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Studies on Comparative Cytoarchitectonics: Effects of Aging on Anterior Transverse Temporal Gyral Cortex and Posterior Transverse Temporal Gyral Cortex in Human Brain[1]

Seung Chul Lee*, Byung Lan Lee and Key June Seoung

Department of Anatomy, College of Medicine, Seoul National University, Seoul 110-744, and
**Department of Dermatology, Inha Hospital, Incheon 402-751, Korea*

= Abstract = The corticies of summit of anterior transverse temporal gyrus (Brodmann's cortical area 41) and of posterior transverse temporal gyrus (Brodmann's cortical area 42) have been compared in terms of aging effects on the cytoarchitecture of both areas. Samples were taken from 290 hemispheres of 145 normal human brains (85 of male and 60 of female).

No statistically significant differences between the cortical thickness and the relative total glial cell density of the two cortical areas were noted. But the relative total neuronal cell density of Brodmann's cortical area 41 was significantly higher than that of area 42.

There was no aging effect on the relative total neuronal cell density in both cortical areas. But the relative total glial cell density tended to increase gradually along with the increment of age. The cortical thickness tended to increase gradually until the age 16-20 and thereafter decrease in both cortical areas.

Key words: ***Cytoarchitectonics, Aging effects, Brodmann's cortical area 41 and 42***

INTRODUCTION

All the regions of the cerebral cortex had been considered homogenous until the white line on the visual cortex of cerebrum was noticed by Gennari (19782). Meynert analyzed the layered pattern of cerebral cortex in 1868, and established the basis of cerebral cytoarchitectonics. Brodmann (1908, 1909 & 1910) presented the cytoarchitectonic nature of all the cerebral cortical layers and prepared the cortical map which divided cerebral cortex into 52 distinctive areas. They differ from each other in total thickness, the thickness and density of individual layers and in the arrangement of cells and fibers.

Since 1963, many reports have been published by examining human brains collected in our department in order to study the cytoarchitecture of the cerebral cortex (Kang *et al.* 1968; Seoung 1983; Yang *et al.* 1983). Our present work intended to compare the cytoarchitectures of the summit of the anterior transverse temporal gyral (area 41 of Brodmann) and the posterior transverse temporal gyral (area 42 of Brodmann) cortices and to investigate the differences between those two areas by means of quantitative assessment.

MATERIALS AND METHODS

Normal brains were used in this study. Anterior transverse temporal gyral corticies of 142 (82 male and 60 female) and posterior transverse temporal gyral corticies of 142 (85 male and 57 female) brains were obtained after the fixation with 10% neutral formalin. The range of the age distribution was 0-85 in the male and 0-61 in the female.

After cerebral hemispheres were obtained from the junction area of the upper and the middle third

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Table 1. Statistical phases on thickness, relative total neuronal and glial cell densities at the anterior transverse temporal gyral cortex (Brodmann's area 41) and the posterior transverse temporal gyral cortex (Brodmann's area 42) of the right human cerebral hemisphere in successive increase of the postnatal age-group in both sexes

