☐ Descriptives plots

Assumption Checks

☐ Normality

Résultat

```
##
## ONE SAMPLE T-TEST
##
## One Sample T-Test
##
## _____
##                               stat    p
## _____
## Poids      Mann-Whitney U    23.0    0.273
##
## Note. H2 population mean > 500
```

Test de Student sur mesures paires

Saisie des données

	◆ T0	◆ T1	◆ T2
1	38	15	16
2	29	10	4
3	37	7	13
4	30	10	33
5	36	12	9
6	37	2	11
7	43	14	26
8	40	3	0
9	25	20	11
10	38	14	16
11	46	31	43
12	46	14	24

Choix du test

Analyses → T-Tests → Paired Samples T-Test

The screenshot shows the JASP software interface. The top navigation bar has 'Data' and 'Analyses' tabs, with 'Analyses' being the active tab. Below the navigation bar is a row of icons representing different statistical analyses: Exploration, T-Tests, ANOVA, Regression, Frequencies, Factor, Linear Models, and medmod. The 'T-Tests' icon is highlighted, and a dropdown menu is open, showing three options: 'Independent Samples T-Test', 'Paired Samples T-Test', and 'One Sample T-Test'. The background shows a data table with columns and rows, and a blue selection bar is visible in the first row.

→

T0

T1

T2

→

T1

T2

ests

☒ Student's

☐ Bayes factor

Prior

0.707

☐ Wilcoxon rank

hypothesis

☐ Measure 1 ≠ Measure 2
 ☐ Measure 1 > Measure 2
 ☒ Measure 1 < Measure 2

issing values

☒ Exclude cases analysis by analysis
 ☐ Exclude cases listwise

Additional Statistics

☐ Mean difference
 ☐ Effect size
 ☐ Confidence interval

Interval

95

%

☐ Descriptives
 ☐ Descriptives plots

Assumption Checks

☐ Normality

Résultat

```
# PAIRED SAMPLES T-TEST
#
# Paired Samples T-Test
#
#
```

			statistic	df	p
T1	T2	Student's t	-1.69	11.0	0.059

```
# Note. Ha: Measure 1 < Measure 2
#
```

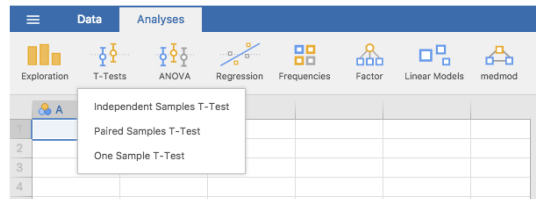
Test de Student sur deux groupes indépendants

Saisie des données

	Subject#	CompletedList0ToDoList1	PSG_SOL
1	101	Completed	19.5
2	102	To Do	26.5
3	103	To Do	9.5
4	105	Completed	46.5
5	106	Completed	25.0
6	107	To Do	29.0
7	108	Completed	30.5
8	109	Completed	22.0
9	110	To Do	8.0
10	111	To Do	4.5
11	112	Completed	30.7
12	114	Completed	68.0
13	115	To Do	15.5
14	116	Completed	41.0
15	117	To Do	6.0
16	118	Completed	21.0
17	119	To Do	15.5
18	120	Completed	3.0
19	121	Completed	7.5
20	122	To Do	28.0

Choix du test

Analyses → T-Tests → Independent Samples T-Test



Choix des options

Subject#

Include1exclude0

NumberItems_ListSpecificity

ConditionXListSpecificity_Interacti...

PSG_LightsOut

PSG_LightsOn

PSG_TST

PSG_Awakenings

Dependent Variables

PSG_SOL

Grouping Variable

CompletedList0ToDoList1

☒ Student's

☐ Bayes factor

Prior 0.707

☐ Welch's

☐ Mann-Whitney U

☒ Mean difference

☒ Effect size

☐ Confidence interval

Interval 95 %

☒ Descriptives

☐ Descriptives plots

☒ Group 1 ≠ Group 2

☐ Group 1 > Group 2

☐ Group 1 < Group 2

☐ Normality

☒ Equality of variances

Additional Statistics

Assumption Checks

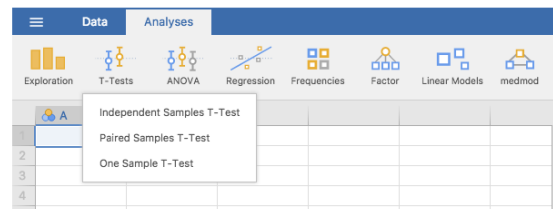
Test de Welch sur deux groupes indépendants

