Supplementary Table 1. The comparative demographic and clinical profile of patient cohorts

	HC n=110	ALS-NEG n=133	ALS-C9 n=22	ALS-ATXi n=5	p - value
Age	59.2(10.5)	61.6(10.2)	56.4(8.9)	59.6(15.1)	.09
Gender -male	65(59%)	74(55%)	12(54.5%)	5(100%)	.25
Handedness – right n(%)	102 (92%)	124 (93%)	19 (86%)	4 (80%)	.50
Symptom onset – spinal n(%)	n/a	113 (85%)	16 (72%)	4 (80%)	.35
Symptom Duration (months)	n/a	19.6(9.2)	20.8(6.2)	18.8(5.9)	.82
ALSFRS-r (max.48)	n/a	36.8(6.6)	37.9(6.8)	35.8(3.7)	.73
Availability of cerebellar exam n(%)	n/a	101(75%)	19(86%)	4(80%)	.55
Comorbid FTD n(%)	n/a	15(11%)	13(59%)	1(20%)	**.00***
Availability of ECAS n(%)	n/a	93(69%)	14(63%)	4(80%)	.73
Abnormal ECAS in those available n(%)	n/a	23(24%)	9(64%)	1(25%)	**.01***

Supplementary Table 2. Cerebellar cortical thickness in healthy controls and ALS-ATXi

Cerebellar CT		Estimated marginal means ± S.E. for groups		Statistics	
		HC N=110	ALS-ATXi n=5	Univariate effect size	HC vs ALS-ATXi
Left Lobules[a]	I-II	1.416 ± 0.033	1.715 ± 0.158	$\eta^2p = 0.030$	0.067
	III	3.213 ± 0.035	3.438 ± 0.169	$\eta^2p = 0.015$	0.197
	IV	4.911 ± 0.014	4.909 ± 0.066	$\eta^2p = 0.000$	0.973
	V	4.898 ± 0.014	4.882 ± 0.068	$\eta^2p = 0.000$	0.818
	VI	4.978 ± 0.010	4.939 ± 0.050	$\eta^2p = 0.005$	0.451
	VIIB	4.608 ± 0.019	4.657 ± 0.093	$\eta^2p = 0.002$	0.604
	VIIIA	4.648 ± 0.017	4.723 ± 0.081	$\eta^2p = 0.007$	0.371
	VIIIB	4.513 ± 0.033	4.647 ± 0.157	$\eta^2p = 0.006$	0.407
	IX	3.569 ± 0.042	3.833 ± 0.202	$\eta^2p = 0.015$	0.204
	X	2.491 ± 0.043	2.829 ± 0.205	$\eta^2p = 0.023$	0.110
	Crus I	4.577 ± 0.020	4.520 ± 0.093	$\eta^2p = 0.003$	0.557
	Crus II	4.366 ± 0.026	4.271 ± 0.123	$\eta^2p = 0.005$	0.452
Right Lobules[b]	I-II	1.354 ± 0.030	1.764 ± 0.143	$\eta^2p = 0.066$	0.006
	III	3.092 ± 0.034	3.242 ± 0.161	$\eta^2p = 0.007$	0.363
	IV	4.771 ± 0.017	4.702 ± 0.083	$\eta^2p = 0.006$	0.417
	V	4.751 ± 0.018	4.653 ± 0.086	$\eta^2p = 0.011$	0.270
	VI	4.927 ± 0.012	4.844 ± 0.055	$\eta^2p = 0.019$	0.143
	VIIB	4.787 ± 0.016	4.782 ± 0.078	$\eta^2p = 0.000$	0.943
	VIIIA	4.641 ± 0.016	4.713 ± 0.077	$\eta^2p = 0.008$	0.361
	VIIIB	4.572 ± 0.025	4.762 ± 0.121	$\eta^2p = 0.021$	0.127
	IX	3.761 ± 0.037	3.991 ± 0.179	$\eta^2p = 0.014$	0.211
	X	2.250 ± 0.037	2.260 ± 0.175	$\eta^2p = 0.000$	0.956
	Crus I	4.636 ± 0.021	4.604 ± 0.102	$\eta^2p = 0.001$	0.760
	Crus II	4.576 ± 0.020	4.576 ± 0.098	$\eta^2p = 0.000$	0.996

Estimated marginal means ± standard error for cortical thickness adjusted for age and gender. Post-hoc univariate comparisons across groups were only considered significant if the multivariate omnibus test reached significance (neither hemisphere)**: [a]Wilks' Lambda = 0.919; F = 0.739; p = 0.710; η^2p = 0.081. [b]Wilks' Lambda = 0.859; F = 1.367; p = 0.194; η^2p = 0.141.** Partial η^2 effect size is interpreted as small ($\eta^2p = 0.01$), medium ($\eta^2p = 0.06$) or large ($\eta^2p = 0.14$).