Age group in year / Item: Area / Sex		Cortical thickness (in mm)				Relative total neuronal density (in cell)				Relative total glial density (in cell)			
		n.	Area 41	n.	Area 42	n.	Area 41	n.	Area 42	n.	Area 41	n.	Area 42
0 — 1	m	8	2.14±0.25	8	2.20±0.29	8	1063±145	8	1036±203	8	533± 72	8	658±74
	f	6	2.18±0.34	7	2.30±0.27	6	1036±155	7	942±136	6	554± 84	7	596±80
2 — 5	m	13	2.41±0.33	16	2.46±0.36	13	709±112	16	530± 66	13	493± 68	16	503±53
	f	13	2.39±0.35	10	2.52±0.40	13	657±114	10	483± 62	13	520± 82	10	482±90
6 — 10	m	7	2.51±0.34	6	2.50±0.29	7	610± 92	6	437± 59	7	551± 90	6	537±62
	f	7	2.46±0.28	8	2.62±0.31	7	622± 89	8	408± 62	7	523± 75	8	500±92
11 — 15	m	6	2.57±0.37	5	2.57±0.38	6	619±115	5	407± 52	6	581± 82	5	552±79
	f	8	2.55±0.35	7	2.62±0.39	8	621± 96	7	372± 39	8	554± 78	7	530±80
16 — 20	m	7	2.57±0.36	7	2.61±0.37	7	622± 94	7	409± 53	7	614± 94	7	523±78
	f	6	2.55±0.43	5	2.65±0.31	6	609± 78	5	354± 52	6	608± 94	5	568±70
21 — 30	m	10	2.57±0.33	9	2.58±0.38	10	550± 96	9	414± 55	10	685± 96	9	593±69
	f	9	2.52±0.37	10	2.57±0.42	9	579± 85	10	401± 58	9	527±123	10	613±72
31 — 40	m	8	2.53±0.40	9	2.54±0.29	8	552± 93	9	387± 54	8	700±120	9	591±72
	f	5	2.49±0.41	6	2.56±0.32	5	636±104	6	351± 70	5	719±115	6	566±80
41 — 50	m	9	2.45±0.36	11	2.44±0.37	9	595± 74	11	397± 47	9	720±121	11	644±70
	f	4	2.52±0.30	3	2.53±0.29	4	565± 78	3	371± 52	4	695±108	3	612±71
51 — 60	m	5	2.47±0.29	5	2.43±0.39	5	627± 94	5	427± 58	5	749±118	5	722±10
	f	1	2.44±1	1	2.47—	1	590—	1	375—	1	720—	1	675—
61···	m	9	2.32±0.36	9	2.47±0.44	9	553± 88	9	419± 52	9	739±125	6	805±93
	f	1	2.40 —	—	—	1	606 —	—	—	1	700 —	-	—
Adult average (21—50)	m	27	2.52±0.40	29	2.52±0.30	27	566± 74	29	400± 51	27	701±118	29	613±83
	f	18	2.51±0.41	10	2.56±0.30	18	593± 85	19	381± 48	18	668±134	19	596±70

of the summit of the anterior transverse temporal gyral and posterior transverse temporal gyral cortices at right angle to the long axis of each gyrus. Specimens were further fixed with 10% neutral formalin followed by paraffin embedding procedure. Paraffin blocks were sectioned with a thickness of 20 μm and stained with aqueous cresyl violet and hematoxylin. The thickness of each section was measured under $\times 10$ ocular lens with an attached micrometer and $\times 10$ objective lens.

The number of neurons or glial cells in a unit volume of cortex was computed from counts of nucleoil with the application of the Abercrombie (1946) correction. The counts were made using an eyepiece grid that enabled the image of the section to be divided into a number of strips of known width (100 μ), length (100 μ) and thickness (20 μ) under $\times 10$ ocular and $\times 40$ objective lenses, each strip being parallel to the pial surface. After the cell number in each strip with 20×10^4 μ^3 was multiplied by 5, the relative total neuronal or glial cell density (number of neurons or glial cells/unit volume of cortex) could be computed. In the present study, the unit volume of cortex was taken

Table 2. Statistical phases on thickness, relative total neuronal and glial cell densities at the anterior transverse temporal gyral cortex (Brodmann's area 41) and the posterior transverse temporal gyral cortex (Brodmann's area 42) of the left human cerebral hemisphere in successive increase of the postnatal age-group in both sexes