Saisie des données

	Subject#	Comple...	NumberItems_ListSpecificity
1	101	Completed	10
2	102	To Do	10
3	103	To Do	33
4	105	Completed	14
5	106	Completed	13
6	107	To Do	9
7	108	Completed	14
8	109	Completed	6
9	110	To Do	5
10	111	To Do	11
11	112	Completed	18
12	114	Completed	22
13	115	To Do	25
14	116	Completed	7
15	117	To Do	30
16	118	Completed	7
17	119	To Do	11
18	120	Completed	9
19	121	Completed	4
20	122	To Do	6

Choix du test

Analyses → T-Tests → Independent Samples T-Test



Choix des options

Subject#

ConditionXListSpecificity_Interac

PSG_LightsOut

PSG_LightsOn

PSG_SOL

PSG_TST

PSG_Awakenings

PSG_WASO

Dependent Variables

NumberItems_ListSpecificity

Grouping Variable

CompletedList0ToDoList1

☐ Student's

☐ Bayes factor

Prior 0.707

☒ Welch's

☐ Mann-Whitney U

☐ Mean difference

☒ Effect size

☐ Confidence interval

Interval 95 %

☒ Descriptives

☐ Descriptives plots

☒ Group 1 ≠ Group 2

☐ Group 1 > Group 2

☐ Group 1 < Group 2

☐ Normality

☐ Equality of variances

Additional Statistics

Assumption Checks

Résultat

```
##
## INDEPENDENT SAMPLES T-TEST
##
## Independent Samples T-Test
##
##               statistic   df    p    Mean difference   SE difference   Cohen's d
##
## PSG_SOL      Student's t      2.32  55.0   0.024           9.27           3.98   0.616
##
##
## ASSUMPTIONS
##
## Test of Equality of Variances (Levene's)
##
##           F         df    p
##
## PSG_SOL   0.365      1    0.548
##
## Note. A low p-value suggests a
## violation of the assumption of
## equal variances
##
##
## Group Descriptives
##
##           Group    N    Mean    Median    SD    SE
##
## PSG_SOL      0      29    25.1    21.0    15.9   2.96
##              1      28    15.8    10.2    14.1   2.66
##
```

Résultat

```
##
## INDEPENDENT SAMPLES T-TEST
##
## Independent Samples T-Test
##
##               statistic   df    p    Cohen's d
##
## NumberItems_ListSpecificity  Welch's t      -0.917  45.2   0.364   -0.245
##
##
## Group Descriptives
##
##           Group    N    Mean    Median    SD    SE
##
## NumberItems_ListSpecificity  0      29    14.1    13.0    5.74   1.07
##                             1      28    16.0    11.0    9.14   1.73
##
```

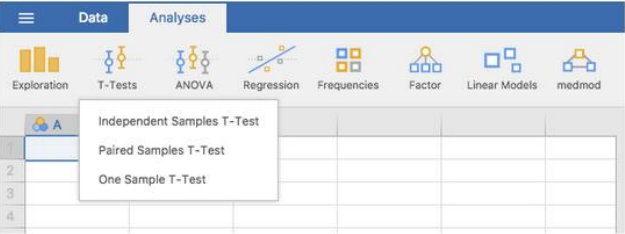
Test de Mann-Whitney

Saisie des données

	Sexe	Pensees
1	Homme	25
2	Homme	23
3	Homme	15
4	Homme	26
5	Homme	29
6	Homme	7
7	Homme	25
8	Homme	21
9	Homme	50
10	Homme	11
11	Homme	18
12	Homme	18
13	Homme	18
14	Homme	17
15	Homme	16
16	Femme	4
17	Femme	8
18	Femme	11
19	Femme	9
20	Femme	7
21	Femme	12
22	Femme	6
23	Femme	13
24	Femme	12
25	Femme	12

