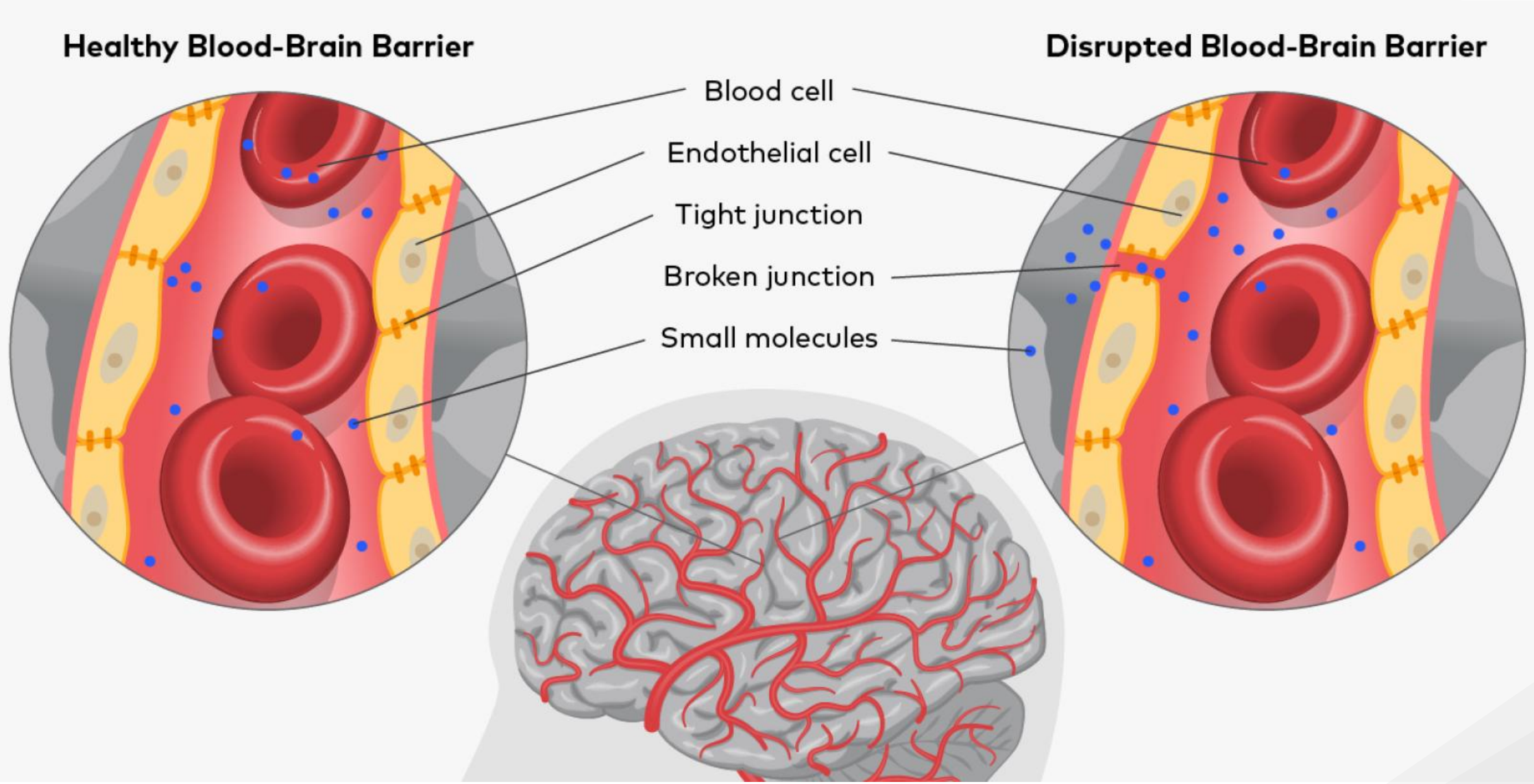
Uso abusivo de anabolizantes

e

alterações do sistema nervoso central

Barreira hematoencefálica (BHE)



Pomara C, et al. Curr Neuropharmacol. 2015;13(1):132-45.

Presença de AR no SNC

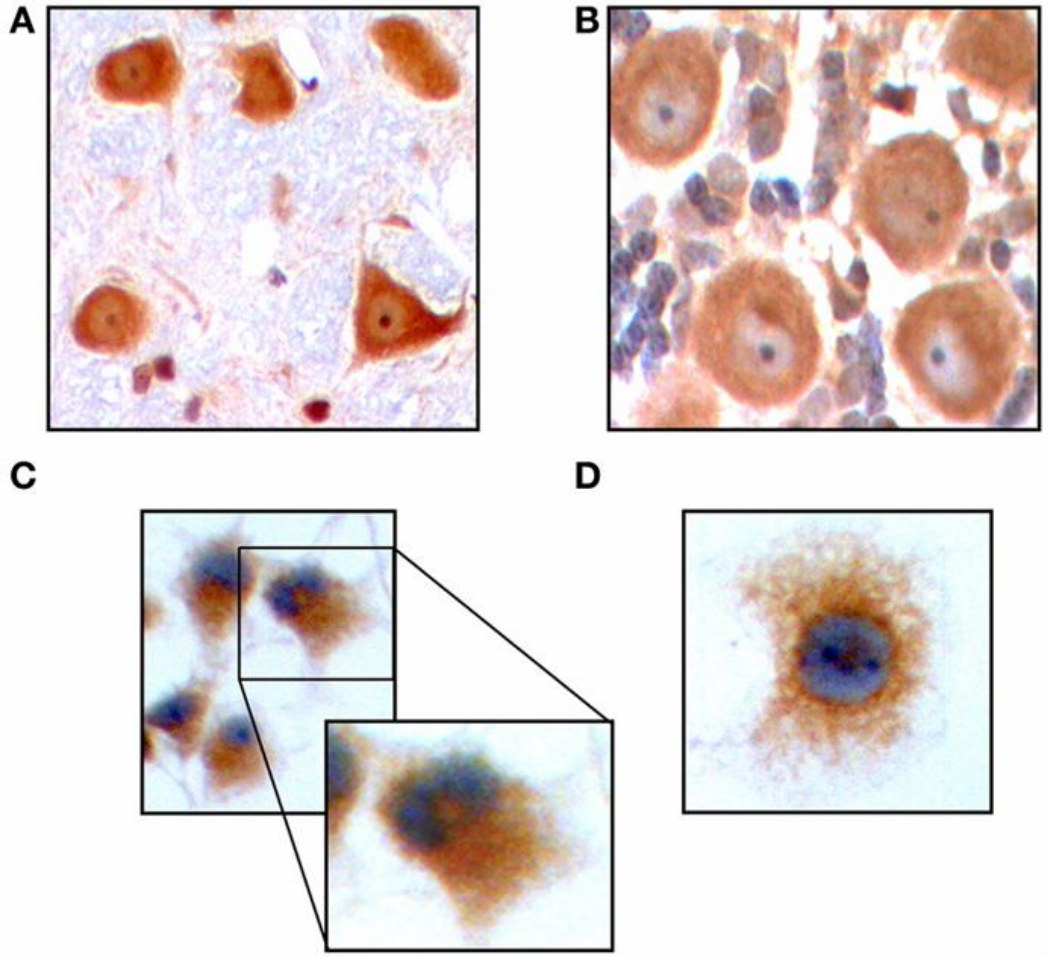
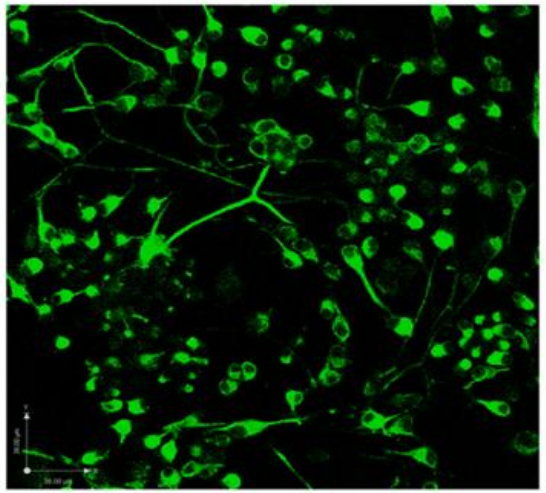
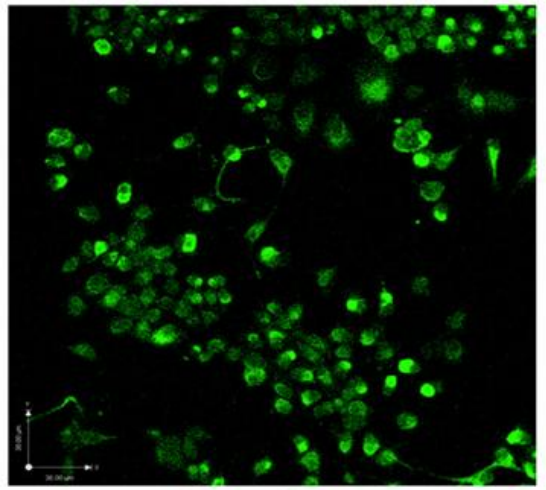


FIGURE 1 | Immunohistochemistry in Purkinje cells of the rat cerebellum demonstrates expression of AR. Original magnification 200 X **(A).** AR expression in neurons of the rat brain stem. Original magnification 200 X **(B).** Immunocytochemistry for AR on PC12 in culture. Details of



