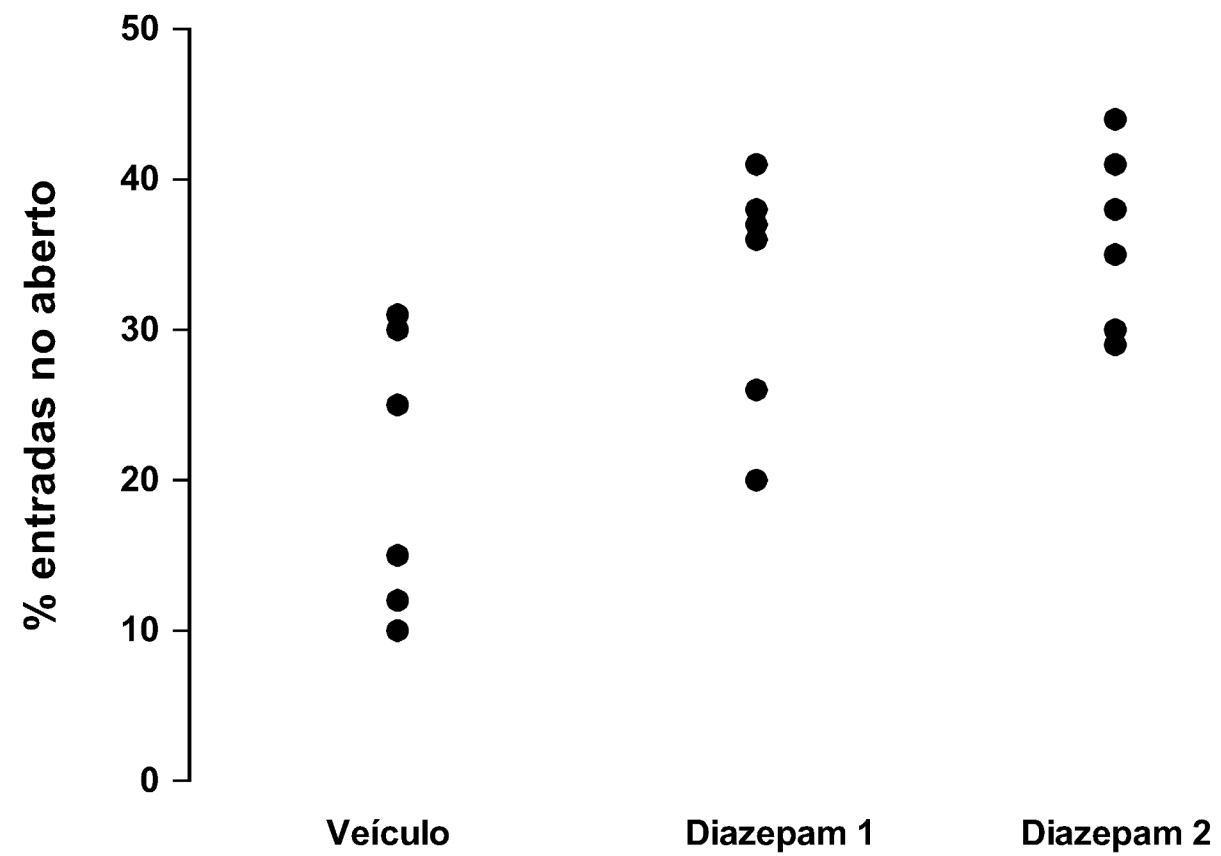
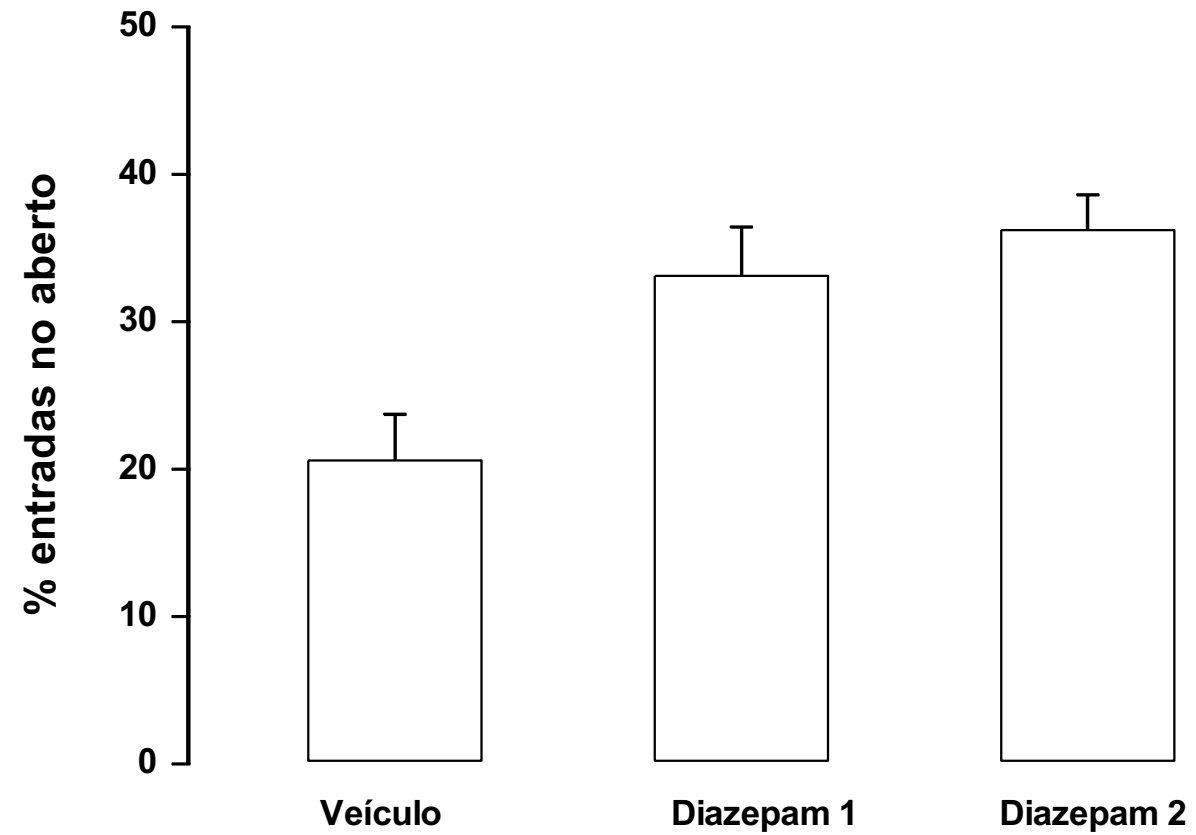


**Seminário 5 a. Experimento com labirinto em cruz elevado:
droga 1: veículo, droga 2: diazepam 1 mg/kg, droga 3:
diazepam 2 mg/kg.**

Droga	% entradas aberto
1,00	15,00
1,00	12,00
1,00	30,00
1,00	25,00
1,00	31,00
1,00	10,00
2,00	20,00
2,00	41,00
2,00	38,00
2,00	36,00
2,00	37,00
2,00	26,00
3,00	44,00
3,00	30,00
3,00	41,00
3,00	29,00
3,00	38,00
3,00	35,00





Médias + EPM, n=6/grupo

Descriptives

perab

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	6	20,5000	9,31128	3,80132	10,7284	30,2716	10,00	31,00
2	6	33,0000	8,14862	3,32666	24,4485	41,5515	20,00	41,00
3	6	36,1667	5,98052	2,44154	29,8905	42,4428	29,00	44,00
Total	18	29,8889	10,19740	2,40355	24,8178	34,9599	10,00	44,00

Test of Homogeneity of Variances

perab

Levene Statistic	df1	df2	Sig.
1,826	2	15	,195

ANOVA

perab

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	823,444	2	411,722	6,540	,009
Within Groups	944,333	15	62,956		
Total	1767,778	17			

perab

Duncan

trat	N	Subset for alpha = 0.05	
		1	2
1	6	20,5000	
2	6		33,0000
3	6		36,1667
Sig.		1,000	,500

Means for groups in homogeneous subsets are displayed.