Choix du test

Analyses → T-Tests → Independent Samples T-Test



Choix des options

Independent Samples T-Test

C

→

Dependent Variables

Pensees

→

Grouping Variable

Sexe

Tests

☐ Student's

☐ Bayes factor

Prior 0.707

☐ Welch's

☒ Mann-Whitney U

Additional Statistics

☐ Mean difference

☐ Effect size

☐ Confidence interval

Interval 95 %

☐ Descriptives

☐ Descriptives plots

Hypothesis

☒ Group 1 ≠ Group 2

☐ Group 1 > Group 2

☐ Group 1 < Group 2

Assumption Checks

☒ Normality

☐ Equality of variances

Résultat

```
##
## INDEPENDENT SAMPLES T-TEST
##
## Independent Samples T-Test
##
##               statistic    p
## -----
## Pensees    Mann-Whitney U    138 < .001
##
##
## ASSUMPTIONS
##
## Test of Normality (Shapiro-Wilk)
##
##           W           p
## -----
## Pensees    0.866    0.004
##
## Note. A low p-value
## suggests a violation of
## the assumption of
## normality
```

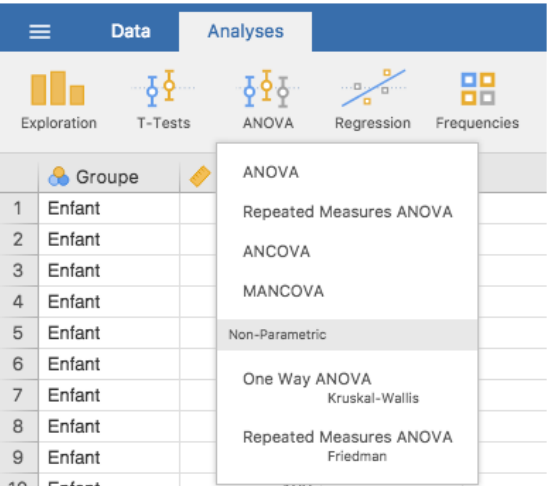
Analyse de variance à un facteur de classification

Saisie des données

	Groupe	Rappels
1	Enfant	107
2	Enfant	133
3	Enfant	129
4	Enfant	63
5	Enfant	145
6	Enfant	113
7	Enfant	159
8	Enfant	119
9	Enfant	136
10	Enfant	109
11	Enfant	97
12	Enfant	87
13	Enfant	91
14	Enfant	97
15	Parent	84
16	Parent	97
17	Parent	57
18	Parent	31
19	Parent	107
20	Parent	114
21	Parent	105
22	Parent	42
23	Parent	136
24	Parent	46
25	Parent	89
26	Parent	113
27	Parent	84
28	Adulte	64
29	Adulte	120
30	Adulte	63
31	Adulte	60
32	Adulte	79

Choix du test

Analyses → ANOVA → ANOVA



Choix des options

ANOVA

→

Dependent Variable

Rappels

→

Fixed Factors

Groupe

Effect Size

☐ η^2

☐ partial η^2

☐ ω^2

Vérification des conditions d'application

Assumption Checks

☒ Homogeneity tests

☒ Q-Q plot of residuals

Comparaisons multiples

Post Hoc Tests

→

Groupe

Correction

☒ No correction

☐ Tukey

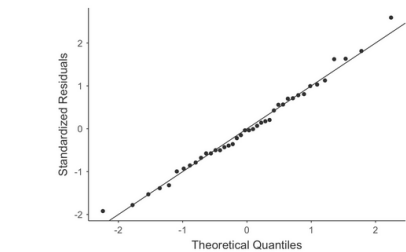
☐ Scheffe

☒ Bonferroni

☐ Holm

Résultats

```
##
## ANOVA
##
## ANOVA
##
##               Sum of Squares    df    Mean Square    F    p
## -----
## Groupe          11085         2         5542.5    6.47    0.004
## Residuals       21719        27         800.7
##
##
## ASSUMPTION CHECKS
## Test for Homogeneity of Variances (Levene's)
##
##           F    df1    df2    p
## -----
## 0.322    2    27    0.726
##
##
## POST HOC TESTS
## Post Hoc Comparisons - Groupe
##
##           Groupe    Mean Difference    SE    df    t    p    p-bonferroni
## -----
## 1 - 2          28.2    11.3    27.0    2.502    0.017    0.051
## 1 - 3          39.1    11.3    27.0    3.470    0.001    0.004
## 2 - 3          10.9    11.3    27.0    0.962    0.348    1.000
```