control



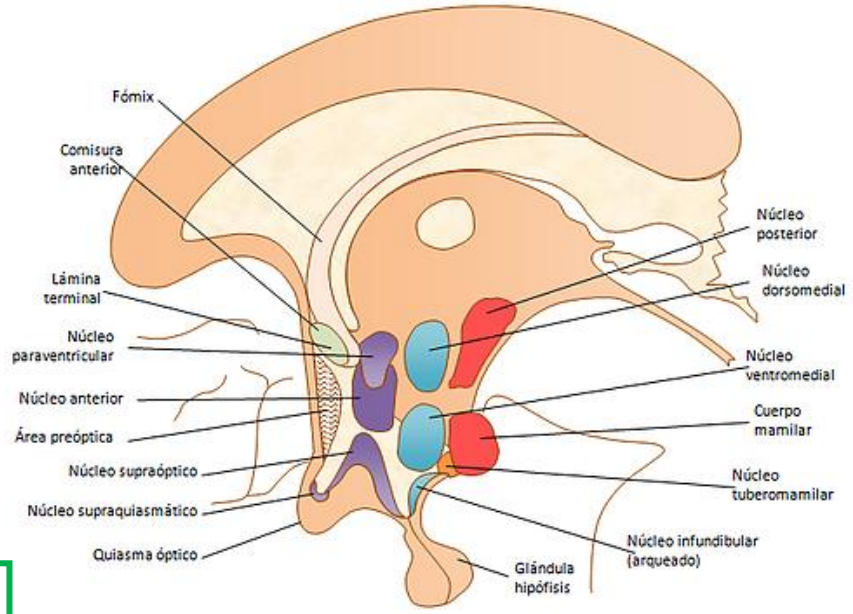
methandienone

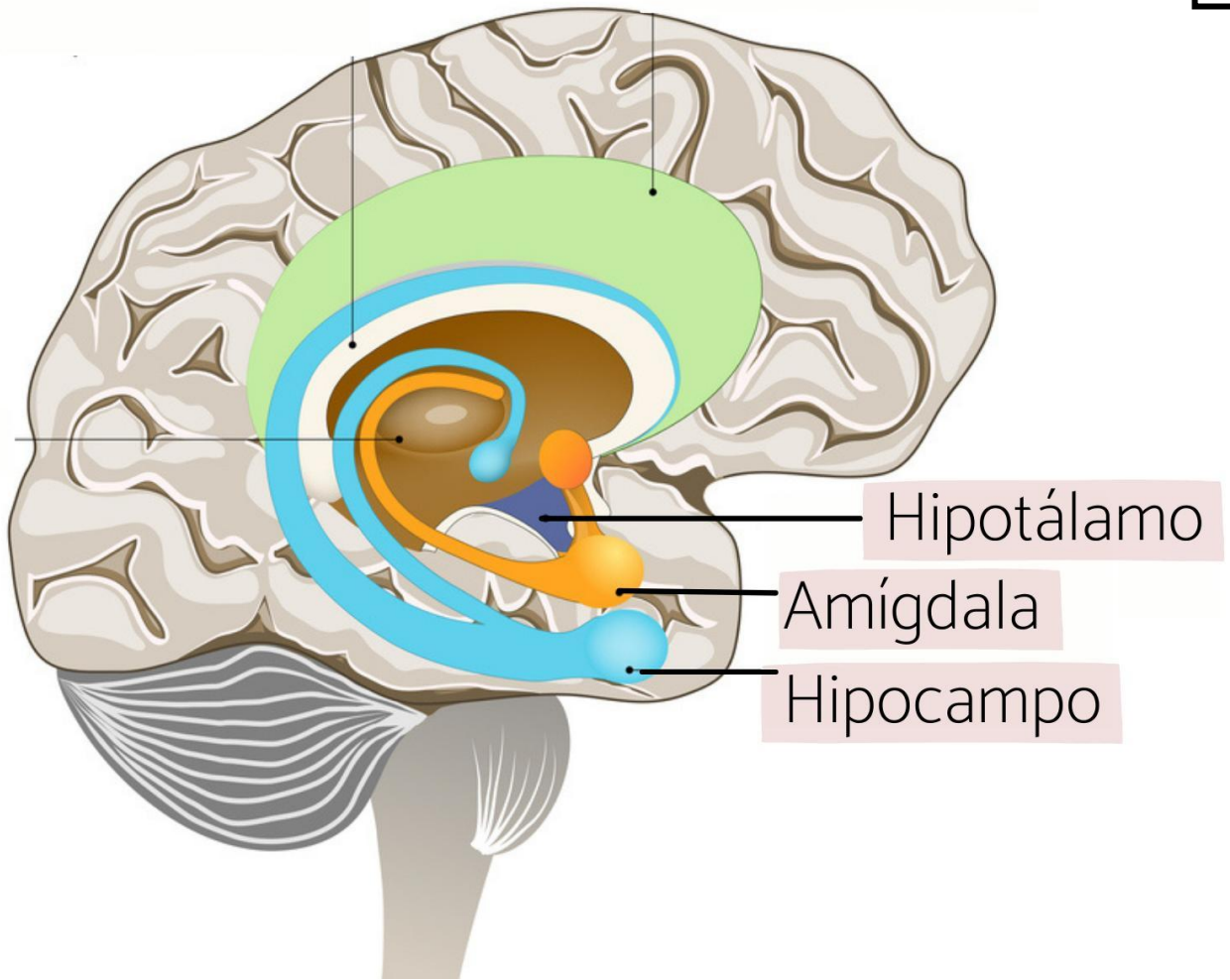
Dianabol

Basile JR, et al. Front Cell Neurosci. 2013;7:69.

AR no sistema nervoso centra

AR presente no hipotálamo, **amígdala**, hipocampo, córtex cerebral e tronco encefálico

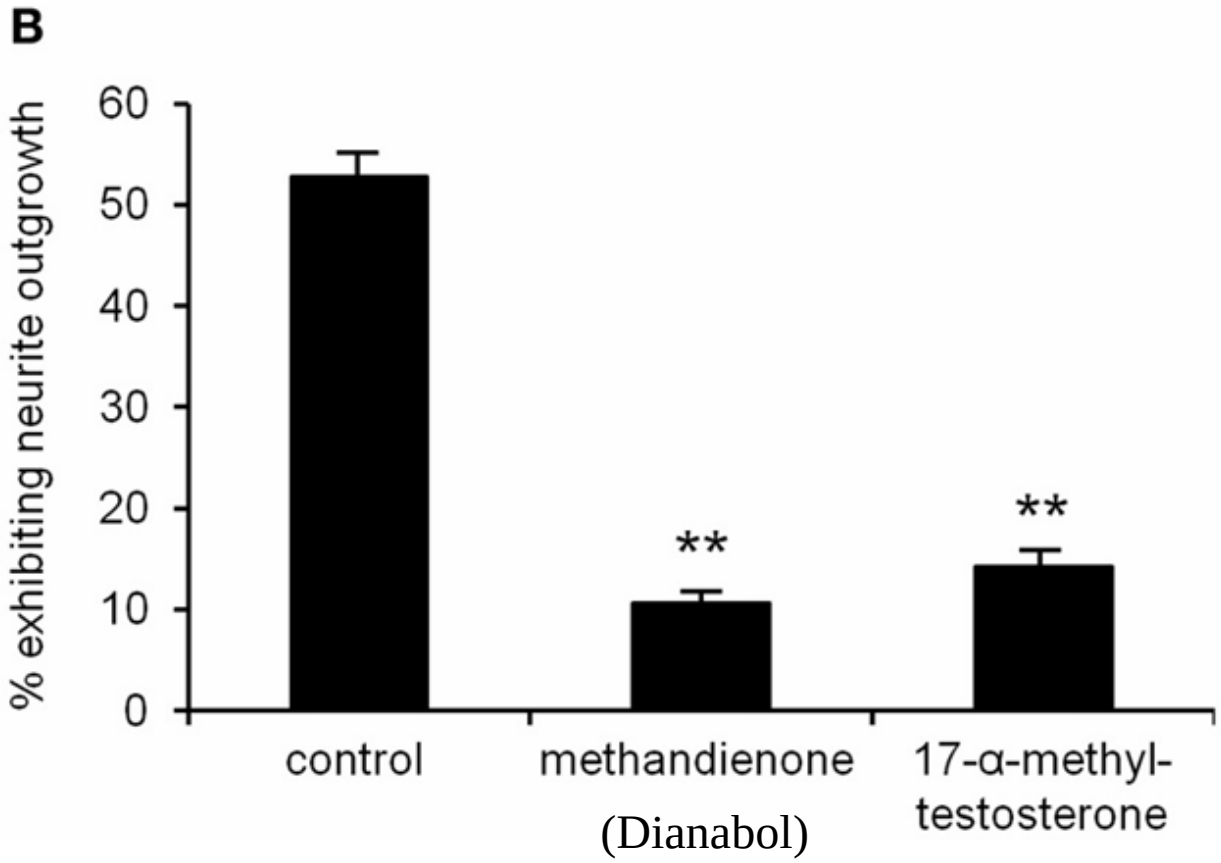


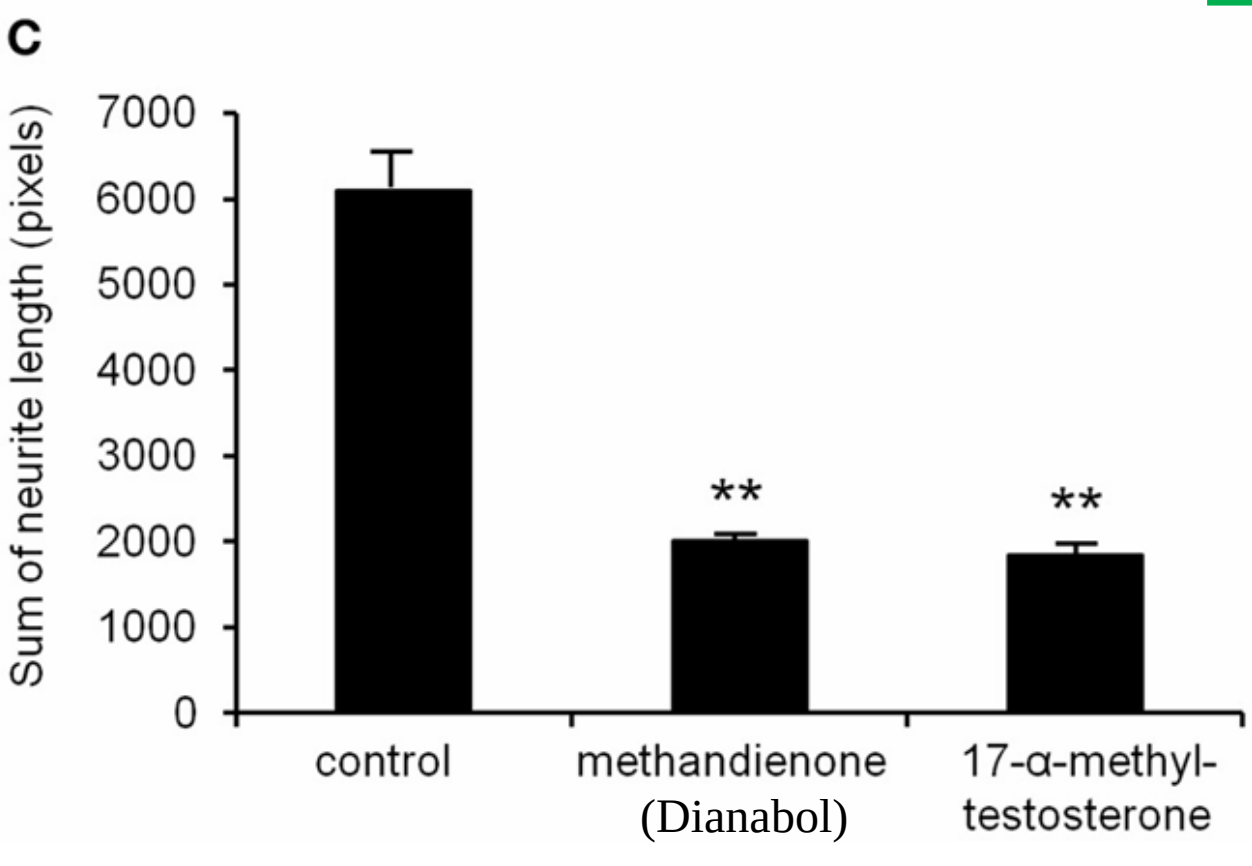


Proliferação, diferenciação, crescimento de neuritos, formação de sinapses, mielinização e morte celular programada.