Age group in year	Item / Area / Sex	Cortical thickness (in mm)				Relative total neuronal density (in cell)				Relative total glial density (in cell)			
		n.	Area 41	n.	Area 42	n.	Area 41	n.	Area 42	n.	Area 41	n.	Area 42
0 — 1	m	8	2.13±0.26	8	2.16±0.31	8	1033±162	8	1078±172	8	526± 84	8	679±92
	f	6	2.19±0.27	7	2.25±0.36	6	1067±162	7	967±128	6	579± 79	7	568±72
2 — 5	m	13	2.45±0.31	16	2.42±0.3	13	674± 96	16	571± 73	13	472± 66	16	524±69
	f	13	2.42±0.37	10	2.51±0.39	13	679±126	10	501± 70	13	484± 66	10	505±74
6 — 10	m	7	2.52±0.29	6	2.57±0.41	7	594± 84	6	412± 62	7	532± 73	6	518±49
	f	7	2.48±0.36	8	2.53±0.28	7	591± 82	8	427± 58	7	517± 83	8	532±78
11 — 15	m	6	2.59±0.40	5	2.64±0.31	6	627± 99	5	363± 48	6	592± 84	5	567±58
	f	8	2.53±0.34	7	2.58±0.25	8	586± 73	7	390± 48	8	567± 62	7	515±74
16 — 20	m	7	2.60±0.35	7	2.63±0.33	7	619±108	7	392± 48	7	573± 75	7	542±82
	f	6	2.59±0.37	5	2.57±0.28	6	638± 92	5	383± 48	6	628±102	5	541±93
21 — 30	m	10	2.57±0.37	9	2.60±0.41	10	589± 82	9	404± 62	10	680±102	9	585±74
	f	9	2.54±0.40	10	2.53±0.38	9	596± 83	10	432± 62	9	659± 96	10	617±68
31 — 40	m	8	2.57±0.39	9	2.48±0.25	8	580±104	9	404± 49	8	675± 95	9	618±82
	f	5	2.47±0.35	6	2.53±0.41	5	602± 97	6	377± 62	5	732±132	6	581±69
41 — 50	m	9	2.49±0.28	11	2.41±0.33	9	595± 82	11	429± 62	9	743±119	11	665±93
	f	4	2.52±0.29	3	2.49±0.37	4	548± 82	3	380± 48	4	681± 96	3	623±62
51 — 60	m	5	2.45±0.44	5	2.45±0.41	5	606±106	5	409± 53	5	766± 99	5	735±89
	f	1	2.42 —	1	2.41 —	1	570 —	1	440 —	1	760 —	1	705 —
61···	m	9	2.35±0.38	9	2.40±0.41	9	570± 82	9	458± 48	9	759±132	9	782±90
	f	1	2.43 —	—	—	1	580 —	—	—	1	720 —	—	—
Adult average (21—50)	m	27	2.54±0.39	29	2.49±0.30	27	588± 89	29	412± 55	27	700±132	29	627±71
	f	18	2.52±0.37	19	2.52±0.29	18	589±102	19	409± 55	18	684±128	19	606±74

as 0.001 mm^3 (10^6 μ^3 (Sholl 1959).

Values, obtained by observation of anterior transverse temporal gyral and posterior transverse temporal gyral cortices, were statistically processed for the biological significance (Snedector 1956; Alder and Roessler 1960).

RESULTS

1. Comparison of cortical thickness

1) Age related cortical thickness

Although area 42 of Brodmann showed mean value higher than that of area 41, statistically significant difference was not present between the two areas regardless of age, sex, or side ($p > 0.05$). The cortical thickness tended to increase gradually until age 16-20 and decrease after that in both areas and sexes (Table 1, 2).

2) Brain weight related cortical thickness

No significant difference between the two areas was noticed in each weight group. Sex didn't cause any difference in the results of the comparison ($p > 0.05$) (Table 3,4).