Supplementary Table 3. Cerebellar grey matter volumes in healthy controls and ALS-ATXi

Cerebellar GM		Estimated marginal means ± S.E. for groups		Statistics	
		HC n=110	ALS-ATXi n=5	Univariate effect size	HC vs ALS-ATXi
Left Lobules[a]	I-II	0.030 ± 0.001	0.036 ± 0.005	$\eta^2p = 0.015$	0.202
	III	0.508 ± 0.011	0.568 ± 0.053	$\eta^2p = 0.011$	0.270
	IV	2.093 ± 0.032	2.031 ± 0.153	$\eta^2p = 0.001$	0.690
	V	3.608 ± 0.043	3.507 ± 0.208	$\eta^2p = 0.002$	0.637
	VI	7.946 ± 0.096	7.985 ± 0.463	$\eta^2p = 0.000$	0.934
	VIIB	4.050 ± 0.059	4.148 ± 0.284	$\eta^2p = 0.001$	0.736
	VIIIA	4.951 ± 0.060	5.730 ± 0.290	$\eta^2p = 0.059$	0.010
	VIIIB	3.359 ± 0.052	3.447 ± 0.248	$\eta^2p = 0.001$	0.729
	IX	2.690 ± 0.044	2.846 ± 0.210	$\eta^2p = 0.005$	0.468
	X	0.587 ± 0.007	0.533 ± 0.036	$\eta^2p = 0.019$	0.149
	Crus I	11.179 ± 0.155	11.412 ± 0.744	$\eta^2p = 0.001$	0.760
	Crus II	6.936 ± 0.098	7.081 ± 0.472	$\eta^2p = 0.001$	0.764
Right Lobules[b]	I-II	0.035 ± 0.001	0.041 ± 0.004	$\eta^2p = 0.019$	0.145
	III	0.498 ± 0.010	0.543 ± 0.046	$\eta^2p = 0.008$	0.334
	IV	1.962 ± 0.028	1.708 ± 0.133	$\eta^2p = 0.031$	0.065
	V	3.330 ± 0.043	3.233 ± 0.208	$\eta^2p = 0.002$	0.650
	VI	7.937 ± 0.099	7.830 ± 0.476	$\eta^2p = 0.000$	0.827
	VIIB	4.230 ± 0.055	4.279 ± 0.264	$\eta^2p = 0.000$	0.854
	VIIIA	4.851 ± 0.060	5.286 ± 0.287	$\eta^2p = 0.020$	0.141
	VIIIB	3.436 ± 0.057	3.545 ± 0.277	$\eta^2p = 0.001$	0.701
	IX	2.854 ± 0.044	3.032 ± 0.210	$\eta^2p = 0.006$	0.411
	X	0.585 ± 0.007	0.528 ± 0.035	$\eta^2p = 0.022$	0.120
	Crus I	11.180 ± 0.149	11.685 ± 0.716	$\eta^2p = 0.004$	0.493
	Crus II	7.120 ± 0.108	7.419 ± 0.519	$\eta^2p = 0.003$	0.574

Estimated marginal means ± standard error for GM volumes adjusted for age, gender and total intracranial volumes. Post-hoc univariate comparisons across groups were only considered significant if the multivariate omnibus test reached significance (neither hemisphere): [a]Wilks' Lambda = 0.880; F = 1.120; p = 0.353; $\eta^2p = 0.120$. [b]Wilks' Lambda = 0.875; F = 1.181; p = 0.307; $\eta^2p = 0.125$. Partial η^2 effect size is interpreted as small ($\eta^2p = 0.01$), medium ($\eta^2p = 0.06$) or large ($\eta^2p = 0.14$).

Supplementary Table 4. Cerebellar white matter volume profiles in healthy controls and ALS-NEG and ALS-C9