Pomara C, et al. Curr Neuropharmacol. 2015;13(1):132-45.

Presença de AR no SNC

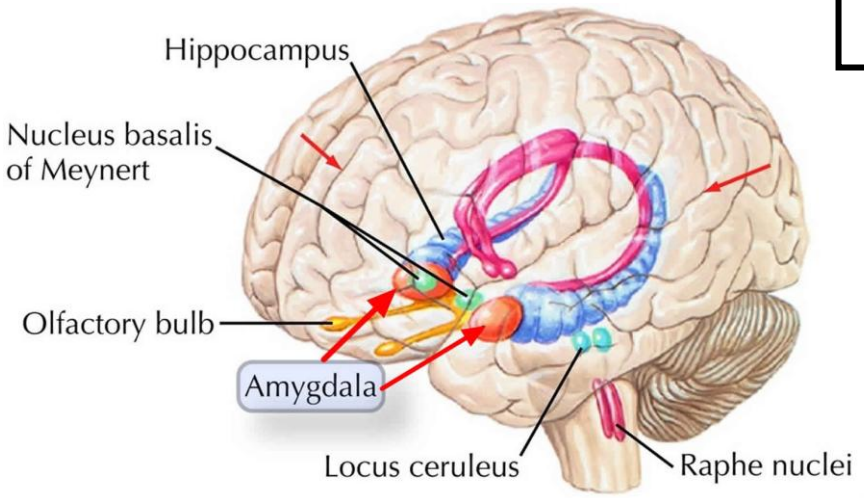


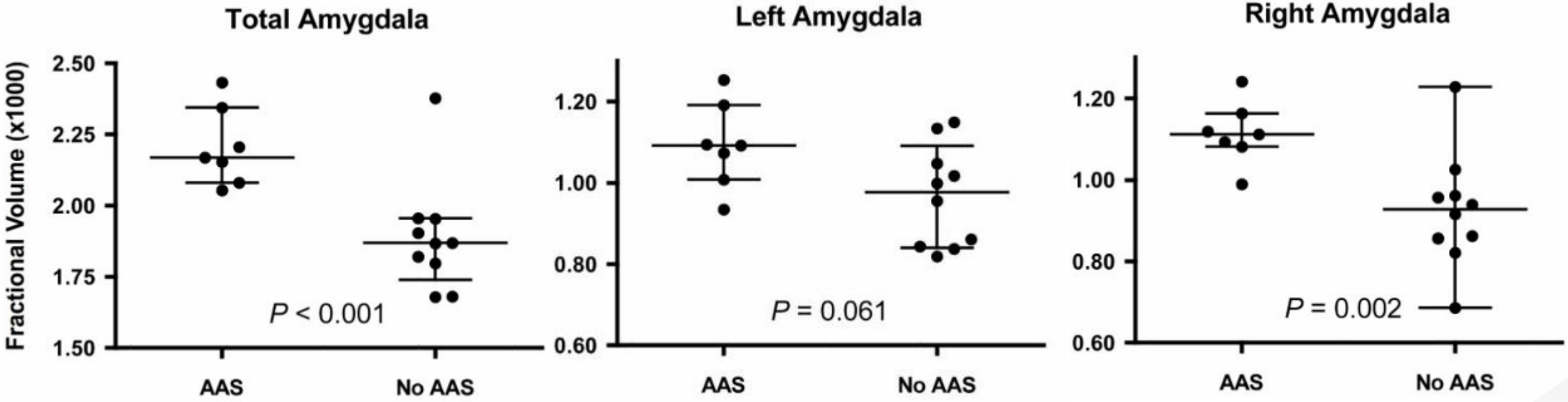


Menor expansão neural e comprimento de neurônios com uso de EAA

Basile JR, et al. Front Cell Neurosci. 2013;7:69.

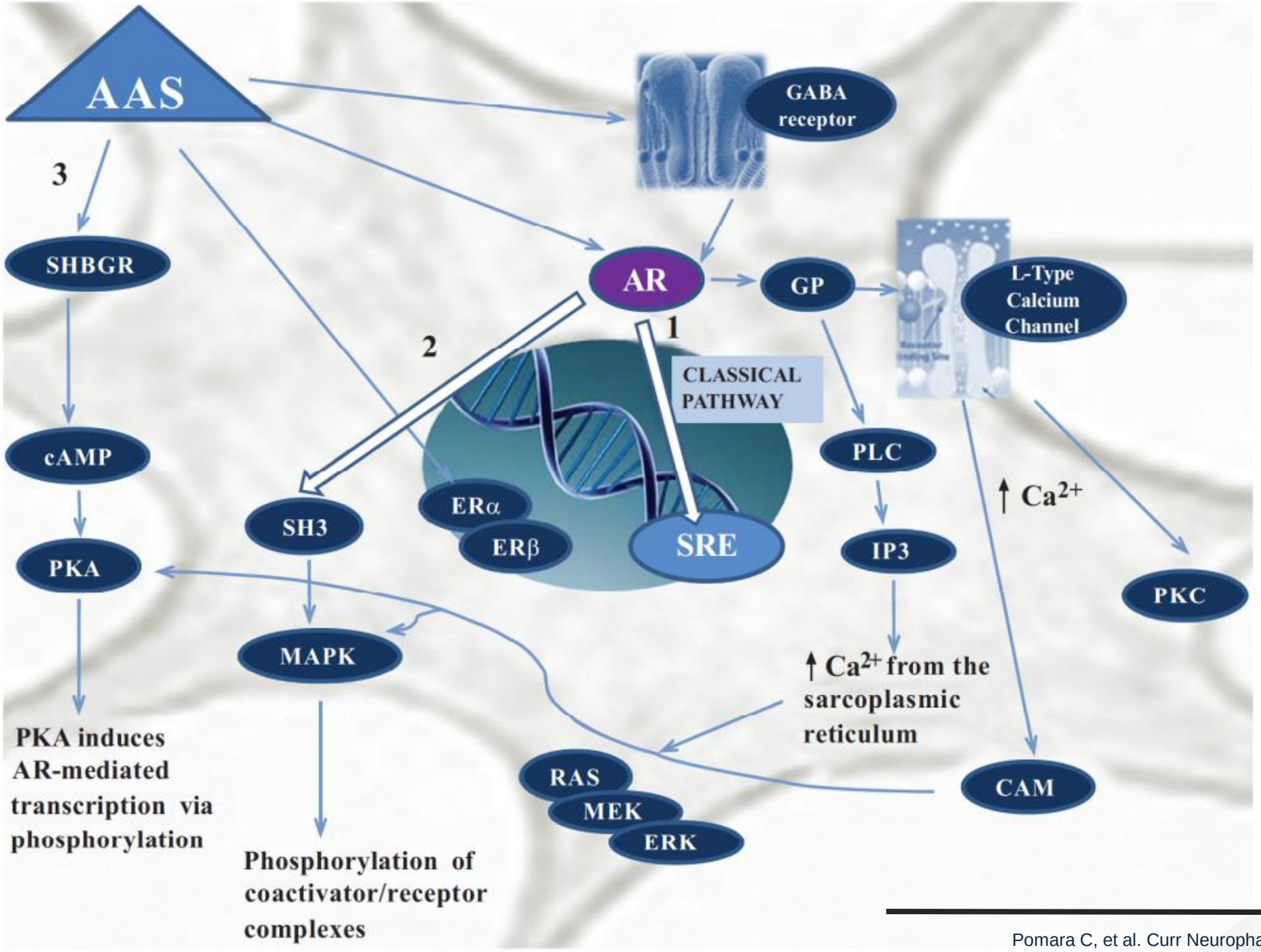
Aumento do volume da amígdala





Processamento emocional (raiva, medo, tristeza e memória) + modulação do comportamento

Kaufman MJ, et al. Drug Alcohol Depend. 2015;154:47-56.



Pomara C, et al. Curr Neuropharmacol. 2015;13(1):132-45.