Anova Fatorial:

Quando você possui duas ou mais
variáveis independentes

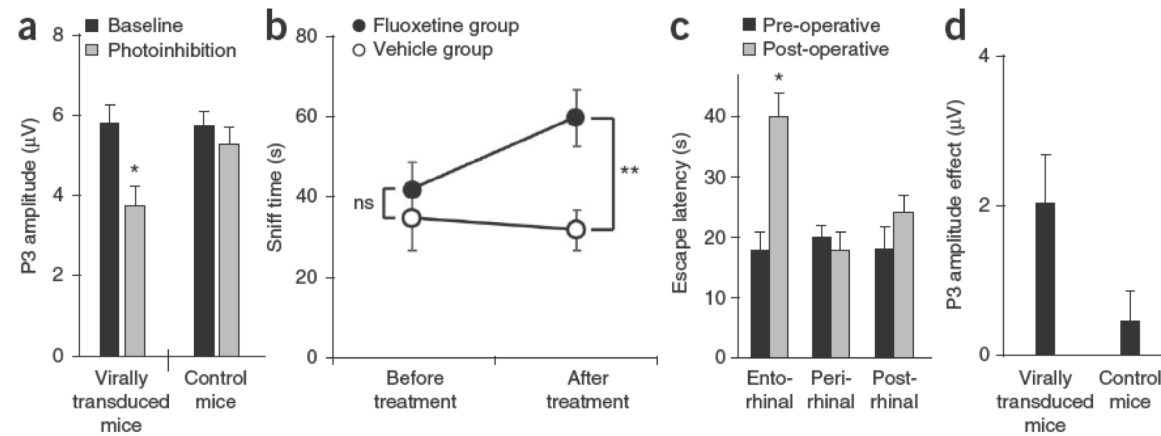
Permite verificar os efeitos principais de
cada variável independente bem como
a interação entre elas

Erroneous analyses of interactions in neuroscience: a problem of significance

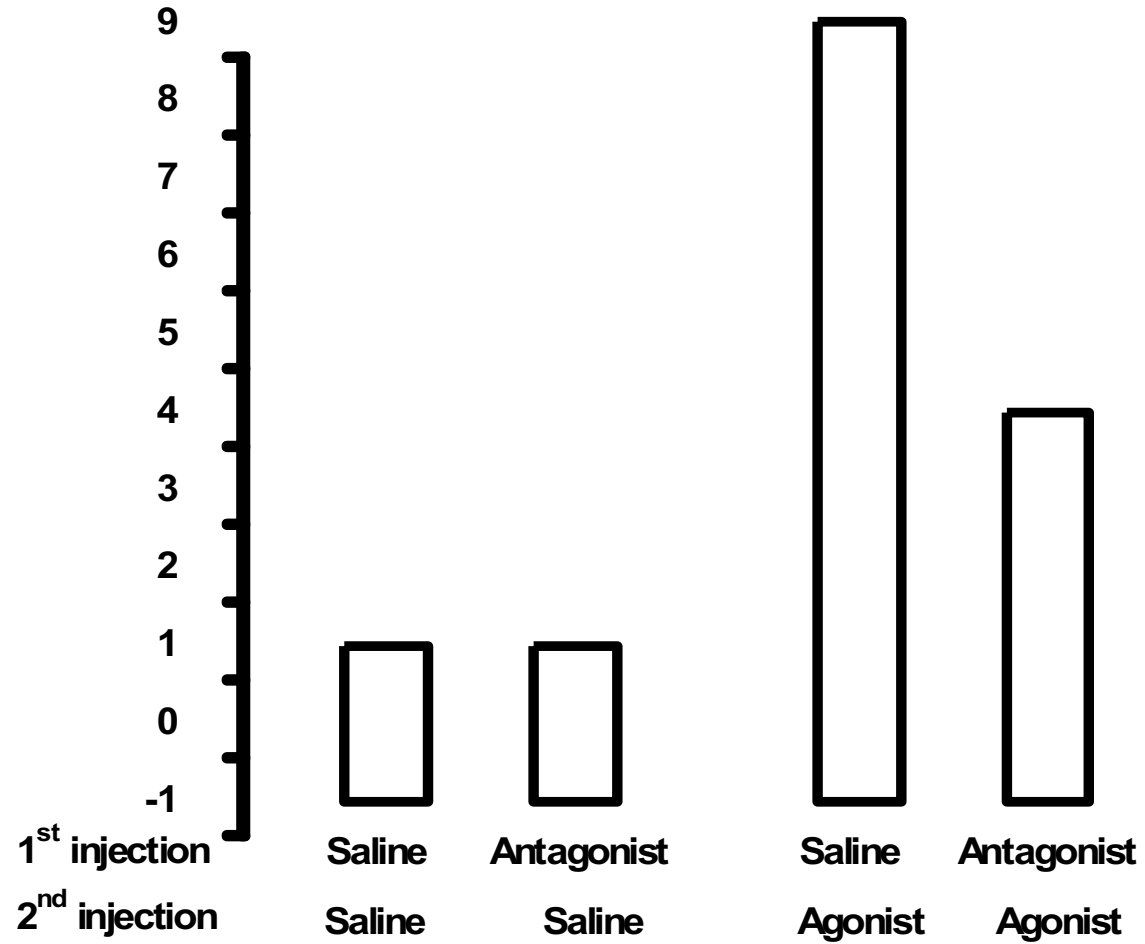
Sander Nieuwenhuis^{1,2}, Birte U Forstmann³ & Eric-Jan Wagenmakers³

Nature Neuroscience 2011

Figure 1 Graphs illustrating the various types of situations in which the error of comparing significance levels occurs. (a) Comparing effect sizes in an experimental group/condition and a control group/condition. (b) Comparing effect sizes during a pre-test and a post-test. (c) Comparing several brain areas and claiming that a particular effect (property) is specific for one of these brain areas. (d) Data presented in a, after taking the difference of the two repeated-measures (photoinhibition and baseline). Error bars indicate s.e.m.; ns, nonsignificant ($P > 0.05$), * $P < 0.05$, ** $P < 0.01$.



Anova Fatorial: exemplo



Dados reais

One-way ANOVA
seguida de
comparações
múltiplas
(Bonferroni)

É a melhor
abordagem?

ANOVA

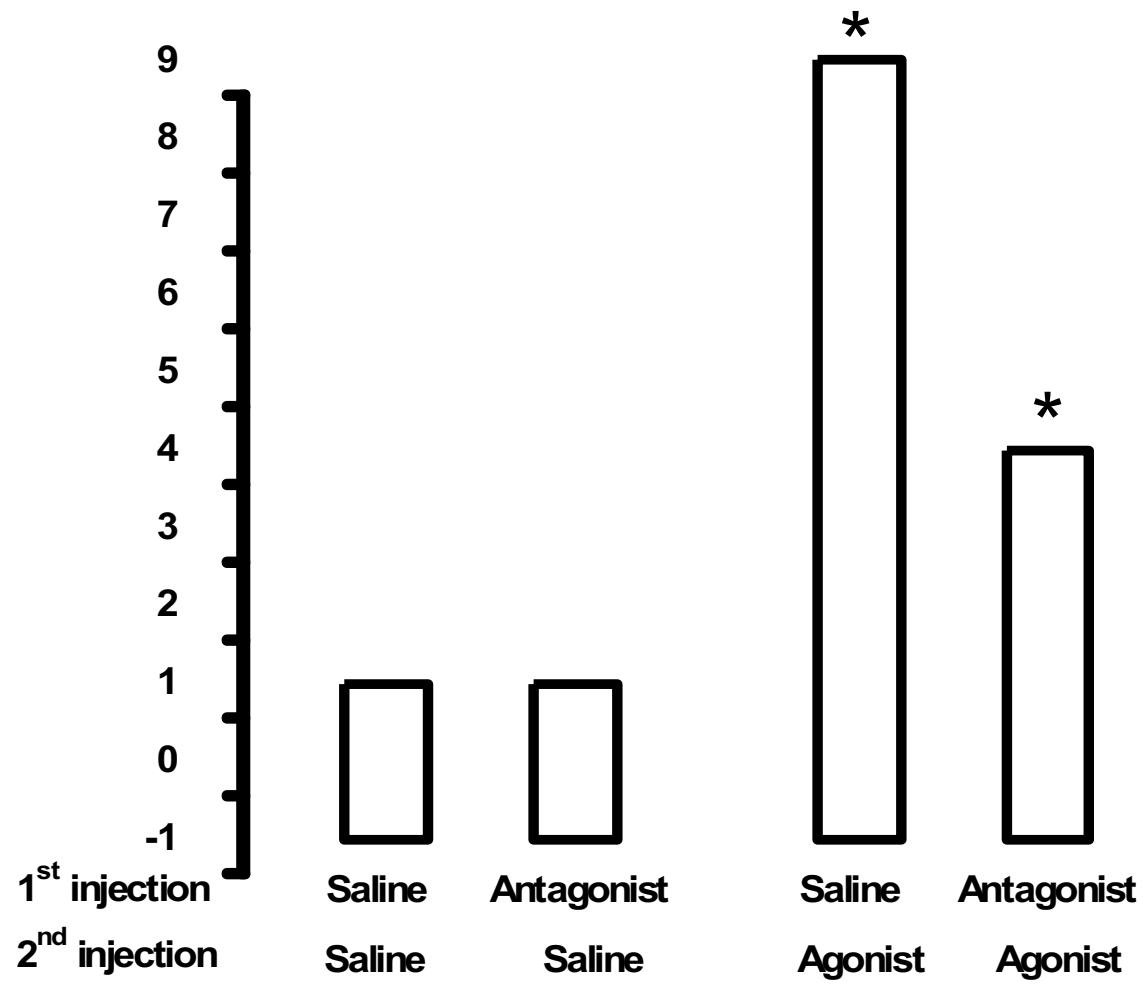
medida					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	128,250	3	42,750	27,360	,000
Within Groups	12,500	8	1,563		
Total	140,750	11			