Cerebellar WM		Estimated marginal means ± S.E. for groups			Statistics		
		HC n=110	ALS-NEG n=133	ALS-C9 n=22	Univariate effect size	HC vs ALS-NEG	HC vs ALS-C9
Left Lobules[a]	**I-II**	0.031 ± 0.001	0.029 ± 0.001	0.025 ± 0.003	$\eta^2p = 0.024$	0.494	0.051
	III	0.216 ± 0.006	0.204 ± 0.006	0.210 ± 0.014	$\eta^2p = 0.008$	0.437	1.000
	IV	0.328 ± 0.007	0.320 ± 0.006	0.293 ± 0.016	$\eta^2p = 0.015$	1.000	0.154
	V	0.592 ± 0.013	0.572 ± 0.012	0.549 ± 0.030	$\eta^2p = 0.009$	0.771	0.564
	VI	0.886 ± 0.017	0.889 ± 0.015	0.923 ± 0.038	$\eta^2p = 0.003$	1.000	1.000
	VIIB	0.760 ± 0.016	0.742 ± 0.014	0.782 ± 0.036	$\eta^2p = 0.006$	1.000	1.000
	VIIIA	0.959 ± 0.018	0.923 ± 0.017	0.948 ± 0.042	$\eta^2p = 0.008$	0.457	1.000
	VIIIB	0.792 ± 0.020	0.796 ± 0.018	0.747 ± 0.046	$\eta^2p = 0.004$	1.000	1.000
	IX	0.888 ± 0.025	0.867 ± 0.023	0.813 ± 0.057	$\eta^2p = 0.006$	1.000	0.695
	X	0.057 ± 0.003	0.052 ± 0.002	0.043 ± 0.006	$\eta^2p = 0.022$	0.351	0.086
	Crus I	1.940 ± 0.038	1.946 ± 0.035	1.983 ± 0.088	$\eta^2p = 0.001$	1.000	1.000
	Crus II	1.201 ± 0.203	1.215 ± 0.021	1.264 ± 0.053	$\eta^2p = 0.005$	1.000	0.815
Right Lobules[b]	**I-II**	0.030 ± 0.001	0.029 ± 0.001	0.026 ± 0.003	$\eta^2p = 0.005$	0.682	0.255
	III	0.227 ± 0.006	0.213 ± 0.005	0.217 ± 0.014	$\eta^2p = 0.012$	0.074	0.501
	IV	0.350 ± 0.008	0.324 ± 0.007	0.292 ± 0.017	$\eta^2p = 0.045$	0.015	0.002
	V	0.669 ± 0.014	0.681 ± 0.013	0.656 ± 0.031	$\eta^2p = 0.003$	0.500	0.707
	VI	1.002 ± 0.016	1.009 ± 0.015	0.982 ± 0.037	$\eta^2p = 0.002$	0.768	0.624
	VIIB	0.629 ± 0.016	0.639 ± 0.015	0.659 ± 0.037	$\eta^2p = 0.002$	0.644	0.466
	VIIIA	0.866 ± 0.019	0.879 ± 0.017	0.898 ± 0.042	$\eta^2p = 0.002$	0.600	0.487
	VIIIB	0.633 ± 0.017	0.648 ± 0.016	0.661 ± 0.039	$\eta^2p = 0.003$	0.520	0.510
	IX	0.835 ± 0.023	0.816 ± 0.021	0.800 ± 0.053	$\eta^2p = 0.002$	0.548	0.539
	X	0.071 ± 0.003	0.070 ± 0.003	0.069 ± 0.007	$\eta^2p = 0.000$	0.851	0.823
	Crus I	1.975 ± 0.034	2.030 ± 0.031	2.047 ± 0.078	$\eta^2p = 0.006$	0.240	0.401
	Crus II	1.176 ± 0.022	1.201 ± 0.020	1.315 ± 0.051	$\eta^2p = 0.023$	0.409	0.014

Estimated marginal means ± standard error for WM volumes adjusted for age, gender and total intracranial volumes. Post-hoc univariate comparisons across groups were only considered significant if the multivariate omnibus test reached significance (neither hemisphere): [a]Wilks' Lambda = 0.905; F = 1.062; p = 0.384; $\eta^2p = 0.049$. [b]Wilks' Lambda = 0.904; F = 1.073; p = 0.370; $\eta^2p = 0.049$. Partial η^2 effect size is interpreted as small ($\eta^2p = 0.01$), medium ($\eta^2p = 0.06$) or large ($\eta^2p = 0.14$).

Supplementary Table 5. Cerebellar white matter volume profiles in healthy controls and ALS-ATXi

Cerebellar WM		Estimated marginal means ± S.E. for groups		Statistics	
		HC n=110	ALS-ATXi n=5	Univariate effect size	HC vs ALS-ATXi
Left Lobules[a]	**I-II**	0.031 ± 0.001	0.031 ± 0.005	$\eta^2p = 0.000$	0.824
	III	0.218 ± 0.005	0.211 ± 0.025	$\eta^2p = 0.001$	0.790
	IV	0.331 ± 0.007	0.277 ± 0.036	$\eta^2p = 0.019$	0.143
	V	0.594 ± 0.013	0.553 ± 0.062	$\eta^2p = 0.004$	0.512
	VI	0.893 ± 0.015	0.925 ± 0.073	$\eta^2p = 0.002$	0.669
	VIIB	0.764 ± 0.017	0.748 ± 0.081	$\eta^2p = 0.000$	0.847
	VIIIA	0.967 ± 0.020	1.024 ± 0.096	$\eta^2p = 0.003$	0.563
	VIIIB	0.804 ± 0.019	0.727 ± 0.092	$\eta^2p = 0.006$	0.414
	IX	0.901 ± 0.024	0.747 ± 0.115	$\eta^2p = 0.015$	0.193
	X	0.058 ± 0.003	0.033 ± 0.012	$\eta^2p = 0.033$	0.056
	Crus I	1.945 ± 0.037	2.105 ± 0.179	$\eta^2p = 0.007$	0.386
	Crus II	1.203 ± 0.023	1.254 ± 0.111	$\eta^2p = 0.002$	0.657
Right Lobules[b]	**I-II**	0.030 ± 0.001	0.021 ± 0.005	$\eta^2p = 0.021$	0.130
	III	0.230 ± 0.005	0.242 ± 0.025	$\eta^2p = 0.002$	0.644
	IV	0.352 ± 0.008	0.321 ± 0.037	$\eta^2p = 0.006$	0.416
	V	0.673 ± 0.013	0.661 ± 0.063	$\eta^2p = 0.000$	0.852
	VI	1.010 ± 0.016	1.059 ± 0.076	$\eta^2p = 0.004$	0.532
	VIIB	0.631 ± 0.015	0.680 ± 0.073	$\eta^2p = 0.004$	0.516
	VIIIA	0.874 ± 0.020	0.884 ± 0.096	$\eta^2p = 0.000$	0.924
	VIIIB	0.644 ± 0.015	0.558 ± 0.074	$\eta^2p = 0.012$	0.258
	IX	0.847 ± 0.021	0.714 ± 0.101	$\eta^2p = 0.015$	0.201
	X	0.072 ± 0.003	0.070 ± 0.014	$\eta^2p = 0.000$	0.879
	Crus I	1.980 ± 0.029	2.236 ± 0.140	$\eta^2p = 0.028$	0.076
	Crus II	1.174 ± 0.022	1.257 ± 0.104	$\eta^2p = 0.005$	0.440