Apoptose neural

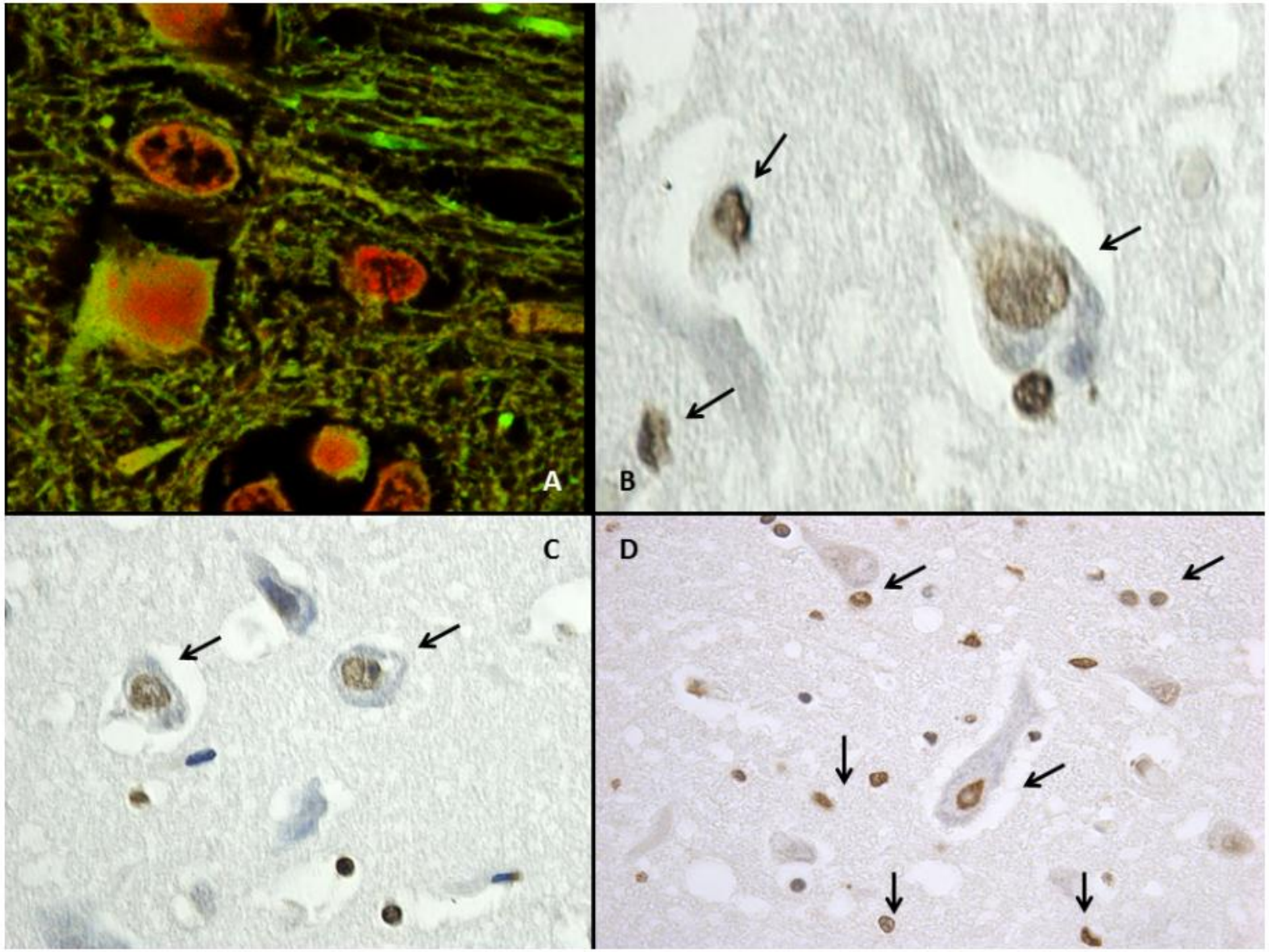
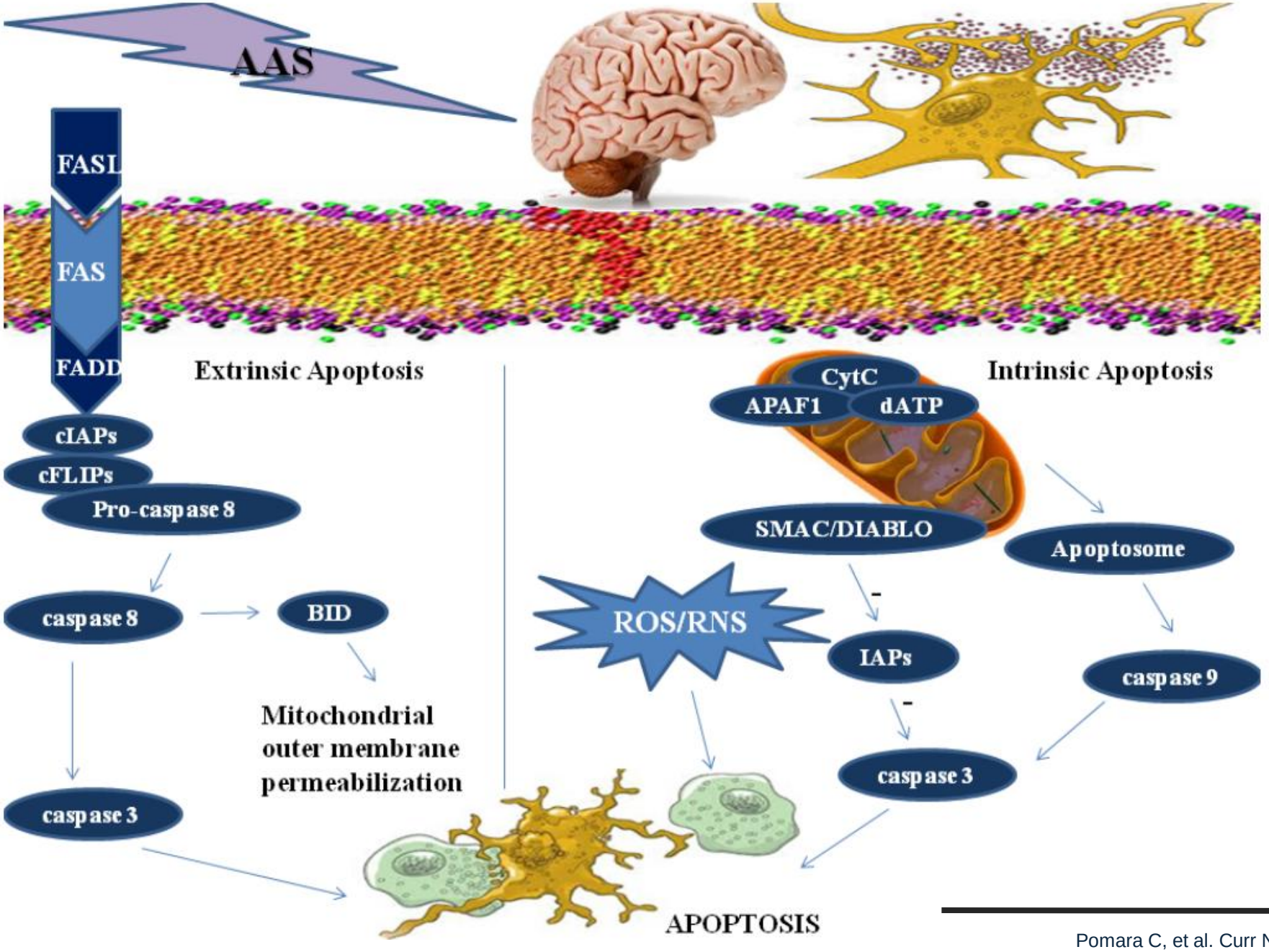
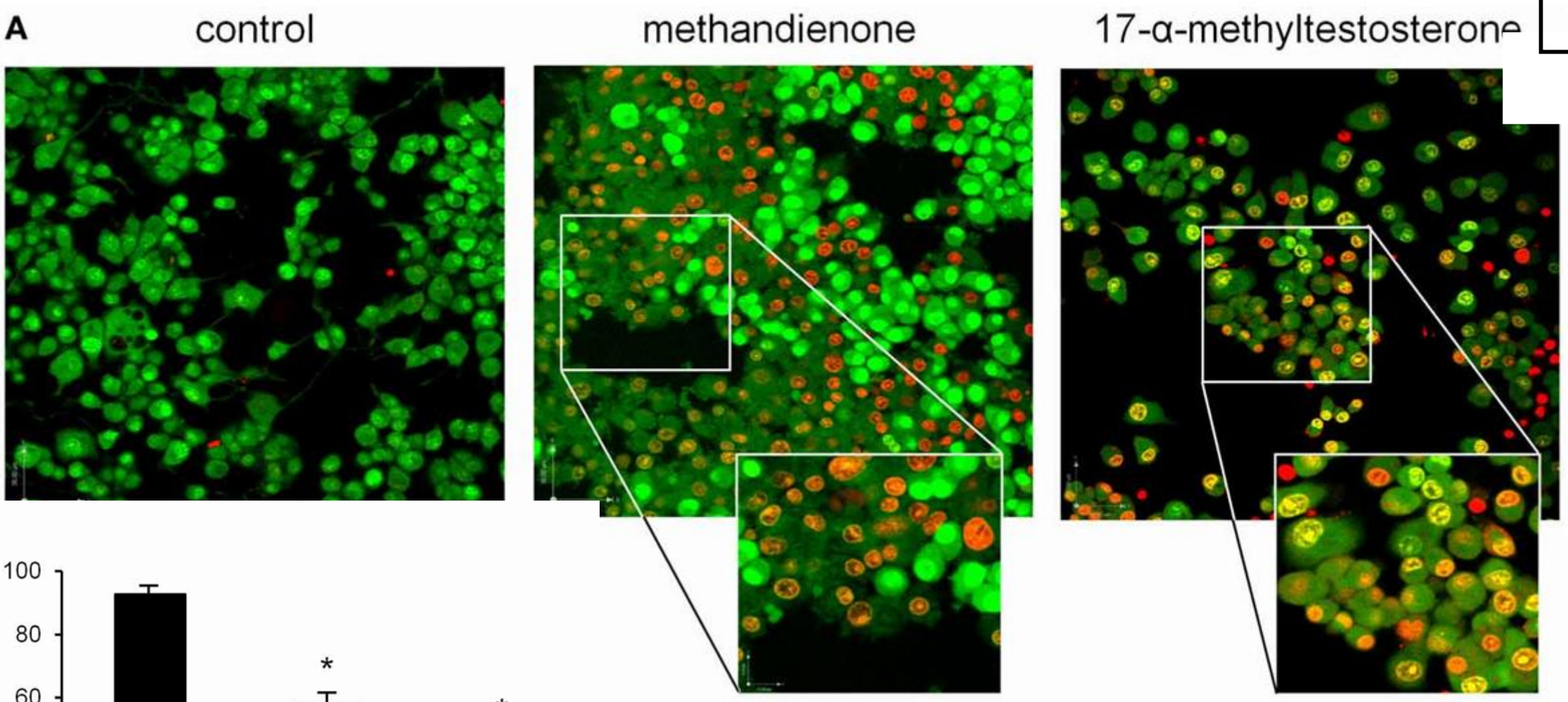


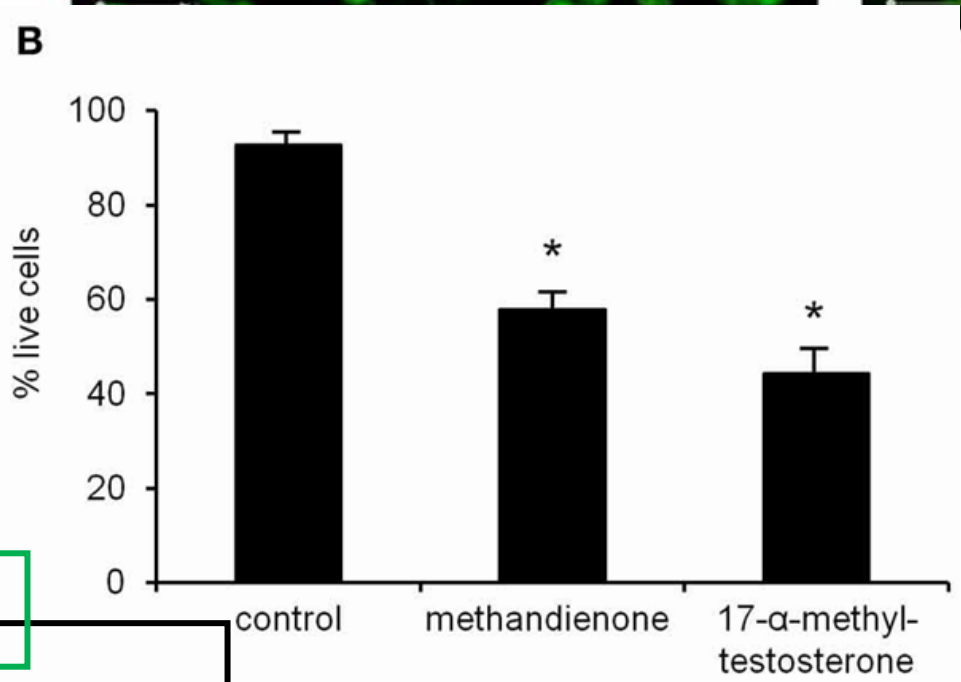
Fig. (3). Mouse brain treated with nandrolone decanoate (**A**) Confocal laser scanning microscope. Increase of apoptosis (Tunel assay) with intense positive reaction (red). (**B-C-D**) TUNEL assay revealed neuronal and glial over-expression of apoptotic nuclei (arrows) with a brownish positive reaction.