Multiple Comparisons

Dependent Variable: medida
Bonferroni

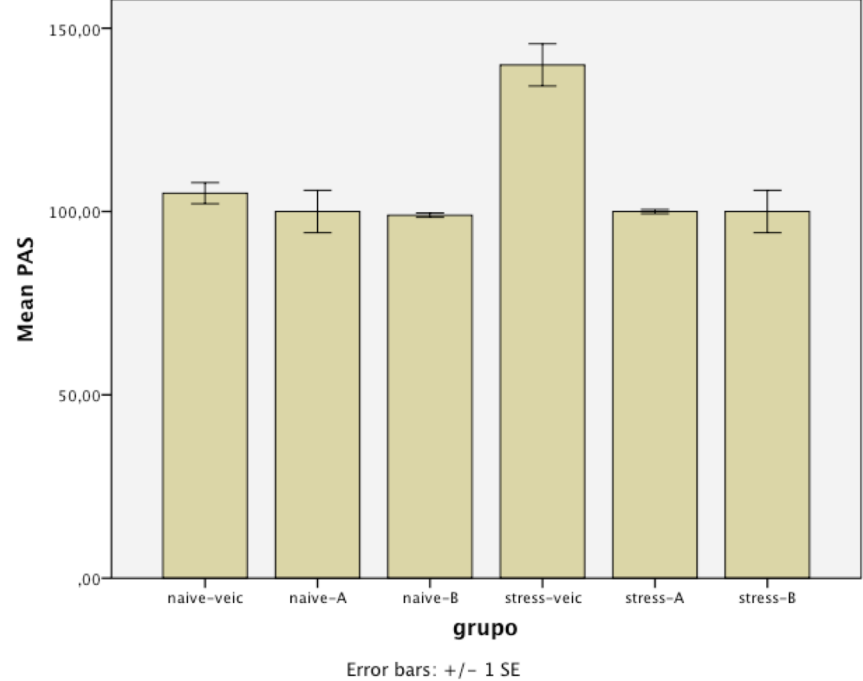
(I) droga	(J) droga	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1,00	2,00	-8,00000*	1,02062	,000	-11,5506	-4,4494
	3,00	,00000	1,02062	1,000	-3,5506	3,5506
	4,00	-3,00000	1,02062	,112	-6,5506	,5506
2,00	1,00	8,00000*	1,02062	,000	4,4494	11,5506
	3,00	8,00000*	1,02062	,000	4,4494	11,5506
	4,00	5,00000*	1,02062	,007	1,4494	8,5506
3,00	1,00	,00000	1,02062	1,000	-3,5506	3,5506
	2,00	-8,00000*	1,02062	,000	-11,5506	-4,4494
	4,00	-3,00000	1,02062	,112	-6,5506	,5506
4,00	1,00	3,00000	1,02062	,112	-,5506	6,5506
	2,00	-5,00000*	1,02062	,007	-8,5506	-1,4494
	3,00	3,00000	1,02062	,112	-,5506	6,5506

*. The mean difference is significant at the .05 level.



Interação entre duas variáveis indica quanto a média de cada célula se afasta do valor esperado baseado na adição dos marginais (indica que o efeito de uma variável sofreu interferência da outra)

Efeito das drogas A e B sobre a pressão sistólica em animais estressados ou não



	controle	drogaA	drogaB		Média do estresse
naive	100	90	98		101,3
	105	100	99		
	110	110	100		
Média do grupo	105 (111)	100 (100)	99 (100)		
Estressado	130	99	90		113,3
	140	100	100		
	150	101	110		
Média do grupo	140 (117)	100 (106)	100 (106)		
Média do tratamento	122,5	100	99,5		107,3

One-way ANOVA seguida de Newman-Keuls

Test of Homogeneity of Variances

PAS

Levene Statistic	df1	df2	Sig.
1,451	5	12	,276

ANOVA

PAS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3910,000	5	782,000	14,349	,000
Within Groups	654,000	12	54,500		
Total	4564,000	17			

PAS

Student-Newman-Keuls^a

grupo	N	Subset for alpha = 0.05	
		1	2
naive-B	3	99,0000	140,0000
naive-A	3	100,0000	
stress-A	3	100,0000	
stress-B	3	100,0000	
naive-veic	3	105,0000	
stress-veic	3		
Sig.		,852	1,000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3,000.

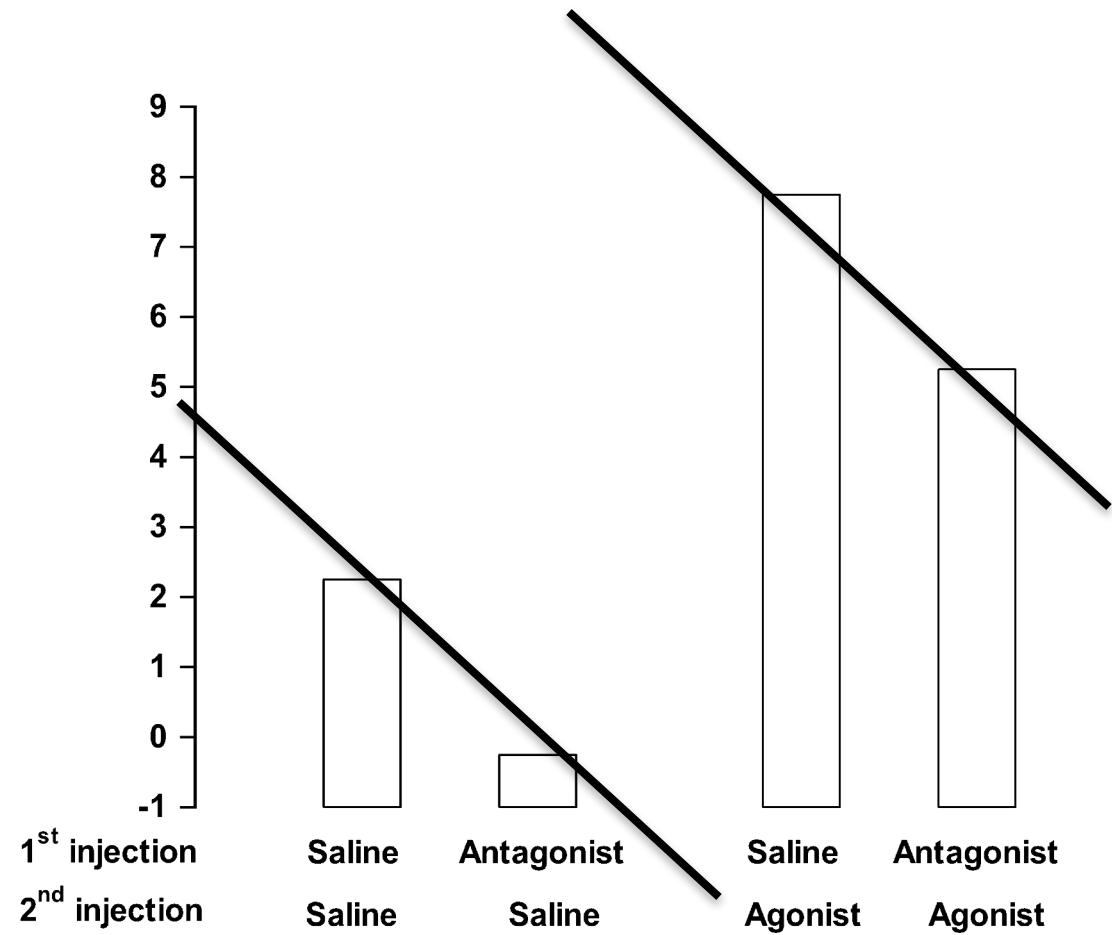
Two-way ANOVA ou ANOVA de dois fatores

Tests of Between-Subjects Effects

Dependent Variable: PAS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3910,000 ^a	5	782,000	14,349	,000
Intercept	207368,000	1	207368,000	3804,917	,000
droga	2071,000	2	1035,500	19,000	,000
estresse	648,000	1	648,000	11,890	,005
droga * estresse	1191,000	2	595,500	10,927	,002
Error	654,000	12	54,500		
Total	211932,000	18			
Corrected Total	4564,000	17			

a. R Squared = ,857 (Adjusted R Squared = ,797)



Dados esperados sem interação

Descriptive Statistics

Dependent Variable: resultado2

droga1	droga2	Mean	Std. Deviation	N
sal	salina	2,0000	1,00000	3
	agonista	8,0000	1,00000	3
	Total	5,0000	3,40588	6
antagonista	salina	,0000	1,00000	3
	agonista	5,5000	,50000	3
	Total	2,7500	3,09435	6
Total	salina	1,0000	1,41421	6
	agonista	6,7500	1,54110	6
	Total	3,8750	3,31748	12