Estimated marginal means ± standard error for WM volumes adjusted for age, gender and total intracranial volumes. Post-hoc univariate comparisons across groups were only considered significant if the multivariate omnibus test reached significance (neither hemisphere): [a]Wilks' Lambda = 0.921; F = 0.709; p = 0.739; $\eta^2p = 0.079$. [b]Wilks' Lambda = 0.904; F = 0.878; p = 0.572; $\eta^2p = 0.096$. Partial η^2 effect size is interpreted as small ($\eta^2p = 0.01$), medium ($\eta^2p = 0.06$) or large ($\eta^2p = 0.14$).

Supplementary Table 6. Superior cerebellar peduncle (SCP) volumes in healthy controls, ALS-NEG and ALS-C9

	Estimated marginal means ± S.E. for groups			Statistics	
	HC n=110	**ALS-NEG n=133**	**ALS-C9 n=22**	**HC vs ALS-NEG**	**HC vs ALS-C9**
SCP volume	260.202 ± 5.246	250.211 ± 4.778	238.923 ± 12.069	0.491	0.325

Estimated marginal means ± standard error for SCP volume adjusted for age, gender and total intracranial volume. Post-hoc univariate comparisons across groups were only considered significant if the multivariate omnibus test reached significance (not applicable): $F = 1.774$; $p = 0.172$; $\eta^2p = 0.014$. Partial η^2 effect size is interpreted as small ($\eta^2p = 0.01$), medium ($\eta^2p = 0.06$) or large ($\eta^2p = 0.14$).

Supplementary Table 7. Superior cerebellar peduncle (SCP) volumes in healthy controls and ALS-ATXi

	Estimated marginal means ± S.E. for groups	
	HC n=100	**ALS-ATXi n=5**
SCP volume	260.254 ± 4.763	224.205 ± 22.908

Estimated marginal means ± standard error for SCP volume adjusted for age, gender and total intracranial volume. The comparison between HC and ALS-ATXi was not significant: $F = 2.363$; $p = 0.127$; $\eta^2 p = 0.021$.

Supplementary Table 8. Radial diffusivity (RD) in cerebro-cerebellar tractography in healthy controls and ALS-NEG and ALS-C9

Cerebro-cerebellar RD×10^{-3} values			Estimated marginal means ± S.E. for groups			Statistics		
			HC n=110	ALS-NEG n=133	ALS-C9 n=22	Univariate effect size	HC vs ALS-NEG	HC vs ALS-C9
Left[a]	**FPC**	**L1L**	0.520 ± 0.006	0.529 ± 0.006	0.534 ± 0.006	$\eta^2p = 0.038$	0.984	0.373
		L1R	0.508 ± 0.009	0.544 ± 0.010	0.552 ± 0.010	$\eta^2p = 0.169$	**0.023**	**0.004**
	PPC	**L1L**	0.537 ± 0.006	0.546 ± 0.006	0.557 ± 0.006	$\eta^2p = 0.081$	0.944	0.065
		L1R	0.540 ± 0.013	0.563 ± 0.013	0.589 ± 0.013	$\eta^2p = 0.102$	0.657	**0.029**
	TPC	**L1L**	0.648 ± 0.020	0.697 ± 0.021	0.711 ± 0.021	$\eta^2p = 0.078$	0.288	0.096
		L1R	0.709 ± 0.029	0.689 ± 0.031	0.746 ± 0.031	$\eta^2p = 0.028$	1.000	1.000
	OPC	**L1L**	0.575 ± 0.013	0.584 ± 0.013	0.615 ± 0.013	$\eta^2p = 0.078$	1.000	0.095
		L1R	0.635 ± 0.025	0.688 ± 0.026	0.658 ± 0.026	$\eta^2p = 0.033$	0.437	1.000
	DRTC	**L1L**	0.592 ± 0.009	0.580 ± 0.009	0.603 ± 0.009	$\eta^2p = 0.048$	1.000	1.000
		L1R	0.643 ± 0.020	0.721 ± 0.021	0.677 ± 0.021	$\eta^2p = 0.100$	**0.032**	0.433
Right[b]	**FPC**	**R1R**	0.504 ± 0.006	0.517 ± 0.006	0.535 ± 0.006	$\eta^2p = 0.167$	0.382	0.002
		R1L	0.543 ± 0.009	0.548 ± 0.009	0.547 ± 0.009	$\eta^2p = 0.004$	1.000	1.000
	PPC	**R1R**	0.530 ± 0.008	0.536 ± 0.008	0.557 ± 0.008	$\eta^2p = 0.092$	1.000	0.056
		R1L	0.593 ± 0.013	0.598 ± 0.014	0.590 ± 0.014	$\eta^2p = 0.003$	1.000	1.000
	TPC	**R1R**	0.632 ± 0.024	0.676 ± 0.024	0.690 ± 0.024	$\eta^2p = 0.049$	0.593	0.272
		R1L	0.683 ± 0.019	0.671 ± 0.020	0.700 ± 0.020	$\eta^2p = 0.018$	1.000	1.000
	OPC	**R1R**	0.565 ± 0.014	0.587 ± 0.014	0.594 ± 0.014	$\eta^2p = 0.034$	0.868	0.484
		R1L	0.617 ± 0.022	0.690 ± 0.023	0.665 ± 0.023	$\eta^2p = 0.080$	0.074	0.420
	DRTC	**R1R**	0.578 ± 0.010	0.599 ± 0.010	0.607 ± 0.010	$\eta^2p = 0.064$	0.464	0.151
		R1L	0.650 ± 0.017	0.651 ± 0.018	0.674 ± 0.018	$\eta^2p = 0.019$	1.000	0.986