Pomara C, et al. Curr Neuropharmacol. 2015;13(1):132-45.



Pomara C, et al. Curr Neuropharmacol. 2015;13(1):132-45.

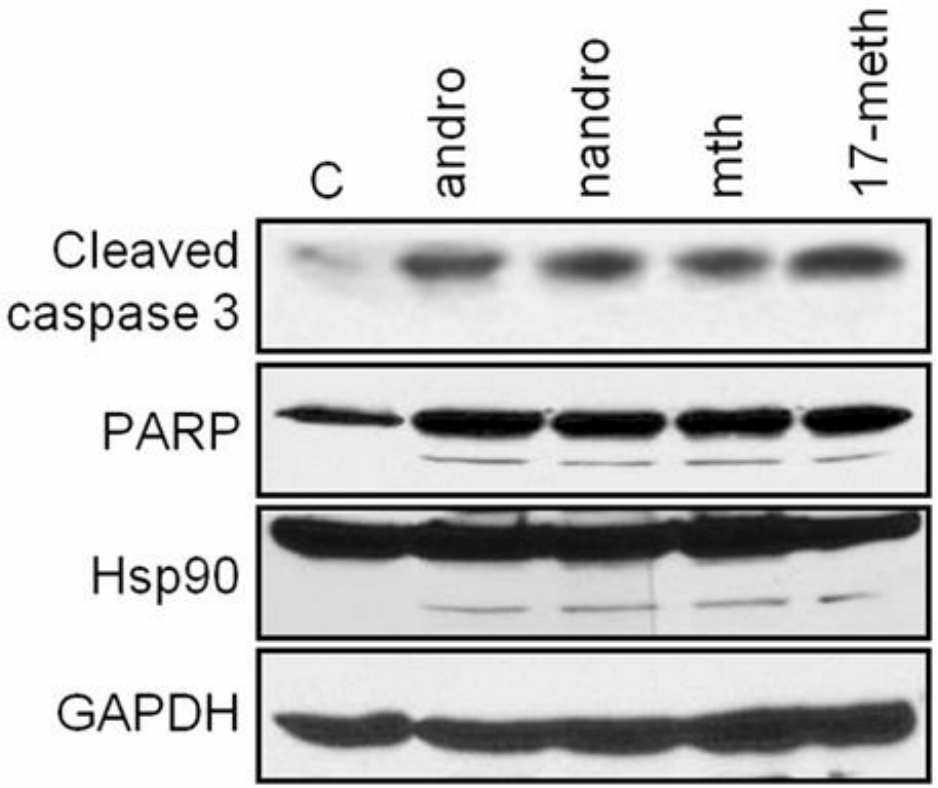


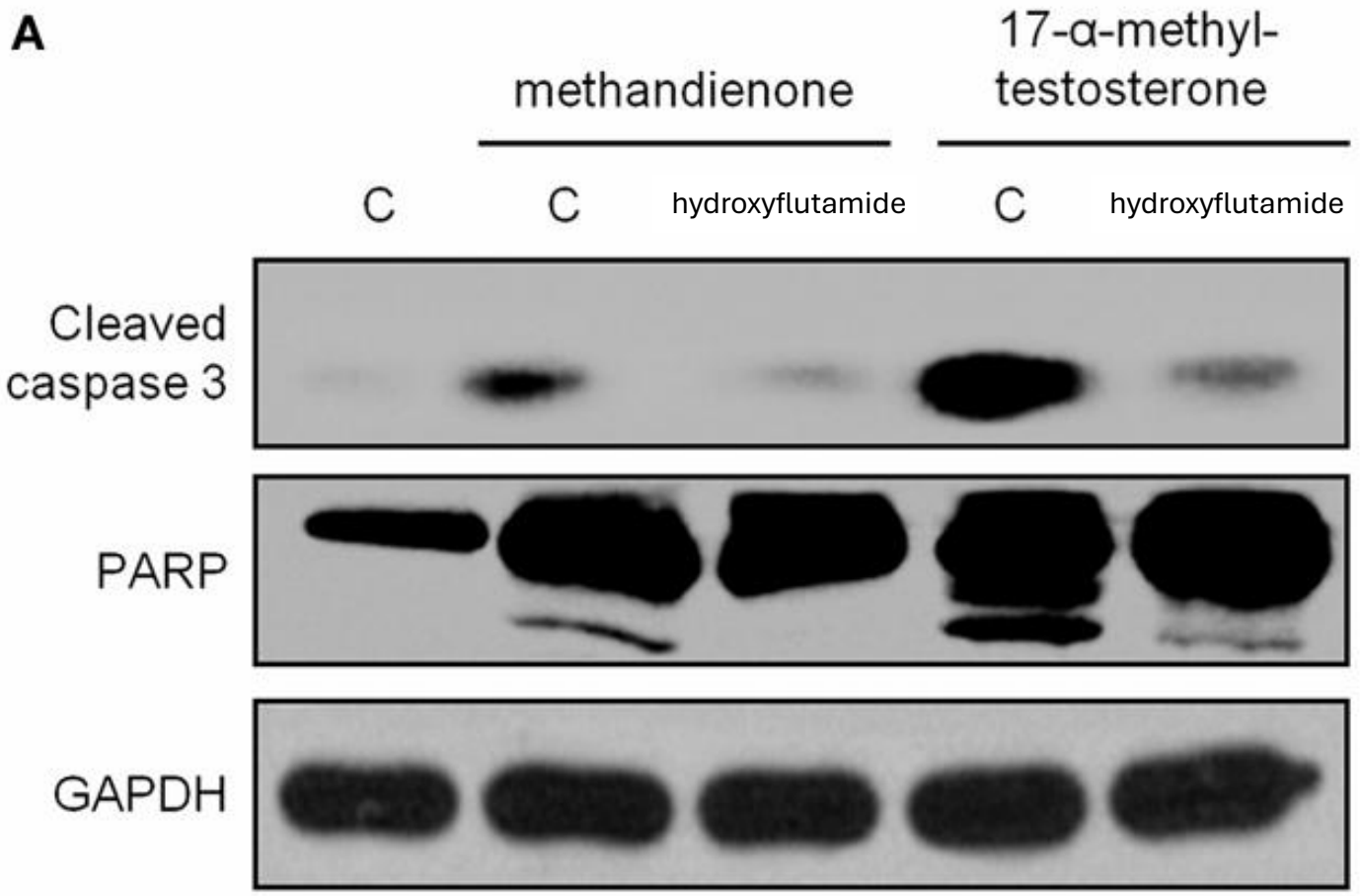


Maior morte celular programada com EAA

Basile JR, et al. Front Cell Neurosci. 2013;7:69.

Aumento de caspase-3 com EAA

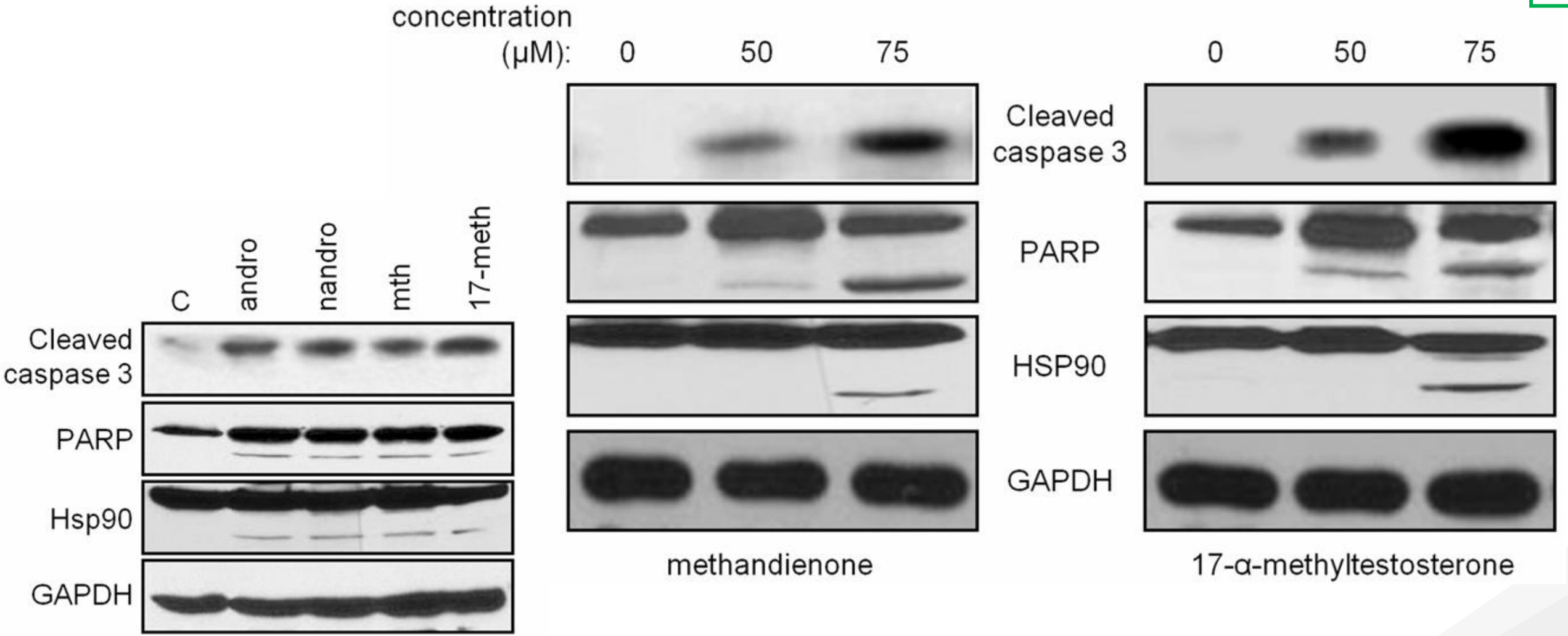




A apoptose é mediada pelos derivados da testosterona, pois a inibição dos ARs apresentou redução de marcadores de apoptose