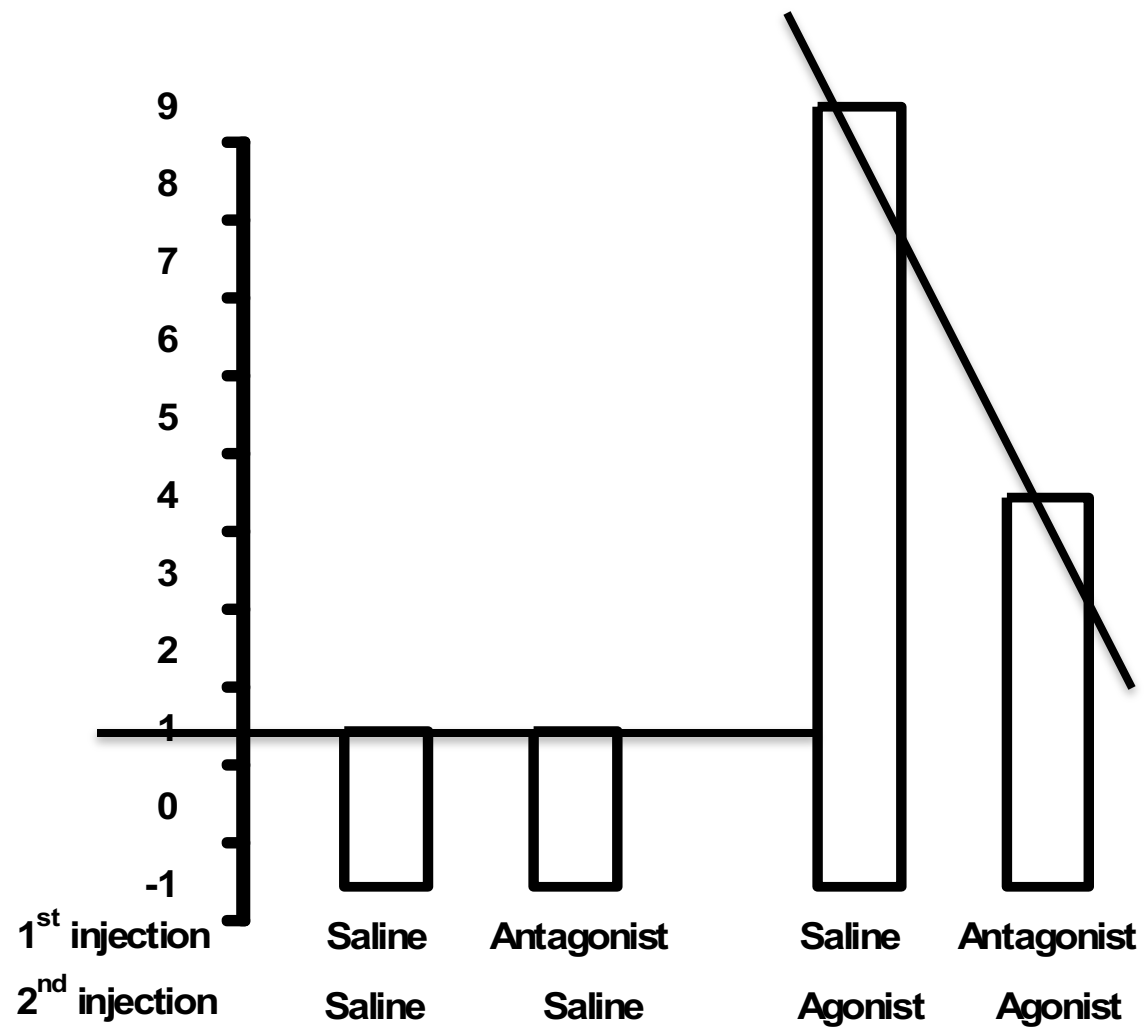
Tests of Between-Subjects Effects

Dependent Variable: resultado2

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	114,562 ^a	3	38,188	47,000	,000
Intercept	180,188	1	180,188	221,769	,000
droga1	15,188	1	15,188	18,692	,003
droga2	99,188	1	99,188	122,077	,000
droga1 * droga2	,188	1	,188	,231	,644
Error	6,500	8	,812		
Total	301,250	12			
Corrected Total	121,062	11			

a. R Squared = ,946 (Adjusted R Squared = ,926)

Exemplo: sem interação



Dados observados (com interação)

Descriptive Statistics

Dependent Variable: resultado1

droga1	droga2	Mean	Std. Deviation	N
sal	salina	1,0000	1,00000	3
	agonista	9,0000	1,00000	3
	Total	5,0000	4,47214	6
antagonista	salina	1,0000	1,00000	3
	agonista	4,0000	1,00000	3
	Total	2,5000	1,87083	6
Total	salina	1,0000	,89443	6
	agonista	6,5000	2,88097	6
	Total	3,7500	3,51943	12

Tests of Between-Subjects Effects

Dependent Variable: resultado1

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	128,250 ^a	3	42,750	42,750	,000
Intercept	168,750	1	168,750	168,750	,000
droga1	18,750	1	18,750	18,750	,003
droga2	90,750	1	90,750	90,750	,000
droga1 * droga2	18,750	1	18,750	18,750	,003
Error	8,000	8	1,000		
Total	305,000	12			
Corrected Total	136,250	11			

a. R Squared = ,941 (Adjusted R Squared = ,919)

Tests of Between-Subjects Effects

Dependent Variable: medida

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	128,250 ^a	3	42,750	27,360	,000
Intercept	168,750	1	168,750	108,000	,000
trat1	18,750	1	18,750	12,000	,009
tra2	90,750	1	90,750	58,080	,000
trat1 * tra2	18,750	1	18,750	12,000	,009
Error	12,500	8	1,563		
Total	309,500	12			
Corrected Total	140,750	11			

a. R Squared = ,911 (Adjusted R Squared = ,878)

E quando ocorreram interações?

E se não ocorreram interações, só efeito dos fatores principais?

Anova fatorial: outro exemplo

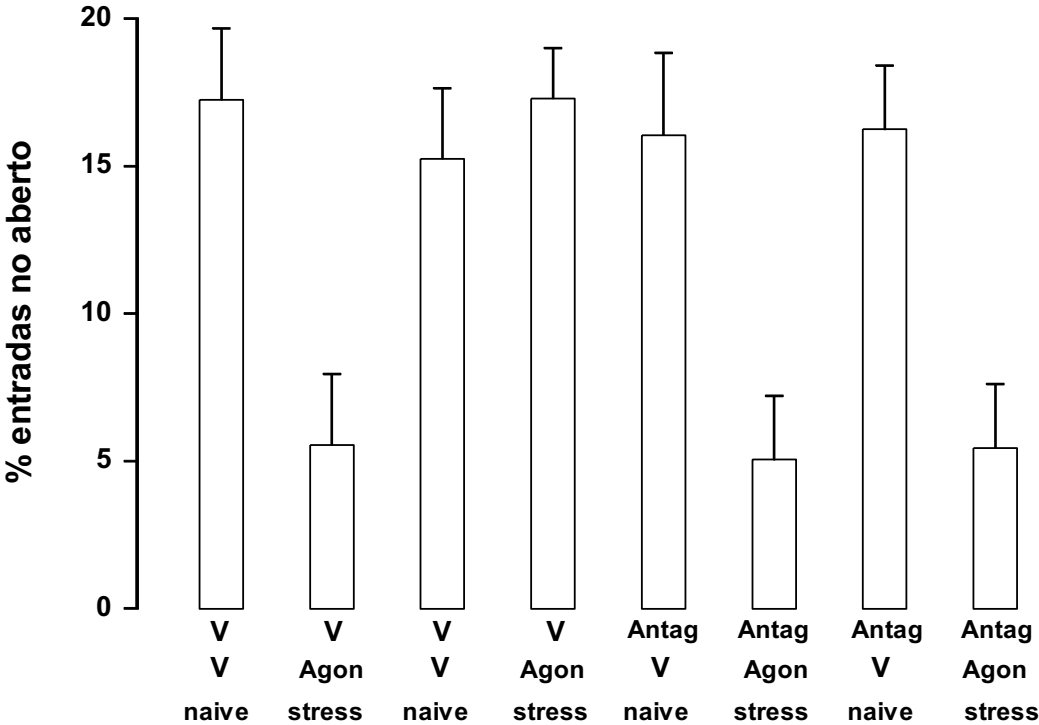
<u>Grupo</u>	<u>Trat1</u>	<u>Tra2</u>	<u>Stress</u>
1	Vei	Vei	Sem
2	Vei	Vei	Com
3	Vei	Ago	Sem
4	Vei	Ago	Com
5	Antag	Vei	Sem
6	Antag	Vei	Com
7	Antag	Ago	Sem
8	Antag	Ago	com

Descriptives

percentagem de entradas no aberto

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1,00	4	17,2500	3,86221	1,93111	11,1044	23,3956	13,00	21,00
2,00	4	5,2500	6,18466	3,09233	-4,5912	15,0912	,00	12,00
3,00	5	15,2000	3,27109	1,46287	11,1384	19,2616	12,00	20,00
4,00	8	17,2500	5,82482	2,05939	12,3803	22,1197	4,00	23,00
5,00	3	16,0000	5,29150	3,05505	2,8552	29,1448	12,00	22,00
6,00	5	5,0000	5,19615	2,32379	-1,4519	11,4519	,00	12,00
7,00	5	16,2000	4,02492	1,80000	11,2024	21,1976	12,00	22,00
8,00	5	5,4000	3,84708	1,72047	,6232	10,1768	,00	10,00
Total	39	12,4359	7,04047	1,12738	10,1536	14,7182	,00	23,00

Test of Homogeneity of Variances			
percentagem de entradas no aberto			
Levene Statistic	df1	df2	Sig.
,429	7	31	,877