Estimated marginal means ± standard error for radial diffusivity adjusted for age and gender. Post-hoc univariate comparisons across groups were only considered significant if the multivariate omnibus test reached significance (left hemisphere): [a]Wilks' Lambda = 0.552; F = 1.869; p = 0.022; $\eta^2p = 0.257$, [b]Wilks' Lambda = 0.643; F = 1.336; p = 0.172; $\eta^2p = 0.198$. Bold p-values are significant at $p < 0.05$, after Bonferroni correction for multiple comparisons. Partial η^2 effect size is interpreted as small ($\eta^2p = 0.01$), medium ($\eta^2p = 0.06$) or large ($\eta^2p = 0.14$).

Supplementary Table 9. Axial Diffusivity (AD) in cerebro-cerebellar tractography in healthy controls and ALS-NEG and ALS-C9

Cerebro-cerebellar AD×10^{-3} values			Estimated marginal means ± S.E. for groups			Statistics		
			HC n=110	ALS-NEG n=133	ALS-C9 n=22	Univariate effect size	HC vs ALS-NEG	HC vs ALS-C9
Left[a]	**FPC**	**L1L**	1.092 ± 0.007	1.097 ± 0.007	1.083 ± 0.007	$\eta^2p = 0.027$	1.000	1.000
		L1R	1.090 ± 0.011	1.110 ± 0.012	1.092 ± 0.012	$\eta^2p = 0.025$	0.716	1.000
	PPC	**L1L**	1.114 ± 0.006	1.120 ± 0.007	1.113 ± 0.007	$\eta^2p = 0.009$	1.000	1.000
		L1R	1.122 ± 0.016	1.143 ± 0.016	1.137 ± 0.016	$\eta^2p = 0.015$	1.000	1.000
	TPC	**L1L**	1.108 ± 0.023	1.159 ± 0.024	1.173 ± 0.024	$\eta^2p = 0.061$	0.412	0.181
		L1R	1.167 ± 0.035	1.147 ± 0.036	1.207 ± 0.036	$\eta^2p = 0.022$	1.000	1.000
	OPC	**L1L**	1.117 ± 0.012	1.118 ± 0.012	1.127 ± 0.012	$\eta^2p = 0.006$	1.000	1.000
		L1R	1.153 ± 0.035	1.182 ± 0.036	1.141 ± 0.036	$\eta^2p = 0.010$	1.000	1.000
	DRTC	**L1L**	1.116 ± 0.010	1.105 ± 0.010	1.138 ± 0.010	$\eta^2p = 0.076$	1.000	0.432
		L1R	1.158 ± 0.020	1.197 ± 0.021	1.166 ± 0.021	$\eta^2p = 0.030$	0.565	1.000
Right[b]	**FPC**	**R1R**	1.060 ± 0.009	1.073 ± 0.009	1.079 ± 0.009	$\eta^2p = 0.036$	0.911	0.420
		R1L	1.119 ± 0.010	1.105 ± 0.011	1.105 ± 0.011	$\eta^2p = 0.019$	1.000	1.000
	PPC	**R1R**	1.090 ± 0.008	1.110 ± 0.008	1.106 ± 0.008	$\eta^2p = 0.050$	0.283	0.506
		R1L	1.163 ± 0.017	1.151 ± 0.017	1.154 ± 0.017	$\eta^2p = 0.004$	1.000	1.000
	TPC	**R1R**	1.064 ± 0.031	1.144 ± 0.033	1.142 ± 0.033	$\eta^2p = 0.061$	0.245	0.275
		R1L	1.153 ± 0.024	1.128 ± 0.025	1.153 ± 0.025	$\eta^2p = 0.011$	1.000	1.000
	OPC	**R1R**	1.092 ± 0.015	1.110 ± 0.016	1.115 ± 0.016	$\eta^2p = 0.018$	1.000	0.914
		R1L	1.138 ± 0.026	1.211 ± 0.027	1.174 ± 0.027	$\eta^2p = 0.054$	0.185	1.000
	DRTC	**R1R**	1.087 ± 0.012	1.123 ± 0.013	1.127 ± 0.013	$\eta^2p = 0.091$	0.128	0.082
		R1L	1.122 ± 0.018	1.151 ± 0.019	1.174 ± 0.019	$\eta^2p = 0.059$	0.839	0.156