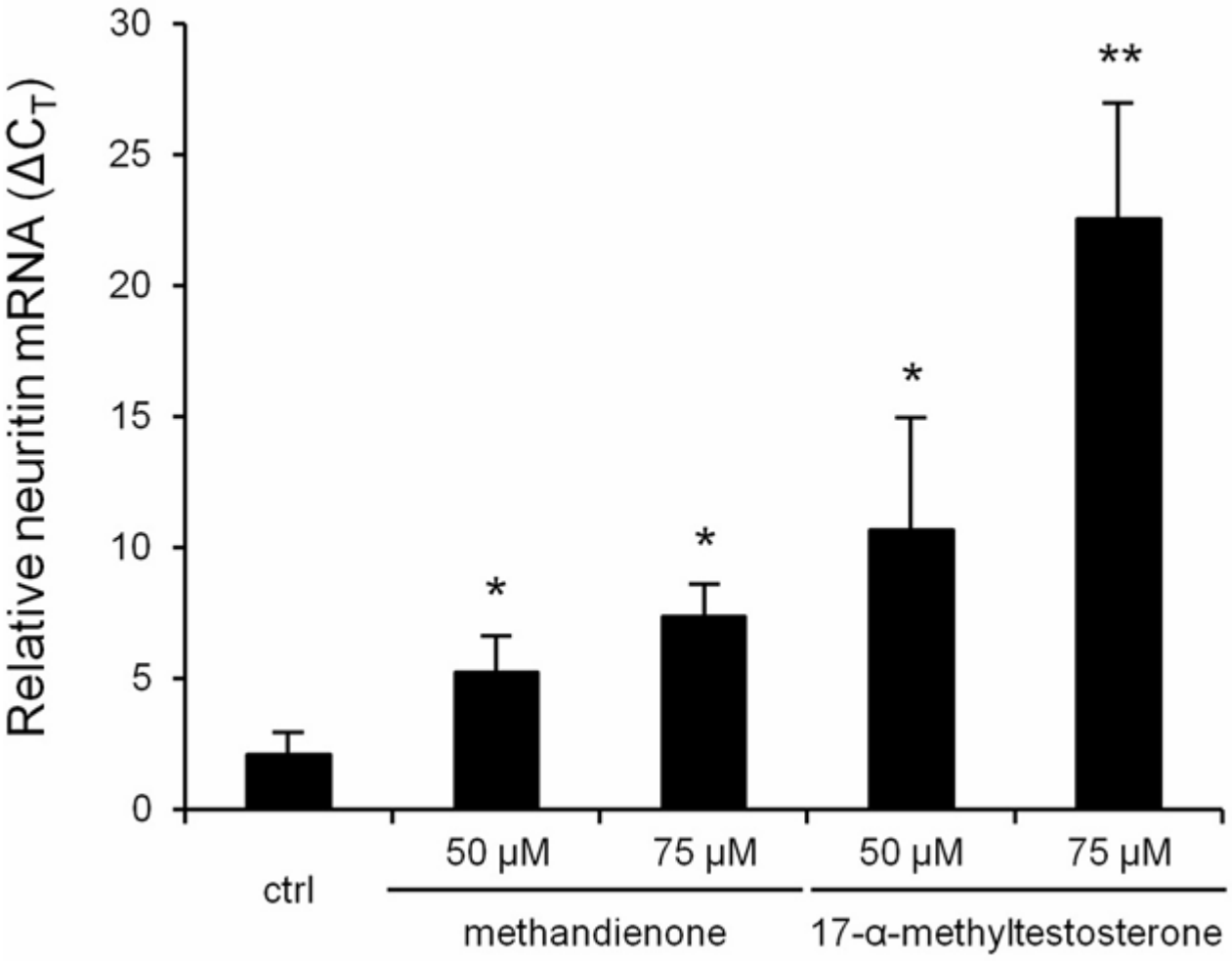
Basile JR, et al. Front Cell Neurosci. 2013;7:69.

Expressão de caspase-3 é dose dependente



Basile JR, et al. Front Cell Neurosci. 2013;7:69.

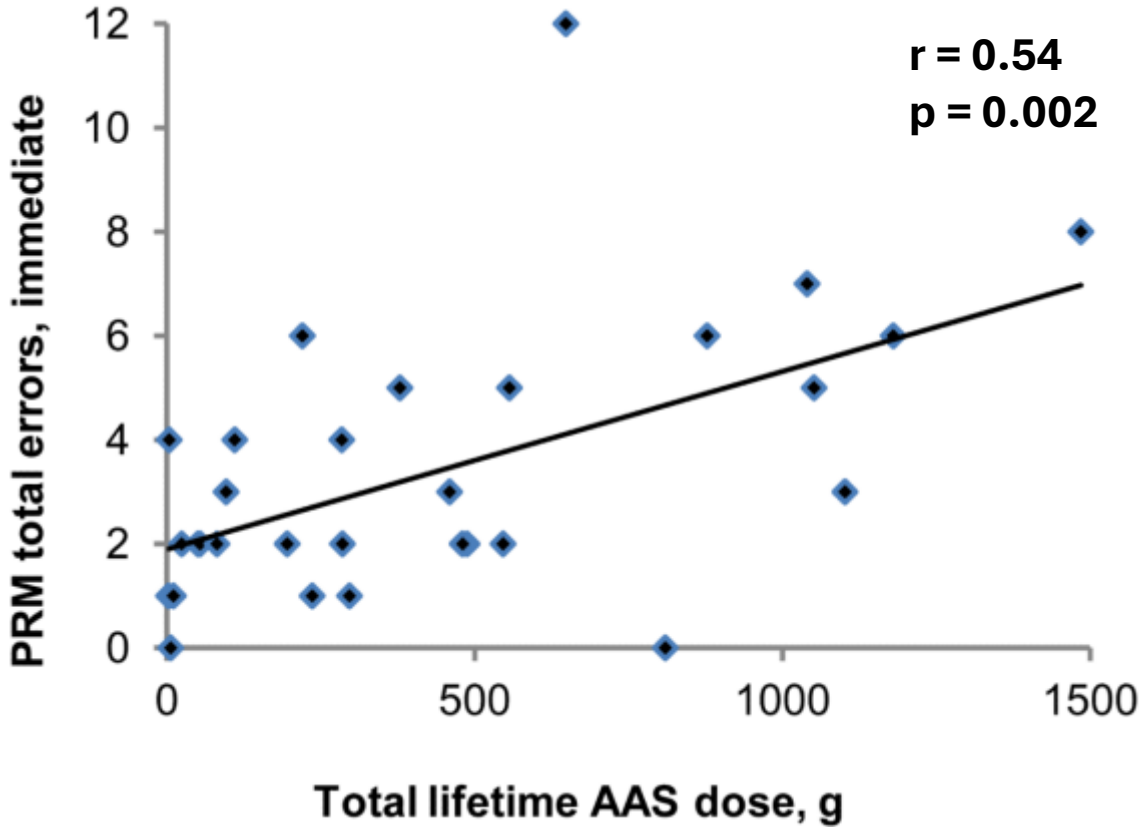
Maior expressão de neuritina

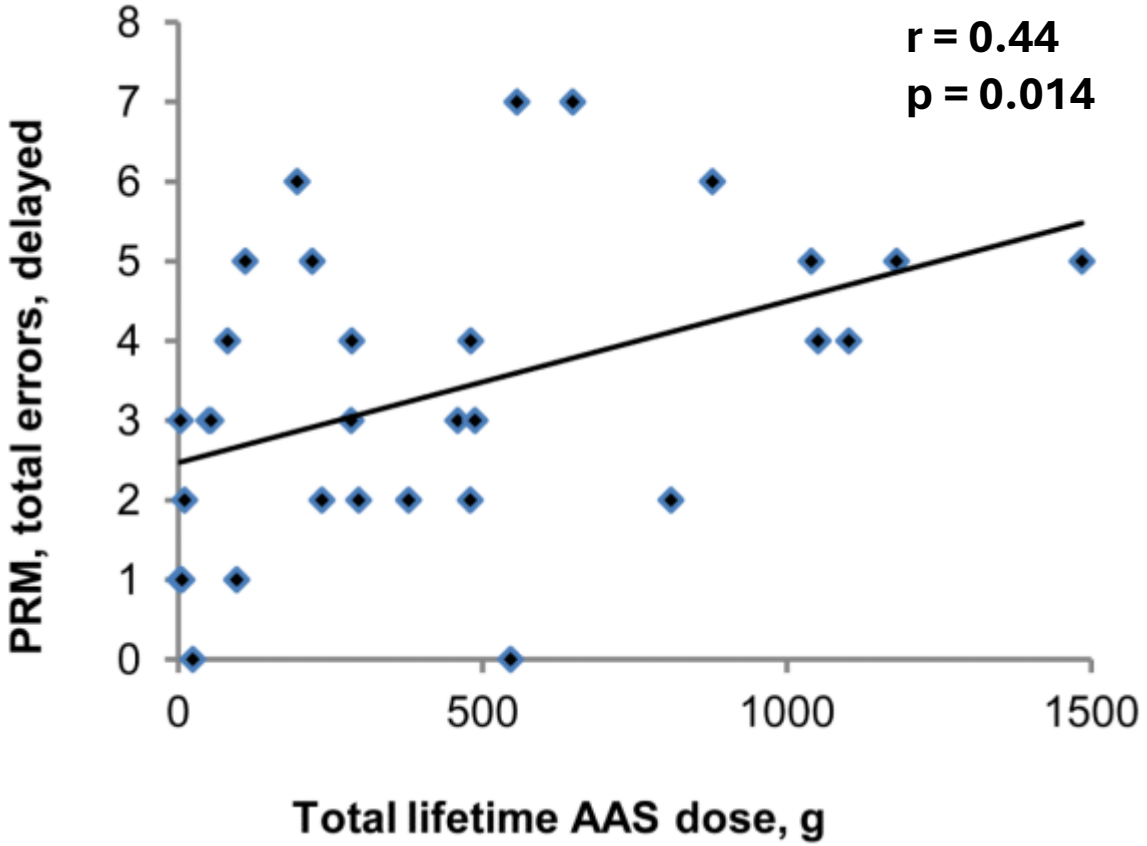


O aumento de neuritina ocorre em decorrência de lesão neural, auxiliando na plasticidade e regeneração neural.

Basile JR, et al. Front Cell Neurosci. 2013;7:69.

Déficit cognitivo em memória visuoespacial





Kanayama G, et al. Drug Alcohol Depend. 2013;130(1-3):208-14.

Uso de EAA reduz conectividade neural

Table 1
Group comparisons on main attributes; demographic information, training information, drug and psychopharmaca use, emotional and behavioral problems.