Test de Kruskal-Wallis

Saisie des données

	Gestes	Erreurs
1	encouragés	2
2	encouragés	3
3	encouragés	3
4	encouragés	5
5	encouragés	6
6	encouragés	6
7	encouragés	6
8	encouragés	6
9	encouragés	8
10	encouragés	8
11	encouragés	10
12	encouragés	12
13	permis	6
14	permis	8
15	permis	8
16	permis	9
17	permis	9
18	permis	9
19	permis	9
20	permis	11
21	permis	13
22	permis	13
23	permis	14
24	permis	14
25	interdits	10
26	interdits	12
27	interdits	14
28	interdits	14
29	interdits	14
30	interdits	14
31	interdits	14
32	interdits	15
33	interdits	16
34	interdits	20
35	interdits	21
36	interdits	26

Choix du test

Analyses → ANOVA → One Way ANOVA (Kruskal-Wallis)

Data

Analyses

Exploration

T-Tests

ANOVA

Regression

Frequencies

Gestes

1 encouragés

2 encouragés

3 encouragés

4 encouragés

5 encouragés

6 encouragés

7 encouragés

8 encouragés

9 encouragés

10 encouragés

11 encouragés

12 encouragés

13 permis

ANOVA

Repeated Measures ANOVA

ANCOVA

MANCOVA

Non-Parametric

One Way ANOVA
Kruskal-Wallis

Repeated Measures ANOVA
Friedman

8

10

12

6

Choix des options

One-way ANOVA (Non-parametric)

→

Dependent Variables

Erreurs

→

Grouping Variable

Gestes

☐ DSCF pairwise comparisons

Résultats

```
##
## ONE-WAY ANOVA (NON-PARAMETRIC)
##
## Kruskal-Wallis
## _____
##          χ²      df    p
## _____
## Erreurs   23.6    2    < .001
## _____
##
```

b) *Comparaisons multiples selon la méthode de Bonferroni*

1) **Hypothèses**

$$H_0[jk] : \mu_j = \mu_k$$

$$H_1[jk] : \mu_j \neq \mu_k$$

2) **Seuil**

$$\alpha = 0.05$$

3) **Valeurs empiriques**

$$t_{jk} = \frac{|\bar{x}_j - \bar{x}_k|}{\sqrt{\left(\frac{1}{n_j} + \frac{1}{n_k}\right) \hat{\sigma}^2}}$$

$$\text{Avec } \hat{\sigma}^2 = CM_R = \frac{\sum (n_j - 1) s_j^2}{n - m}$$

Dans la situation que nous analysons :

$$n = 103 \quad m = 4 \quad CM_R = \frac{292.163}{103 - 4} = 2.951$$

Pour faciliter l'écriture des résultats, ordonnons les groupes selon leur moyenne et numérotons-les :

$$\text{Allemagne} = 1, \text{Angleterre} = 2, \text{France} = 3, \text{USA} = 4.$$

i. *Allemagne - Angleterre*

$$t_{12} = \frac{|1.79 - 2.61|}{\sqrt{\left(\frac{1}{24} + \frac{1}{28}\right) \times 2.951}} \approx 1.716$$

iv. *Angleterre - France*

$$t_{23} = \frac{|2.61 - 2.73|}{\sqrt{\left(\frac{1}{28} + \frac{1}{26}\right) \times 2.951}} \approx 0.256$$

ii. *Allemagne - France*

$$t_{13} = \frac{|1.79 - 2.73|}{\sqrt{\left(\frac{1}{24} + \frac{1}{26}\right) \times 2.951}} \approx 1.933$$

v. *Angleterre - USA*

$$t_{24} = \frac{|2.61 - 3.76|}{\sqrt{\left(\frac{1}{28} + \frac{1}{25}\right) \times 2.951}} \approx 2.433$$

iii. *Allemagne - USA*

$$t_{14} = \frac{|1.79 - 3.76|}{\sqrt{\left(\frac{1}{24} + \frac{1}{25}\right) \times 2.951}} \approx 4.013$$