Estimated marginal means ± standard error for axial diffusivity adjusted for age and gender. Post-hoc univariate comparisons across groups were only considered significant if the multivariate omnibus test reached significance (neither hemisphere): [a]Wilks' Lambda = 0.666; F = 1.216; p = 0.256; $\eta^2p = 0.184$, [b]Wilks' Lambda = 0.723; F = 0.953; p = 0.524; $\eta^2p = 0.150$. Partial η^2 effect size is interpreted as small ($\eta^2p = 0.01$), medium ($\eta^2p = 0.06$) or large ($\eta^2p = 0.14$).

Supplementary Table 10. Fractional anisotropy (FA) values for the cerebro-cerebellar tracts in healthy controls and ALS-ATXi

Cerebro-cerebellar FA values			Estimated marginal means ± S.E. for groups		Statistics	
			HC n=110	ALS-ATXi n=5	Univariate effect size	HC vs ALS-ATXi
Left[a]	**FPC**	**L1L**	0.453 ± 0.005	0.462 ± 0.009	$\eta^2p = 0.030$	0.388
		L1R	0.466 ± 0.005	0.450 ± 0.012	$\eta^2p = 0.052$	0.252
	PPC	**L1L**	0.446 ± 0.003	0.436 ± 0.008	$\eta^2p = 0.043$	0.299
		L1R	0.453 ± 0.005	0.455 ± 0.012	$\eta^2p = 0.002$	0.841
	TPC	**L1L**	0.353 ± 0.006	0.378 ± 0.013	$\eta^2p = 0.104$	0.101
		L1R	0.340 ± 0.009	0.313 ± 0.021	$\eta^2p = 0.050$	0.262
	OPC	**L1L**	0.415 ± 0.005	0.424 ± 0.011	$\eta^2p = 0.018$	0.504
		L1R	0.389 ± 0.010	0.390 ± 0.022	$\eta^2p = 0.000$	0.985
	DRTC	**L1L**	0.396 ± 0.005	0.392 ± 0.012	$\eta^2p = 0.003$	0.798
		L1R	0.381 ± 0.008	0.364 ± 0.018	$\eta^2p = 0.027$	0.414
Right[b]	**FPC**	**R1R**	0.451 ± 0.004	0.450 ± 0.010	$\eta^2p = 0.000$	0.938
		R1L	0.447 ± 0.005	0.451 ± 0.011	$\eta^2p = 0.004$	0.751
	PPC	**R1R**	0.440 ± 0.005	0.446 ± 0.012	$\eta^2p = 0.011$	0.607
		R1L	0.426 ± 0.005	0.418 ± 0.012	$\eta^2p = 0.017$	0.517
	TPC	**R1R**	0.342 ± 0.006	0.339 ± 0.015	$\eta^2p = 0.001$	0.867
		R1L	0.352 ± 0.007	0.354 ± 0.017	$\eta^2p = 0.00$	0.905
	OPC	**R1R**	0.410 ± 0.008	0.417 ± 0.020	$\eta^2p = 0.004$	0.755
		R1L	0.394 ± 0.009	0.355 ± 0.021	$\eta^2p = 0.096$	0.115
	DRTC	**R1R**	0.391 ± 0.005	0.389 ± 0.012	$\eta^2p = 0.001$	0.911
		R1L	0.356 ± 0.008	0.347 ± 0.018	$\eta^2p = 0.010$	0.619

Estimated marginal means ± standard error for fractional anisotropy adjusted for age and gender. Post-hoc univariate comparisons across groups were only considered significant if the multivariate omnibus test reached significance (neither hemisphere): [a]Wilks' Lambda = 0.522; F = 1.468; p = 0.238; $\eta^2p = 0.478$, [b]Wilks' Lambda = 0.801; F = 0.397; p = 0.929; $\eta^2p = 0.199$. Partial η^2 effect size is interpreted as small ($\eta^2p = 0.01$), medium ($\eta^2p = 0.06$) or large ($\eta^2p = 0.14$).

Supplementary Table 11. Axial Diffusivity (AD) in cerebro-cerebellar tractography in healthy controls and ALS-ATXi