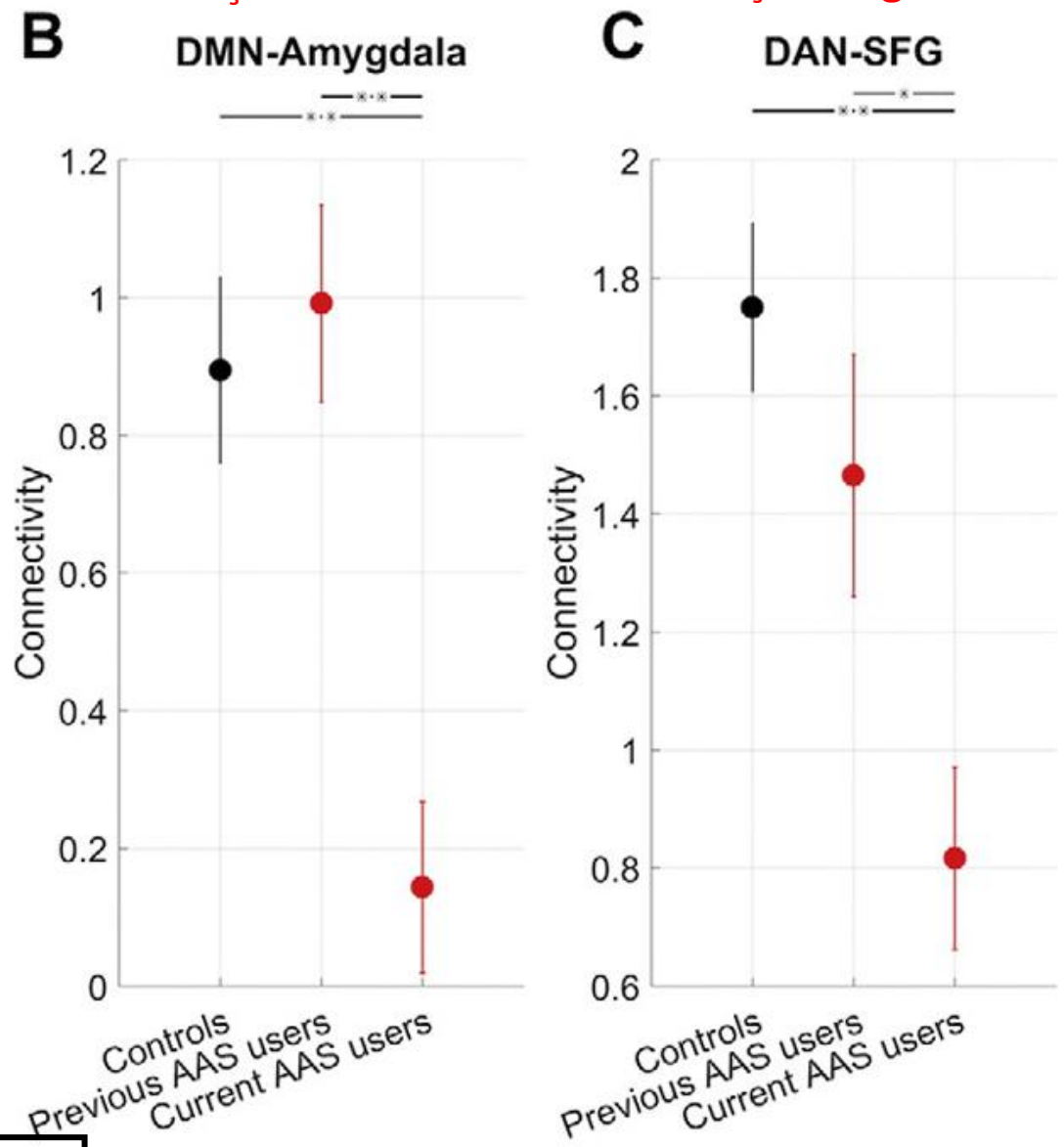
	Controls (n = 59)		Current AAS users (n = 50)		Previous AAS users (n = 16)				
	M	SD	M	SD	M	SD	F	p	
Age (years)	30.7	7.4	33.6	8.7	31.7	5.2	1.967	0.144	
Education (years)	15.9	2.7	14.5	2.6	14.2	1.9	5.230	0.007	a*
IQ	112.7	9.5	105.9	12.6	107.3	10.1	5.518	0.005	a**
Height	180.7	6.5	181.1	6.9	180.5	6.9	0.084	0.920	
Weight	90.2	14.5	99.1	12.0	93.9	15.4	5.737	0.004	a**
BMI	27.6	4.0	30.2	3.6	28.7	4.0	6.243	0.003	a**
Strength training/week (min)	477.3	247.4	383.7	217.4	223.3	123.2	8.600	<0.001	b***, c*
Endurance training/week (min)	92.9	118.4	115.8	197.1	78.1	106.1	0.481	0.619	
Cigarettes (day)	0.4	2.6	1.8	4.3	0.6	2.3	2.631	0.076	
Alcohol units (week)	3.5	5.1	1.6	3.2	1.4	2.3	3.600	0.030	a*

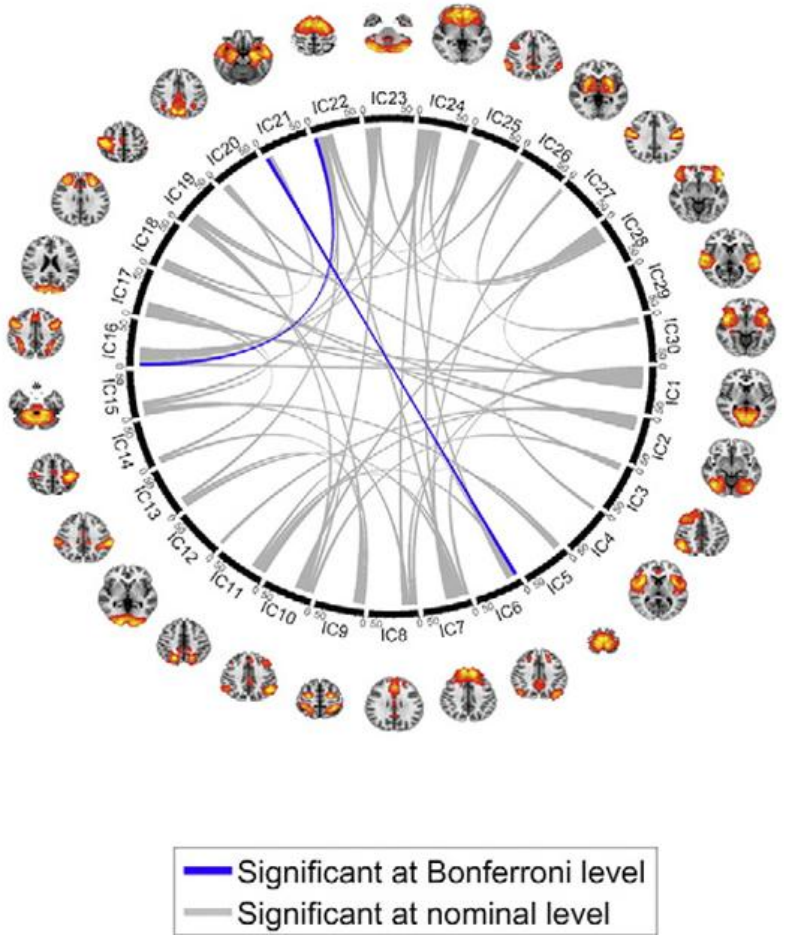
Westlye LT, et al. Nueroimage Clin. 2016;13:62-69.

Uso de EAA reduz conectividade neural

Função emocional

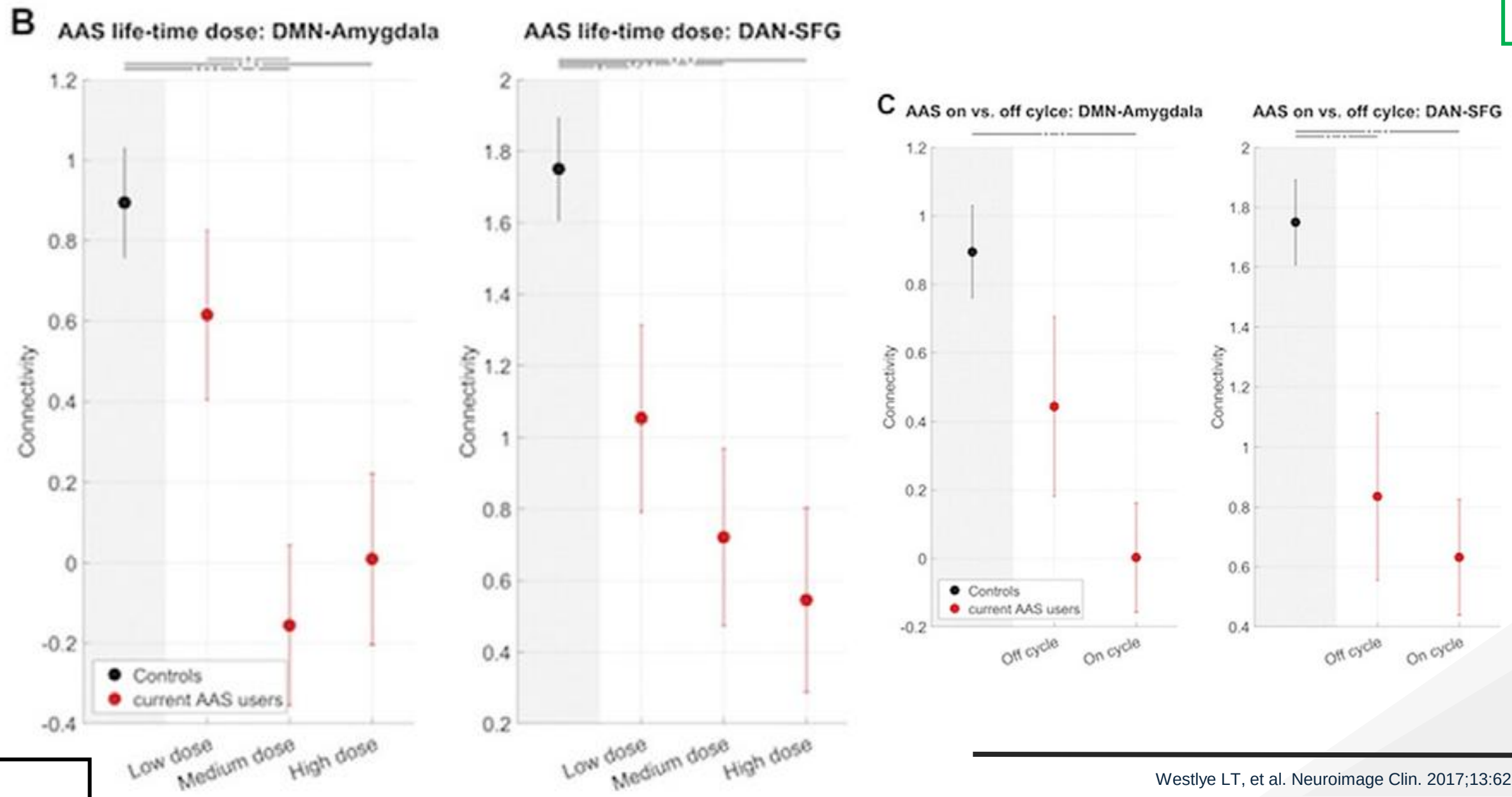
Função cognitiva





Westlye LT, et al. Neuroimage Clin. 201;13:62-69.

Reduz conectividade neural relacionado ao tempo EAA



Westlye LT, et al. Neuroimage Clin. 2017;13:62-69.