vi. *France - USA*

$$t_{34} = \frac{|2.73 - 3.76|}{\sqrt{\left(\frac{1}{26} + \frac{1}{25}\right) \times 2.951}} \approx 2.140$$

$$p = \min[1, m(m-1) \times \text{Prob}(t(n-m) > |t_{\text{emp}}|)]$$

i. *Allemagne - Angleterre*

$$p_{12} = .534$$

ii. *Allemagne - France*

$$p_{13} = .334$$

iii. *Allemagne - USA*

$$p_{14} < .001$$

iv. *Angleterre - France*

$$p_{23} = 1.000$$

v. *Angleterre - USA*

$$p_{24} = .100$$

vi. *France - USA*

$$p_{34} = .207$$

	n_i	\bar{x}_i	s_i
<i>France</i>	26	2.73	1.89
<i>Allemagne</i>	24	1.79	1.58
<i>Angleterre</i>	28	2.61	1.34
<i>Etats-Unis</i>	25	3.76	2.01

Degré	Effectif	Moyenne	Écart-type
Maternelle	19	6.1	1.5
1 ^{ere}	20	6.6	1.8
2 ^e	15	7.7	2.0
3 ^e	17	8.7	1.5

1) **Hypothèses**

$$H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4$$

$$H_1 : (\exists k)(\exists l) \mu_k \neq \mu_l$$

2) **Seuil**

$$\alpha = 0.05$$

3) **Valeur empirique de la variable de décision**

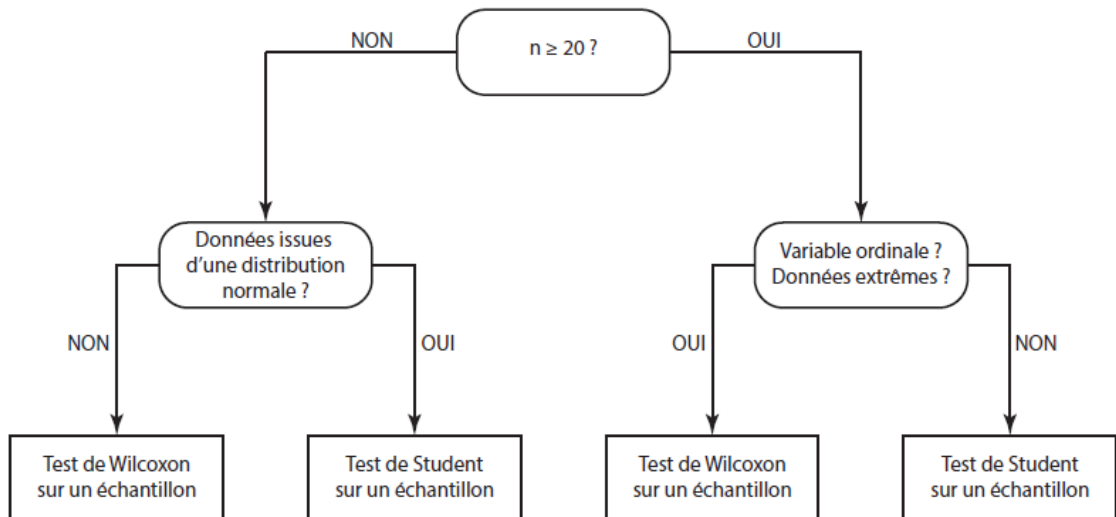
$$m = 4, n = 71, \bar{x} = 7.2014.$$

$$SC_A = \sum_{j=1}^4 n_j (\bar{x}_j - \bar{x})^2 = 72.19$$

$$SC_R = \sum_{j=1}^4 (n_j - 1) s_j^2 = 194.06$$

Table de l'ANOVA				
Source de variation	SC	dl	CM	F_{emp}
expliquée	72.19	3	24.063	8.308
résiduelle	194.06	67	2.896	
totale	266.25	70		

Arbre de décision



Approche paramétrique de deux groupes indépendants

Oui

$$\sigma^2_1 = \sigma^2_2$$

(Variance)

Non

Test de Student sur deux groupes indépendants

Test de Welch sur deux groupes indépendants