Cerebro-cerebellar AD×10^{-3} values			Estimated marginal means ± S.E. for groups		Statistics	
			HC n=110	ALS-ATXi n=5	Univariate effect size	HC vs ALS-ATXi
Left[a]	**FPC**	**L1L**	1.092 ± 0.0075	1.073 ± 0.011	$\eta^2p = 0.087$	0.136
		L1R	1.089 ± 0.007	1.077 ± 0.016	$\eta^2p = 0.016$	0.528
	PPC	**L1L**	1.114 ± 0.004	1.103 ± 0.010	$\eta^2p = 0.037$	0.336
		L1R	1.122 ± 0.018	1.167 ± 0.042	$\eta^2p = 0.036$	0.342
	TPC	**L1L**	1.108 ± 0.015	1.096 ± 0.034	$\eta^2p = 0.004$	0.755
		L1R	1.156 ± 0.029	1.274 ± 0.068	$\eta^2p = 0.090$	0.129
	OPC	**L1L**	1.116 ± 0.009	1.102 ± 0.020	$\eta^2p = 0.014$	0.561
		L1R	1.146 ± 0.022	1.181 ± 0.051	$\eta^2p = 0.016$	0.532
	DRTC	**L1L**	1.118 ± 0.009	1.101 ± 0.022	$\eta^2p = 0.021$	0.475
		L1R	1.164 ± 0.014	1.065 ± 0.033	$\eta^2p = 0.221$	0.013
Right[b]	**FPC**	**R1R**	1.060 ± 0.006	1.045 ± 0.014	$\eta^2p = 0.040$	0.316
		R1L	1.117 ± 0.009	1.115 ± 0.021	$\eta^2p = 0.000$	0.928
	PPC	**R1R**	1.091 ± 0.005	1.097 ± 0.013	$\eta^2p = 0.008$	0.667
		R1L	1.158 ± 0.016	1.197 ± 0.038	$\eta^2p = 0.033$	0.365
	TPC	**R1R**	1.061 ± 0.019	1.095 ± 0.045	$\eta^2p = 0.018$	0.503
		R1L	1.154 ± 0.023	1.174 ± 0.052	$\eta^2p = 0.005$	0.734
	OPC	**R1R**	1.093 ± 0.013	1.094 ± 0.031	$\eta^2p = 0.000$	0.988
		R1L	1.137 ± 0.020	1.113 ± 0.048	$\eta^2p = 0.008$	0.655
	DRTC	**R1R**	1.087 ± 0.012	1.108 ± 0.027	$\eta^2p = 0.018$	0.509
		R1L	1.121 ± 0.021	1.224 ± 0.049	$\eta^2p = 0.125$	0.071

Estimated marginal means ± standard error for axial diffusivity adjusted for age and gender. Post-hoc univariate comparisons across groups were only considered significant if the multivariate omnibus test reached significance (neither hemisphere): [a]Wilks' Lambda = 0.462; F = 1.864; p = 0.129; $\eta^2p = 0.538$, [b]Wilks' Lambda = 0.682; F = 0.745; p = 0.676; $\eta^2p = 0.318$. Partial η^2 effect size is interpreted as small ($\eta^2p = 0.01$), medium ($\eta^2p = 0.06$) or large ($\eta^2p = 0.14$).

Supplementary Table 12. Radial diffusivity (RD) in cerebro-cerebellar tractography in healthy controls and ALS-ATXi

Cerebro-cerebellar RD×10^{-3} values			Estimated marginal means ± S.E. for groups		Statistics	
			HC n=110	ALS-ATXi n=5	Univariate effect size	HC vs ALS-ATXi
Left[a]	**FPC**	**L1L**	0.520 ± 0.006	0.499 ± 0.011	$\eta^2p = 0.112$	0.088
		L1R	0.506 ± 0.007	0.523 ± 0.017	$\eta^2p = 0.032$	0.375
	PPC	**L1L**	0.536 ± 0.004	0.539 ± 0.010	$\eta^2p = 0.003$	0.791
		L1R	0.539 ± 0.013	0.565 ± 0.031	$\eta^2p = 0.022$	0.464
	TPC	**L1L**	0.648 ± 0.012	0.612 ± 0.028	$\eta^2p = 0.051$	0.257
		L1R	0.700 ± 0.027	0.814 ± 0.063	$\eta^2p = 0.094$	0.119
	OPC	**L1L**	0.575 ± 0.009	0.560 ± 0.020	$\eta^2p = 0.017$	0.512
		L1R	0.630 ± 0.021	0.646 ± 0.048	$\eta^2p = 0.004$	0.768
	DRTC	**L1L**	0.593 ± 0.021	0.585 ± 0.022	$\eta^2p = 0.004$	0.768
		L1R	0.648 ± 0.018	0.618 ± 0.042	$\eta^2p = 0.017$	0.519
Right[b]	**FPC**	**R1R**	0.503 ± 0.005	0.497 ± 0.011	$\eta^2p = 0.009$	0.634
		R1L	0.541 ± 0.008	0.537 ± 0.017	$\eta^2p = 0.002$	0.845
	PPC	**R1R**	0.528 ± 0.006	0.526 ± 0.014	$\eta^2p = 0.001$	0.865
		R1L	0.590 ± 0.014	0.622 ± 0.032	$\eta^2p = 0.030$	0.391
	TPC	**R1R**	0.633 ± 0.017	0.654 ± 0.039	$\eta^2p = 0.010$	0.624
		R1L	0.684 ± 0.019	0.676 ± 0.045	$\eta^2p = 0.001$	0.880
	OPC	**R1R**	0.566 ± 0.012	0.561 ± 0.027	$\eta^2p = 0.001$	0.872
		R1L	0.615 ± 0.016	0.644 ± 0.036	$\eta^2p = 0.020$	0.481
	DRTC	**R1R**	0.578 ± 0.010	0.594 ± 0.024	$\eta^2p = 0.016$	0.528
		R1L	0.646 ± 0.022	0.738 ± 0.052	$\eta^2p = 0.086$	0.138