ANOVA

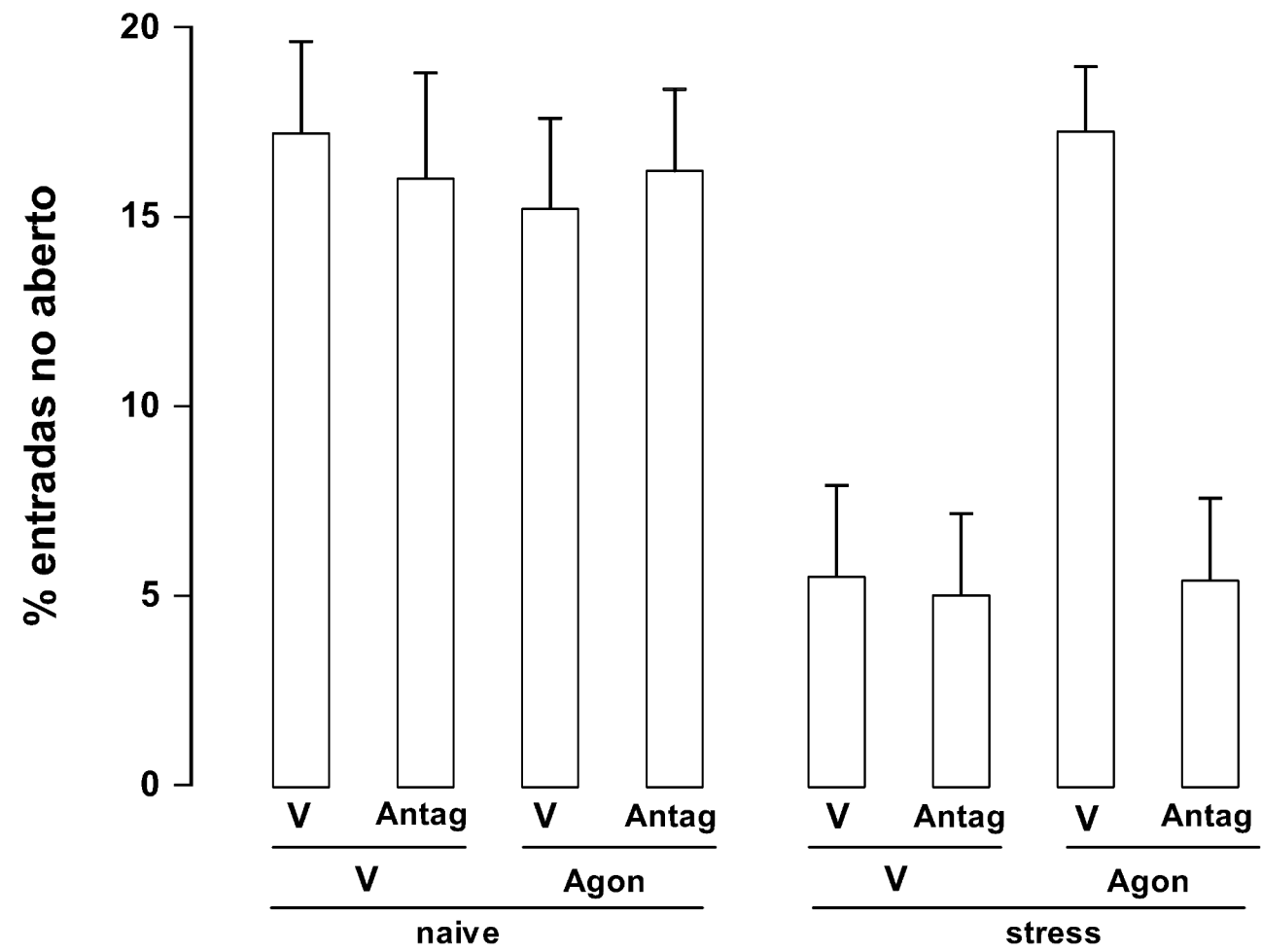
percentagem de entradas no aberto					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1155,790	7	165,113	7,033	,000
Within Groups	727,800	31	23,477		
Total	1883,590	38			

Tests of Between-Subjects Effects

Dependent Variable: percentagem de entradas no aberto

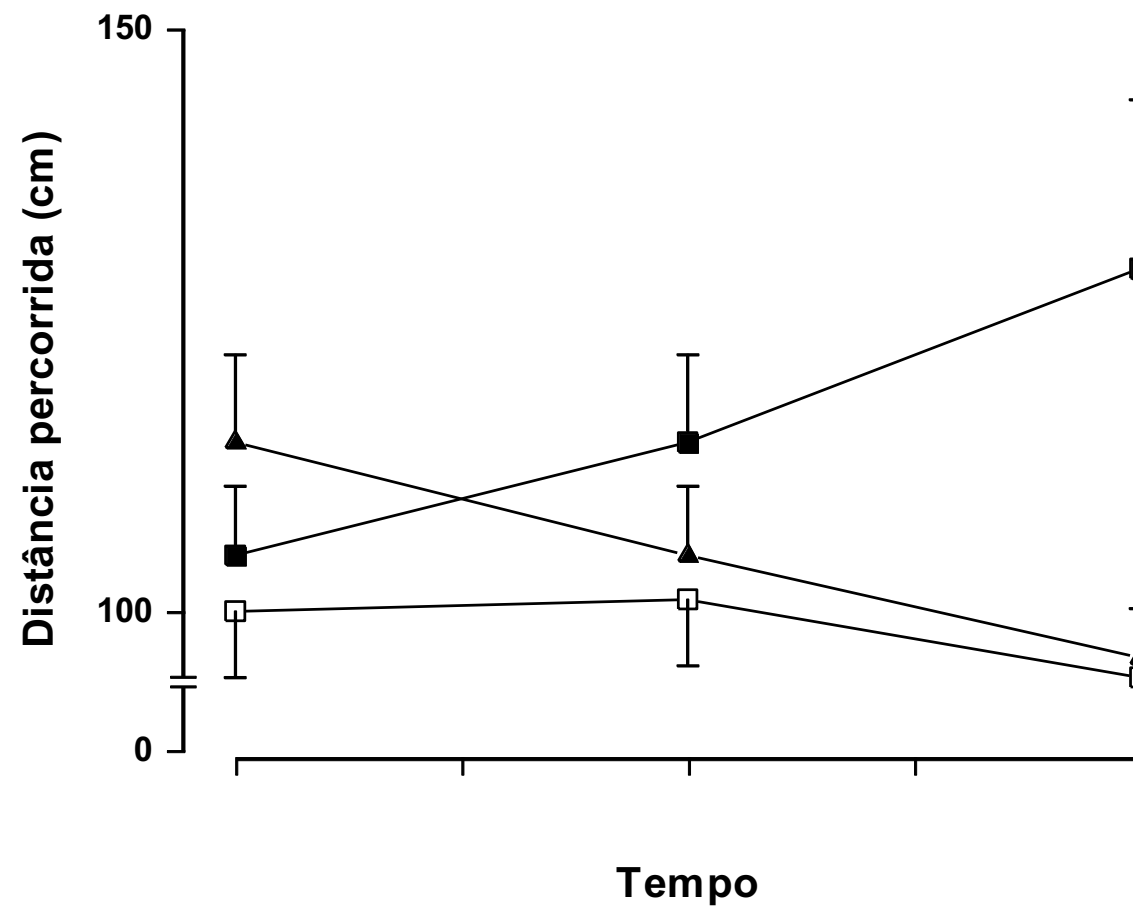
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1155,790 ^a	7	165,113	7,033	,000
Intercept	5411,945	1	5411,945	230,517	,000
trat1	86,743	1	86,743	3,695	,064
tra2	63,300	1	63,300	2,696	,111
stress	573,306	1	573,306	24,419	,000
trat1 * tra2	49,719	1	49,719	2,118	,156
trat1 * stress	79,861	1	79,861	3,402	,075
tra2 * stress	115,486	1	115,486	4,919	,034
trat1 * tra2 * stress	109,093	1	109,093	4,647	,039
Error	727,800	31	23,477		
Total	7915,000	39			
Corrected Total	1883,590	38			

a. R Squared = ,614 (Adjusted R Squared = ,526)



Anova de medidas repetidas

Droga	T1	T2	T3
1,00	120,00	120,00	100,00
1,00	130,00	130,00	90,00
1,00	110,00	110,00	110,00
1,00	80,00	80,00	80,00
1,00	90,00	90,00	90,00
1,00	71,00	71,00	78,00
1,00	114,00	114,00	112,00
1,00	100,00	100,00	98,00
1,00	98,00	98,00	95,00
1,00	97,00	97,00	90,00
2,00	125,00	132,00	240,00
2,00	131,00	135,00	151,00
2,00	120,00	145,00	146,00
2,00	85,00	88,00	90,00
2,00	95,00	99,00	100,00
2,00	74,00	79,00	81,00
2,00	121,00	145,00	146,00
2,00	101,00	112,00	120,00
2,00	99,00	112,00	120,00
2,00	97,00	98,00	100,00
3,00	132,00	125,00	100,00
3,00	135,00	131,00	90,00
3,00	145,00	120,00	120,00
3,00	88,00	85,00	90,00
3,00	99,00	95,00	90,00
3,00	79,00	74,00	70,00
3,00	145,00	121,00	110,00
3,00	112,00	101,00	100,00
3,00	112,00	99,00	95,00
3,00	98,00	97,00	95,00
1,00	120,00	120,00	100,00
1,00	130,00	130,00	90,00
1,00	110,00	110,00	110,00
1,00	80,00	80,00	80,00
1,00	90,00	90,00	90,00
1,00	71,00	71,00	78,00



Como analisar? Múltiplas ANOVAS em cada tempo?