EAA e volume cerebral

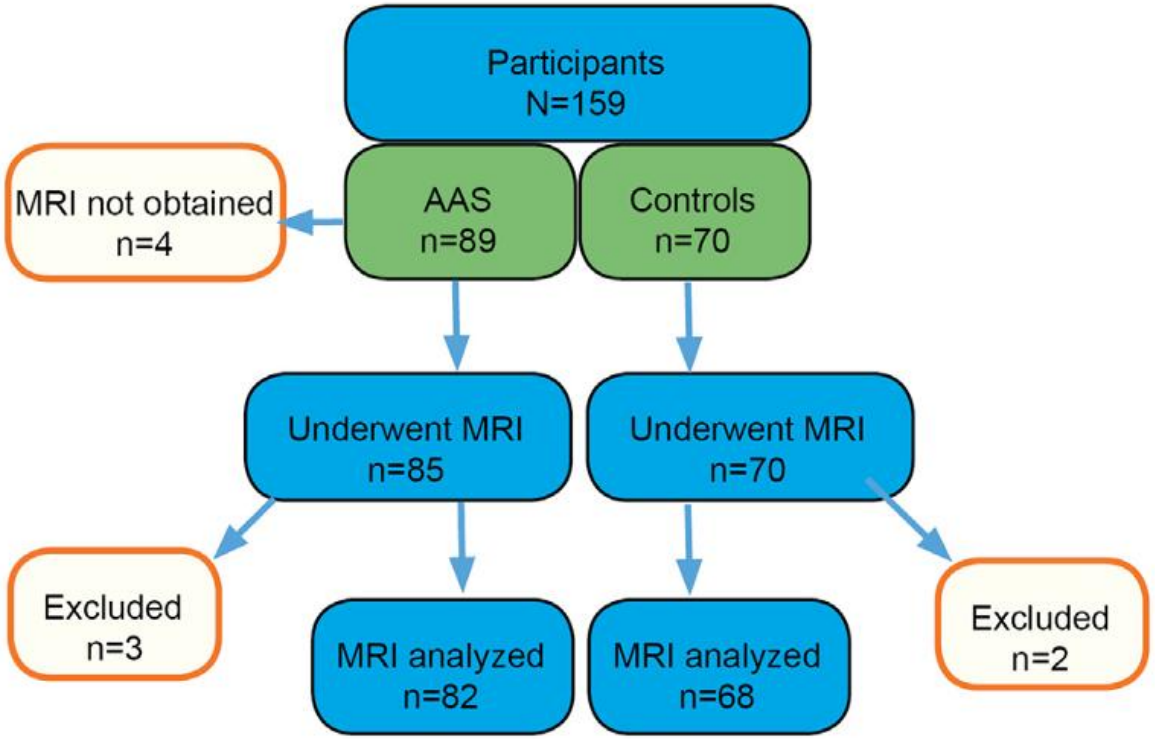
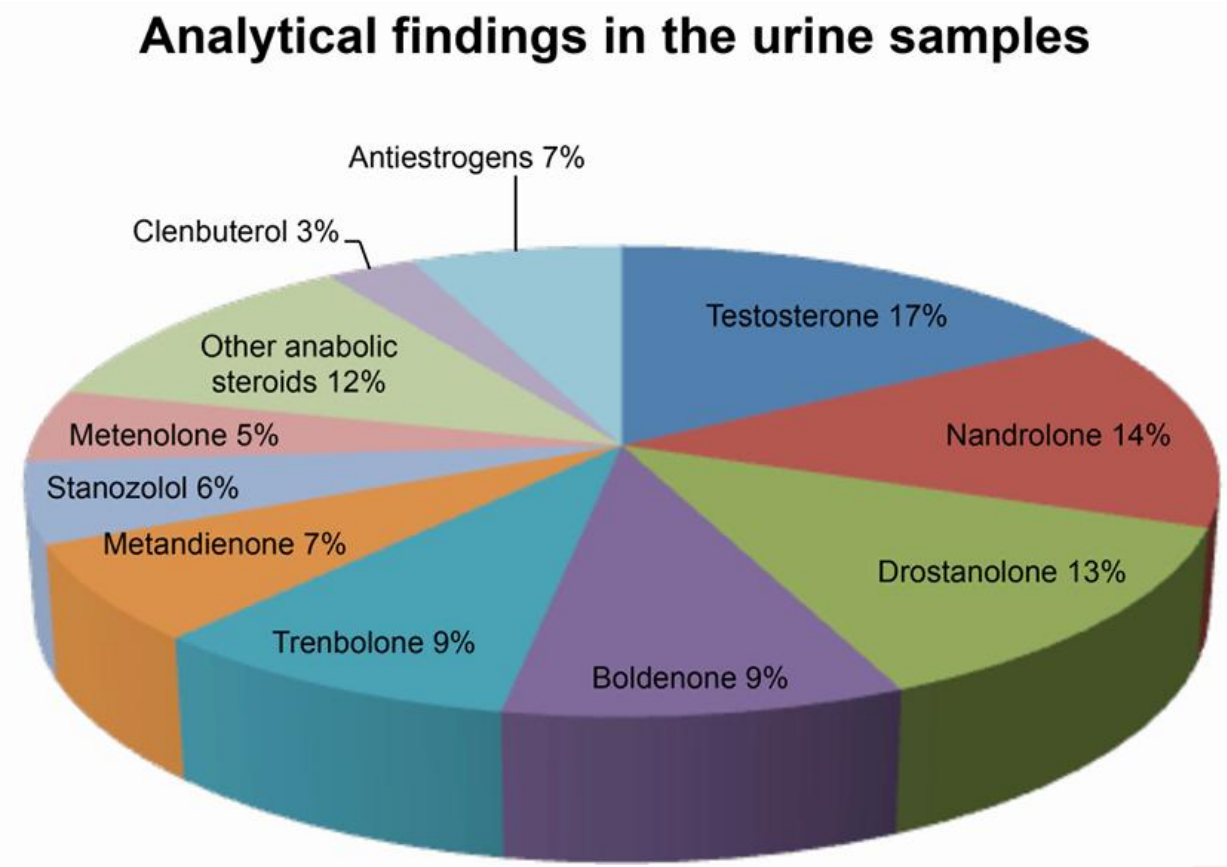


Figure 1. Flow chart. AAS, anabolic-androgenic steroid users; MRI, magnetic resonance imaging.



Bjornebekk A, et al. Biol Psychiatry. 2017;82(4):294-302.

EAA e volume cerebral

Table 1. Demographics, Sports Information, Substance Abuse, and Use of Psychopharmaca

	AAS Group (n = 82)		Control Group (n = 68)			
Attribute	Mean	SD	Mean	SD	t	p Value
Age (Years)	33.0	8.2	31.4	9.1	–1.15	.252
Education (Years)	14.1	2.5	15.9	2.7	4.10	.000
IQ	104.9	12.0	112.9	9.4	4.53	.000
Cigarettes per Day	1.7	4.3	0.3	2.4	–2.42	.016
Alcohol Units per Week	1.7	3.2	3.3	4.8	2.38	.017
Height (cm)	180.7	6.9	180.9	6.7	0.23	.817
Weight (kg)	96.7	13.7	90.4	14.0	–2.87	.005
Body Mass Index (kg/m^2)	29.6	4.1	27.6	4.0	–3.01	.003
Strength Training per Week (min)	351.5	206.7	467.0	241.9	3.13	.002
Endurance Training per Week (min)	124.7	194.1	92.0	112.8	–1.79	.204
Squats Max	217.2	57.4	172.3	41.5	–4.99	.000
Bench Max	168.6	30.8	135.6	32.0	–6.21	.000
Deadlift Max	231.8	49.1	198.8	45.1	–3.81	.000

Bjornebekk A, et al. Biol Psychiatry. 2017;82(4):294-302.

Redução de volume cerebral induzida por EAA

Table 3. Group Differences in Brain Volumes Between AAS Users and Controls

	Controls (n = 68)		All AAS users (n = 82)			
	Mean	SD	Mean	SD	F	p Value
Cerebral Cortex			914	46,871	11.06	.001
Total Gray Matter			682	56,569	10.36	.002
Intracranial Volume	1,670,649	130,821	1,655,202	109,347	0.32	.575
Lateral Ventricles	17,100	8437	18,881	10,699	1.55	.215
Thalamus	15,874	1462	15,511	1347	1.14	.288
Caudate	8358	1093	7997	975	3.11	.080
Putamen					6.55	.012
Pallidum	3268	439	3236	453	0.09	.768
Hippocampus	9351	846	9280	895	0.00	.960
Amygdala	4088	468	4014	496	0.29	.588
Accumbens	1627	239	1541	237	3.07	.082
Corpus Callosum			3274	409	6.27	.013
Cerebellar Cortex	110,392	10,421	108,528	11,441	0.16	.69

Funções motoras e sensoriais

Regulação de movimento voluntários, aprendizagem motora e tomada decisão

Auxilia na comunicação entre hemisférios

Associação do tempo de uso com menor espessura de córtex frontal, temporal, parietal e occipital com EAA

Bjornebekk A, et al. Biol Psychiatry. 2017;82(4):294-302.

Menor densidade neural com AAS

Table 1
The effect of nandrolone decanoate and EPO treatment on neuronal density of hippocampus (CA1, CA2, CA3 and GD regions), prefrontal cortex and parietal cortex.

	Neuronal density (15,800 μm^2)					
	CA1	CA2	CA3	GD	Prefrontal cortex	Parietal cortex
1. Control (n:7)	33.2 ± 6.65**	29.1 ± 4.15**	24.3 ± 4.28*	52.8 ± 12.3*	13.5 ± 1.46**	19.8 ± 2.06**
2. Sham (n:7)	31.9 ± 5.14**	26.3 ± 3.27*	23.8 ± 2.94*	51.9 ± 8.72*	14.1 ± 1.90**	19.8 ± 2.76**
3. ND (n:7)	22.5 ± 4.23	22.1 ± 2.72	20.8 ± 4.06	40.1 ± 8.66	9.6 ± 1.41	12.7 ± 2.56
4. L-EPO (n:7)	23.9 ± 3.83	22.2 ± 4.19	22.0 ± 3.5	41.7 ± 8.09	10.6 ± 1.64	13.5 ± 2.09
5. H-EPO (n:7)	29.6 ± 3.06**	24.2 ± 4.70	23.0 ± 3.30	52.0 ± 10.5*	13.0 ± 2.08**	16.6 ± 1.97**
***p*-Values**						
1 vs 3	<0.001	<0.001	0.022	0.005	<0.001	<0.001
2 vs 3	<0.001	0.002	0.024	0.002	<0.001	<0.001
3 vs 4	0.405	0.868	0.471	0.671	0.059	0.214
3 vs 5	<0.001	0.277	0.126	0.006	<0.001	<0.001
4 vs 5	<0.001	0.279	0.409	0.005	0.001	<0.001

The values are presented as mean ± SD.
* $p < 0.05$ compared with the ND group.
** $p < 0.001$ compared with the ND group.

Tugyan K, et al. Nerosci Lett. 2013;533:28-33.