Estimated marginal means ± standard error for radial diffusivity values adjusted for age and gender. Post-hoc univariate comparisons across groups were only considered significant if the multivariate omnibus test reached significance (neither hemisphere): [a]Wilks' Lambda = 0.582; F = 1.148; p = 0.389; $\eta^2p = 0.418$, [b]Wilks' Lambda = 0.688; F = 0.725; p = 0.692; $\eta^2p = 0.312$. Bold p-values are significant at $p < 0.05$, after Bonferroni correction for multiple comparisons. Partial η^2 effect size is interpreted as small ($\eta^2p = 0.01$), medium ($\eta^2p = 0.06$) or large ($\eta^2p = 0.14$).

Supplementary Table 13. Cerebellar peduncle profiles in healthy controls and ALS-ATXi

Anatomical region	Diffusivity index	Estimated marginal means ± S.E. for groups		Statistics	
		HC n=110	ALS-ATXi n=5	Univariate effect size	HC vs ALS-ATXi
Left Superior Cerebellar Peduncle	**FA**	0.599 ± 0.004	0.577 ± 0.020	$\eta^2p = 0.011$	0.273
	AD×10^{-3}	1.365 ± 0.007	1.344 ± 0.035	$\eta^2p = 0.003$	0.573
	RD×10^{-3}	0.473 ± 0.006	0.499 ± 0.028	$\eta^2p = 0.008$	0.358
Right Superior Cerebellar Peduncle	**FA**	0.591 ± 0.004	0.564 ± 0.020	$\eta^2p = 0.016$	0.180
	AD×10^{-3}	1.372 ± 0.007	1.363 ± 0.033	$\eta^2p = 0.001$	0.789
	RD×10^{-3}	0.488 ± 0.006	0.524 ± 0.028	$\eta^2p = 0.015$	0.203
Left Inferior Cerebellar Peduncle	**FA**	0.483 ± 0.004	0.481 ± 0.018	$\eta^2p = 0.000$	0.917
	AD×10^{-3}	1.079 ± 0.005	1.072 ± 0.025	$\eta^2p = 0.001$	0.778
	RD×10^{-3}	0.494 ± 0.004	0.506 ± 0.021	$\eta^2p = 0.003$	0.568
Right Inferior Cerebellar Peduncle	**FA**	0.480 ± 0.004	0.464 ± 0.018	$\eta^2p = 0.006$	0.399
	AD×10^{-3}	1.080 ± 0.005	1.074 ± 0.026	$\eta^2p = 0.001$	0.800
	RD×10^{-3}	0.491 ± 0.005	0.512 ± 0.022	$\eta^2p = 0.008$	0.340
Middle Cerebellar Peduncle	**FA**	0.502 ± 0.004	0.511 ± 0.017	$\eta^2p = 0.002$	0.601
	AD×10^{-3}	1.052 ± 0.005	1.043 ± 0.023	$\eta^2p = 0.001$	0.695
	RD×10^{-3}	0.454 ± 0.004	0.440 ± 0.019	$\eta^2p = 0.005$	0.469

Estimated marginal means ± standard error for diffusivity values (FA, AD, RD) adjusted for age and gender. Post-hoc univariate comparisons across groups were only considered significant if the multivariate omnibus test reached significance (not applicable): Wilks' Lambda = 0.849; F = 1.154; p = 0.321; η^2p = 0.151. Partial η^2 effect size is interpreted as small ($\eta^2p = 0.01$), medium ($\eta^2p = 0.06$) or large ($\eta^2p = 0.14$). HC- Healthy Control, FA – Fractional Anisotropy, AD – Axial diffusivity, RD – Radial diffusivity

Additional details on genetic analyses

In addition to screening for GGGGCC repeat expansions in *C9orf72* and CAG trinucleotide expansions in *ATXN2*, whole-genome sequence data (1) or targeted DNA sequence data (2) were also evaluated in each participating patient. Sequence data was assessed for quality, aligned to the GRCh37 reference genome and variants were called, annotated and analysed using cutadapt V.1.9.1 (3), SAMtools V1.7 (4), Picard V.2.15.0 (http://picard.sourceforge.net/), Plink V.1.9 (5), R V.3.2.3 (http://www.r-project.org/), SnpEff V.4.3 (6) and Gemini V.0.20.1 (7). Samples were compared to 135 Irish controls sequenced as described previously (1). Samples were screened for protein-altering, exonic or splice-site variants present in 32 genes linked to ALS in the ALS online database (ALSod) (8) (ALS2, ANG, ATXN2, CHCHD10, CHMP2B, DAO, DCTN1, ELP3, ERBB4, FIG4, FUS, HNRNPA1, MATR3, NEFH, NEK1, OPTN, PFN1, PRPH, SARM1, SETX, SIGMAR1, SOD1, SPAST, SPG11, SQSTM1, TAF15, TARDBP, TBK1, UNC13A, UBQLN2, VAPB, VCP).

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