Variable TEMPO1
By Variable TRAT

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	969,2667	484,6333	1,1738	,3245
Within Groups	27	11148,1000	412,8926		
Total	29	12117,3667			

Variable TEMPO2
By Variable TRAT

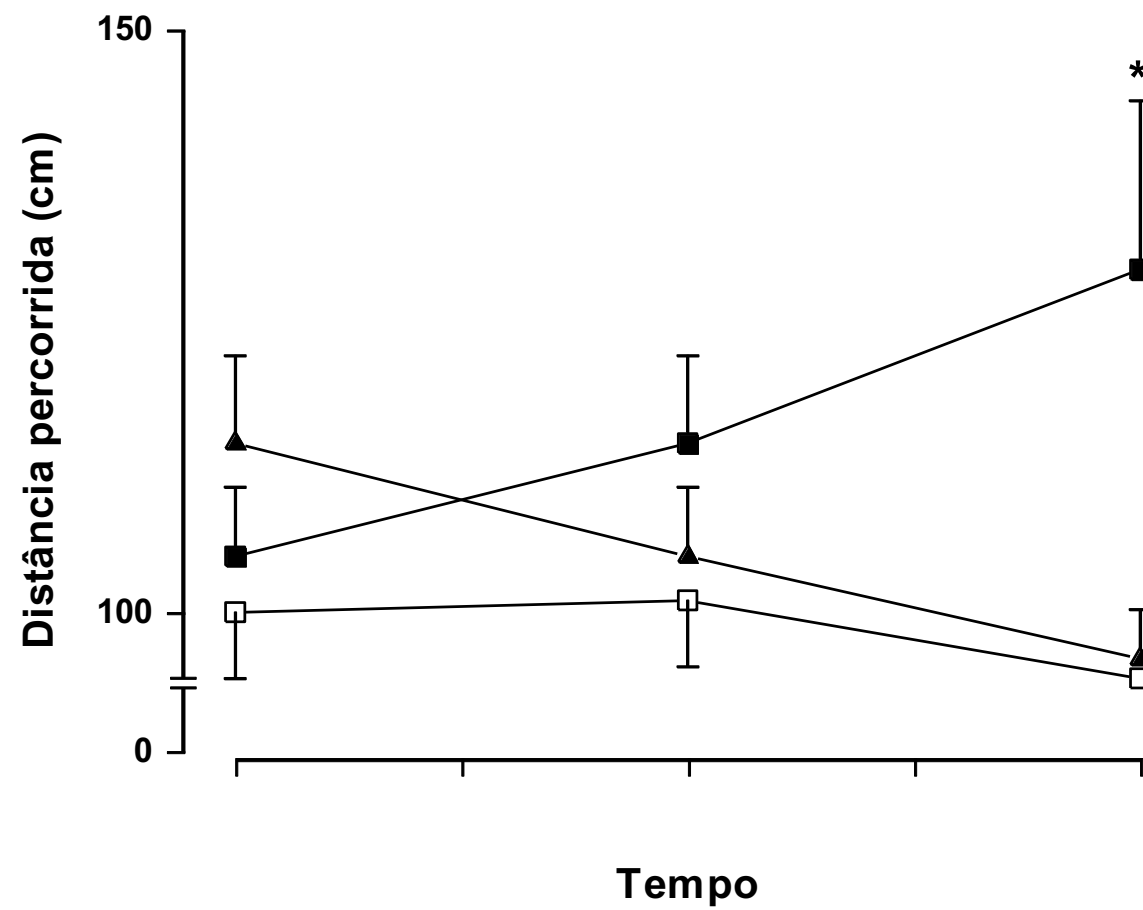
Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	969,2667	484,6333	1,1738	,3245
Within Groups	27	11148,1000	412,8926		
Total	29	12117,3667			

Tempo 3

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	7834,8667	3917,4333	4,8580	,0158
Within Groups	27	21772,5000	806,3889		
Total	29	29607,3667			



Errado!

Anova de medidas repetidas

* * * * * A n a l y s i s o f V a r i a n c e -- design 1 * * * * *

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	39884,71	33	1208,63		
TRAT	6012,06	2	3006,03	2,49	,099

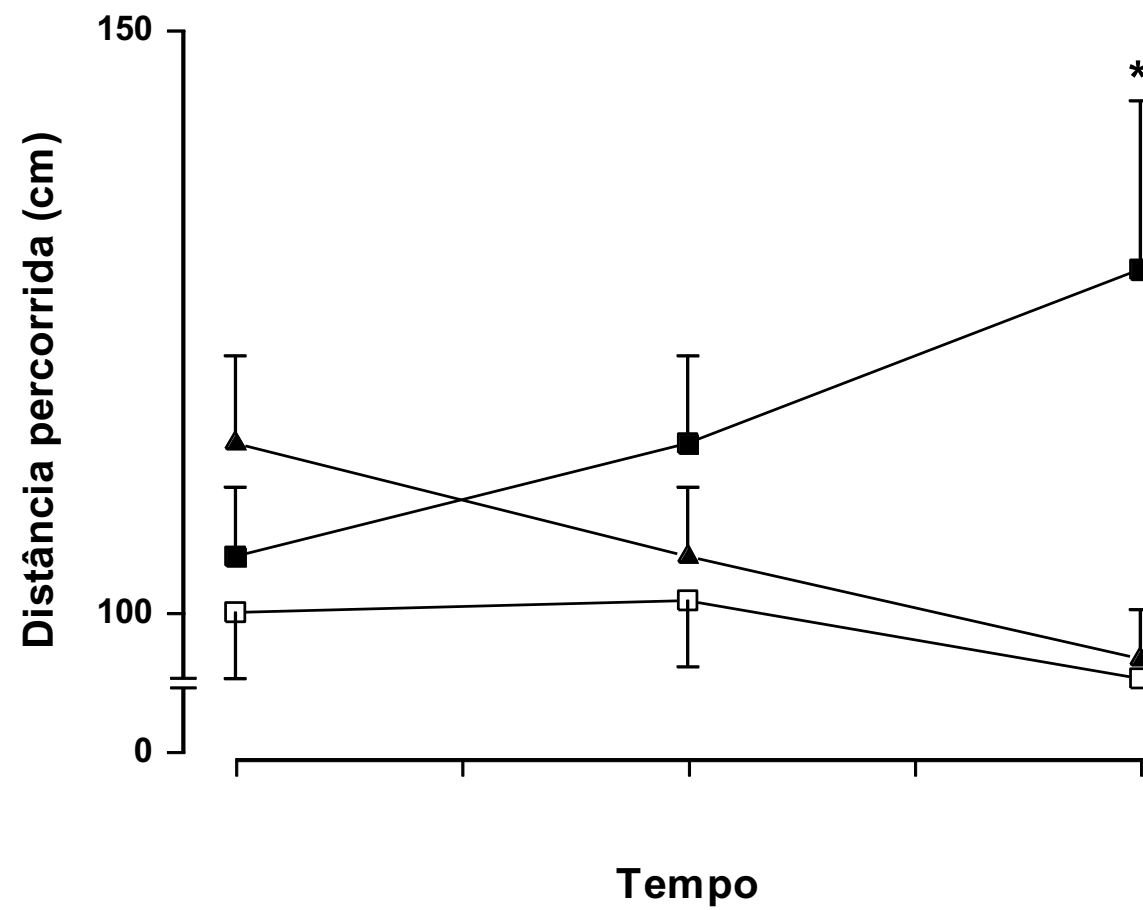
- - - - -

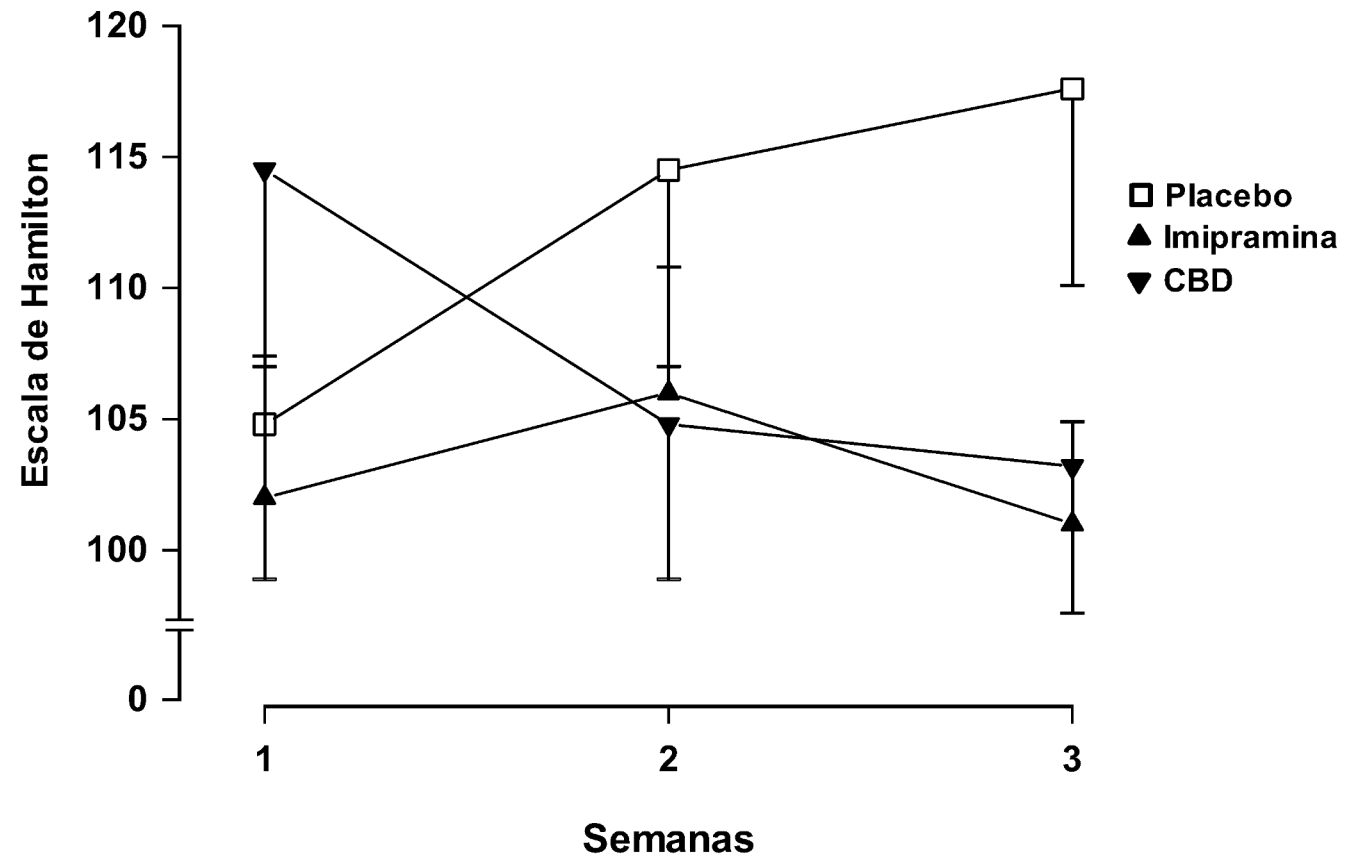
* * * * * A n a l y s i s o f V a r i a n c e -- design 1 * * * * *

Tests involving 'TEMPO' Within-Subject Effect.

AVERAGED Tests of Significance for T using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	10437,20	66	158,14		
TEMPO	4,98	2	2,49	,02	,984
TRAT BY TEMPO	5319,00	4	1329,75	8,41	,000





Outro exemplo de Anova de medidas repetidas

One-way Anova: sem efeitos

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
segunda semana	Between Groups	810,557	2	405,278	,989	,385
	Within Groups	11476,282	28	409,867		
	Total	12286,839	30			
t2	Between Groups	564,997	2	282,498	,733	,489
	Within Groups	10786,100	28	385,218		
	Total	11351,097	30			
t3	Between Groups	1663,871	2	831,935	2,402	,109
	Within Groups	9698,000	28	346,357		
	Total	11361,871	30			

Análise multivariada de medidas repetidas

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1076175,456	1	1076175,456	1007,345	,000
Droga	1289,258	2	644,629	,603	,554
Error	29913,194	28	1068,328		

Mauchly's Test of Sphericity^a

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	,450	21,542	2	,000	,645	,711	,500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.

Design: Intercept+Droga
Within Subjects Design: time

Multivariate Tests^a

Effect		Value	F	Hypothesis df	Error df	Sig.
time	Pillai's Trace	,089	1,316 ^a	2,000	27,000	,285
	Wilks' Lambda	,911	1,316 ^a	2,000	27,000	,285
	Hotelling's Trace	,097	1,316 ^a	2,000	27,000	,285
	Roy's Largest Root	,097	1,316 ^a	2,000	27,000	,285
time * Droga	Pillai's Trace	,789	9,119	4,000	56,000	,000
	Wilks' Lambda	,354	9,184 ^a	4,000	54,000	,000
	Hotelling's Trace	1,419	9,226	4,000	52,000	,000
	Roy's Largest Root	1,025	14,357 ^b	2,000	28,000	,000

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c.

Design: Intercept+Droga
Within Subjects Design: time

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Sphericity Assumed	26,368	2	13,184	,361	,699
	Greenhouse-Geisser	26,368	1,291	20,432	,361	,606
	Huynh-Feldt	26,368	1,423	18,530	,361	,627
	Lower-bound	26,368	1,000	26,368	,361	,553
time * Droga	Sphericity Assumed	1750,167	4	437,542	11,969	,000
	Greenhouse-Geisser	1750,167	2,581	678,064	11,969	,000
	Huynh-Feldt	1750,167	2,846	614,958	11,969	,000
	Lower-bound	1750,167	2,000	875,083	11,969	,000
Error(time)	Sphericity Assumed	2047,188	56	36,557		
	Greenhouse-Geisser	2047,188	36,136	56,653		
	Huynh-Feldt	2047,188	39,844	51,380		
	Lower-bound	2047,188	28,000	73,114		

Anova de medidas repetidas necessita de pré-requisitos adicionais aos da ANOVA: esfericidade: as variâncias dos fatores repetidos bem como suas correlações ao longo das repetições, não devem ser diferentes

Pré-requisito da MANOVA: matrix de variância-covariância: igualdade testada pela estatística Box M (só se importar se os ns não forem iguais e BoxM não for $p < 0.001$)

Mauchly's Test of Sphericity^b

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhous e-Geisser	Huynh-Feldt	Lower-bound
time	,450	21,542	2	,000	,645	,711	,500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.

Design: Intercept+Droga

Within Subjects Design: time

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Sphericity Assumed	26,368	2	13,184	,361	,699
	Greenhouse-Geisser	26,368	1,291	20,432	,361	,606
	Huynh-Feldt	26,368	1,423	18,530	,361	,627
	Lower-bound	26,368	1,000	26,368	,361	,553
time * Droga	Sphericity Assumed	1750,167	4	437,542	11,969	,000
	Greenhouse-Geisser	1750,167	2,581	678,064	11,969	,000
	Huynh-Feldt	1750,167	2,846	614,958	11,969	,000
	Lower-bound	1750,167	2,000	875,083	11,969	,000
Error(time)	Sphericity Assumed	2047,188	56	36,557		
	Greenhouse-Geisser	2047,188	36,136	56,653		
	Huynh-Feldt	2047,188	39,844	51,380		
	Lower-bound	2047,188	28,000	73,114		

Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.
time	Pillai's Trace	,089	1,316 ^a	2,000	27,000	,285
	Wilks' Lambda	,911	1,316 ^a	2,000	27,000	,285
	Hotelling's Trace	,097	1,316 ^a	2,000	27,000	,285
	Roy's Largest Root	,097	1,316 ^a	2,000	27,000	,285
time * Droga	Pillai's Trace	,789	9,119	4,000	56,000	,000
	Wilks' Lambda	,354	9,184 ^a	4,000	54,000	,000
	Hotelling's Trace	1,419	9,226	4,000	52,000	,000
	Roy's Largest Root	1,025	14,357 ^b	2,000	28,000	,000

a. Exact statistic

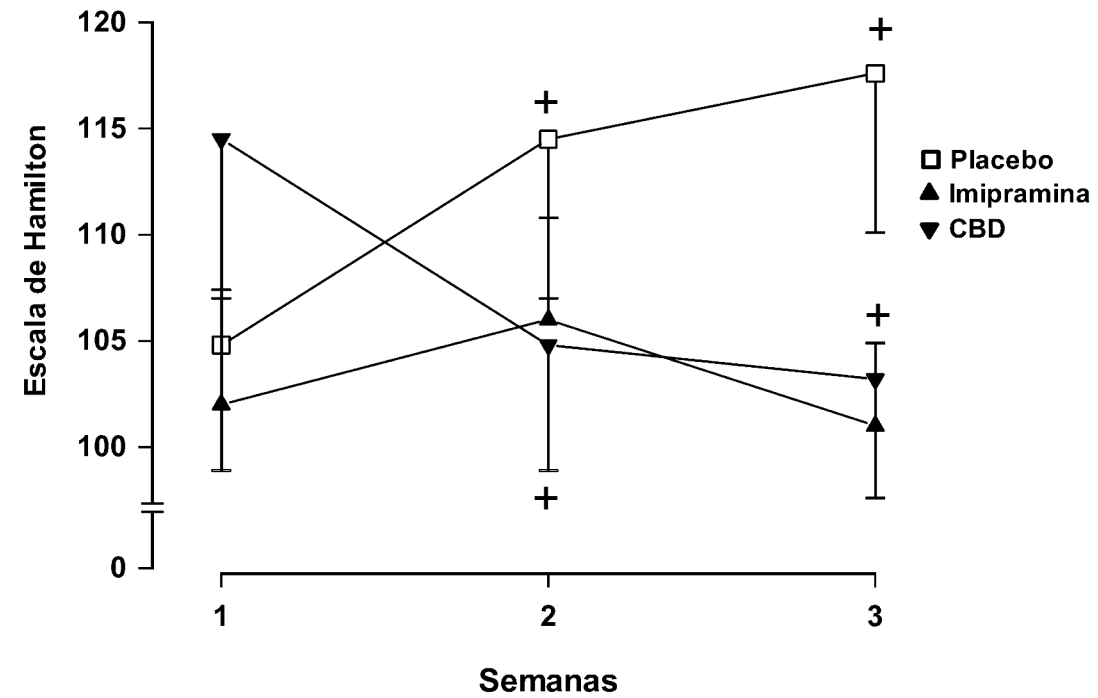
b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c.

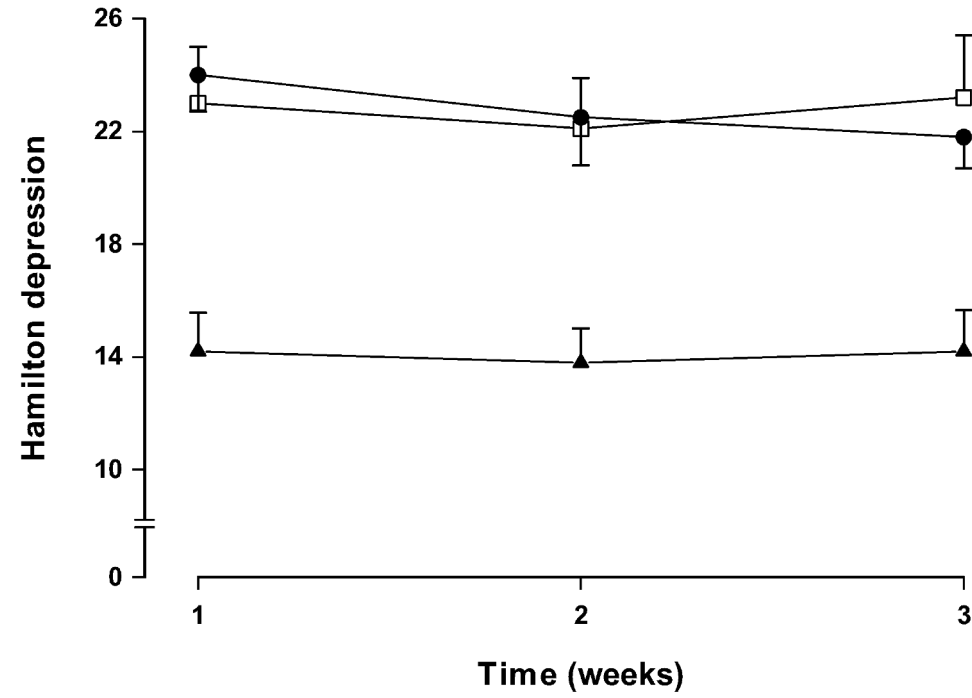
Design: Intercept+Droga

Within Subjects Design: time

Com MANOVA de medidas repetidas em cada tratamento (+ indica diferença da primeira medida)

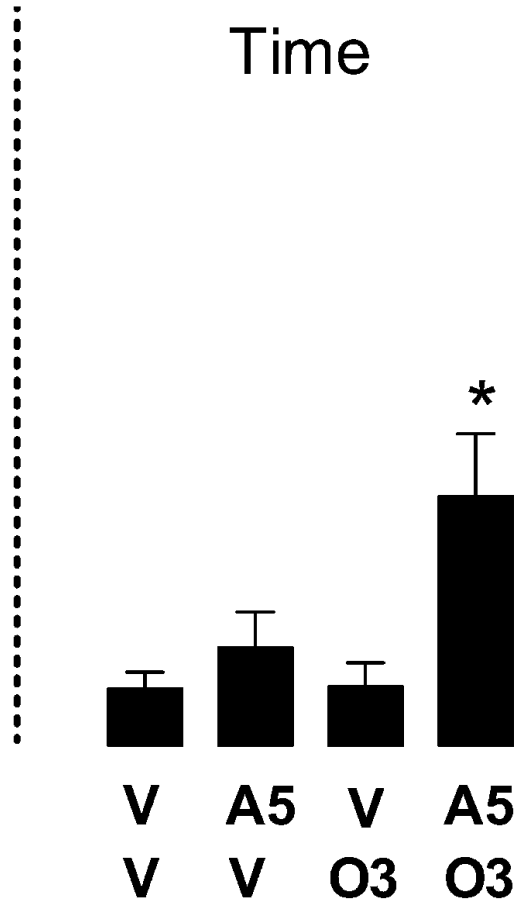


E quando não há interação?



E quando não há interação?

Interação droga 1 versus droga 2:
 $p=0,066$



Resposta ao revisor: We agree that a two- or three-way ANOVA could be a better approach for several results. However, two (or three)-way ANOVA with unequal sizes can be problematic (with a significant lack of power), particularly under moderate heteroscedasticity (Malware MA, Weerahandi S, Statistica Sinica 7, 631, 1997; Weaver B, 2005). This is exactly the case in the present study, since animals that received the injections outside the dIPAG were withdrawal from the groups. Although this problem could be overcome with much larger samples, we think this would be unacceptable for a practical and ethical point of view. Moreover, the possible increase in type I error by performing one-way ANOVAs in our case was compensated by the replication of most of the results in different experiments (with independent groups).

E quando há interação? Preciso fazer sempre as comparações individuais?

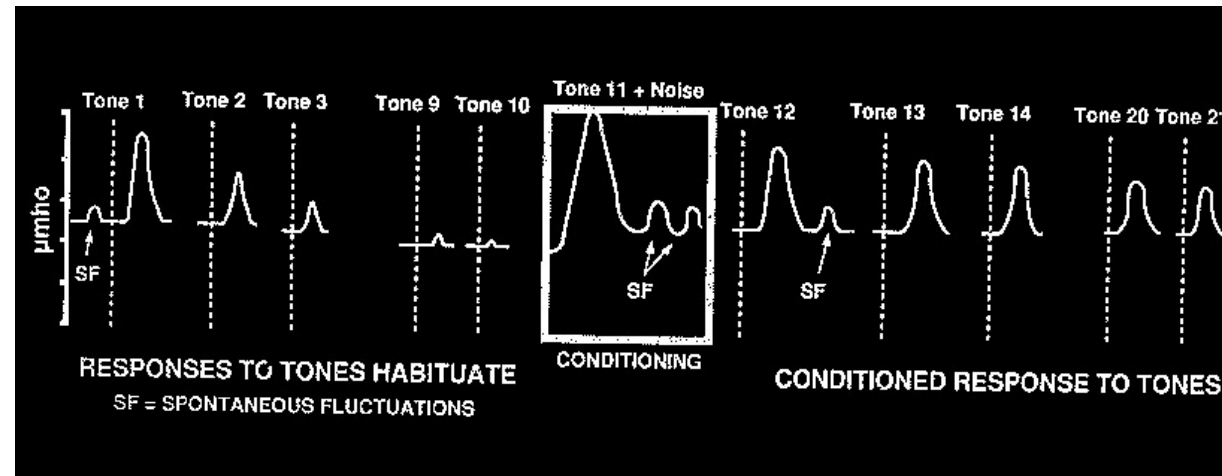
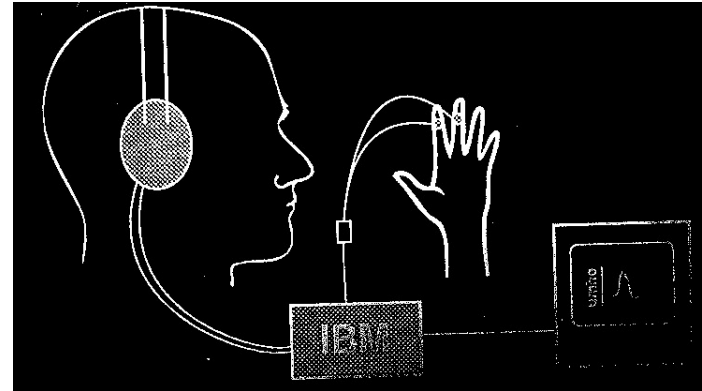
Effects of ritanserin on aversive classical conditioning in humans

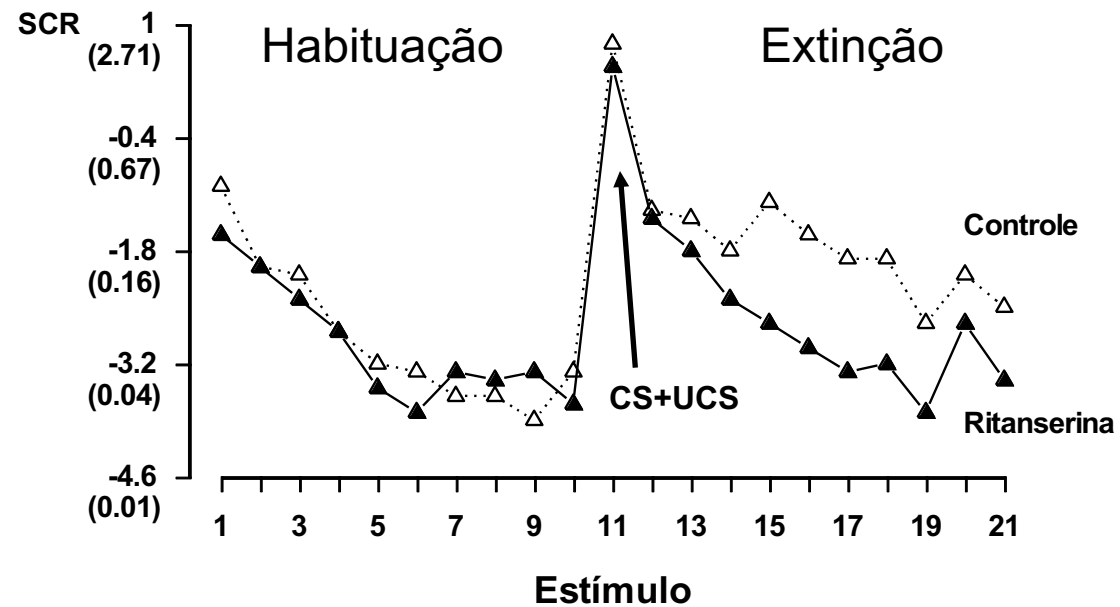
R. Hensman¹, F.S. Guimarães², M. Wang³, and J.F.W. Deakin¹



*Bill Deakin e cols.:
Modelo de
condicionamento
aversivo a sons (1989)*

Psychopharmacology (1991) 104:220–224





ANOVA de medidas repetidas. Fatores independentes: tratamento (2 níveis), fatores repetidos: condicionamento (2), tempo (10)

Resultados: Tratamento: NS

Condicionamento: $F_{1,26}=13,19$, $p<0,001$,

Tempo (* $F_{8,220}=18,62$, $p<0,001$)

Condicionamento x tempo, * $F_{8,218}=1,99$, $p<0,05$

Trat X condicionamento: $F_{1,26}=6,37$, $p=0,018$