Table 3. Statistical phases on thickness, relative total neuronal and glial cell densities at the anterior transverse temporal gyral cortex (Brodmann's area 41) and the posterior transverse temporal gyral cortex (Brodmann's area 42) of the right human cerebral hemisphere in successive increase of the postnatal brain weight-group in both sexes

Age group in year	Item / Area / Sex	Cortical thickness (in mm)				Relative total neuronal density (in cell)				elative total glial density (in cell)			
		n.	Area 41	n.	Area 42	n.	Area 41	n.	Area 42	n.	Area 41	n.	Area 42
300 — 499	m	2	2.05 —	2	2.06 —	2	1180 —	2	1155 —	2	520 —	2	750 —
	f	4	2.10±0.32	4	2.16±0.32	4	1130±152	4	1056±108	4	553± 82	4	690±92
500 — 699	m	4	2.16±0.31	5	2.21±0.41	4	865±138	5	958± 92	4	525± 72	5	588±82
	f	2	2.19 —	1	2.29 —	2	820 —	1	805 —	2	559 —	1	610 —
700 — 899	m	2	2.23 —	2	2.31 —	2	780 —	2	789 —	2	510 —	2	559 —
	f	6	2.28±0.34	6	2.39±0.41	6	814±134	6	680± 94	6	509± 84	6	588±69
900 — 1099	m	13	2.33±0.28	12	2.43±0.36	13	684±124	12	601± 74	13	559± 79	12	553±59
	f	14	2.38±0.29	15	2.51±0.29	14	649±117	15	486± 63	14	560± 86	15	546±68
1100 — 1199	m	14	2.51±0.42	12	2.52±0.32	14	616± 94	12	431± 48	14	623± 88	12	538±64
	f	14	2.47±0.41	13	2.58±0.38	14	619± 94	13	378± 48	14	619± 94	13	566±69
1200 — 1299	m	15	2.50±0.43	17	2.54±0.41	15	595± 78	17	453± 62	15	645± 94	17	681±74
	f	9	2.57±0.48	8	2.51±0.36	9	622± 88	8	467± 62	9	610±a112	8	594±71
1300 — 1399	m	16	2.59±0.35	16	2.54±0.42	16	569± 72	16	418± 52	16	570± 94	16	617±91
	f	6	2.56±0.35	6	2.60±0.32	6	572± 80	6	388± 52	6	644± 92	6	571±74
1400 — 1499	m	10	2.56±0.28	12	2.60±0.41	10	536± 84	12	432± 48	10	632± 85	12	659±79
	f	4	2.58±0.42	3	2.65±0.41	4	484± 62	3	386± 49	4	610±115	3	574±93
1500 — 1599	m	4	2.59±0.35	5	2.64±0.38	4	505± 72	5	401± 62	4	606± 96	5	613±71
	f	1	2.63 —	1	2.69 —	1	475 —	1	350 —	1	630 —	1	630 —
1600···	m	2	2.54 —	2	2.58 —	2	470	2	341 —	2	635 —	2	650 —
	f	—	—	—	—	—	—	—	—	—	—	—	—
Adult average (21—50)	m	27	2.52±0.40	29	2.52±0.30	27	566± 74	29	400± 51	27	701±118	29	613±83
	f	18	2.51±0.41	19	2.56±0.80	18	593± 85	19	381± 48	18	668±134	19	596±70

2. Comparison of neuronal density

1) Age related neuronal density

The values of area 41 were significantly higher than those of area 42 since age 2-5. Above results were same in both sides and sexes (Table 1,2).

2) Brain weight related neuronal density

Area 42 showed higher mean value than that of area 42. In suckling young age, both areas presented successive decrease of neuronal density until 900-1099 gm group. But there was relatively no change between both areas in over 900 gm group (Table 3,4).

3. Comparison of glial cell density

1) Age related glial cell density

No significant differences between area 41 and 42 were noticed in each group. Both areas showed gradual increment of glial density since age 2-5 (Table 1,2).

2) Brain weight related glial density

There were no significant differences between the two areas. Although glial density was successively decreasing until weight 900 gm, there were relatively constant values in other weight groups (Table 3,4).

Table 4. Statistical phases on thickness, relative total neuronal and glial cell densities at the anterior transverse themporal gyral cortex (Brodmann's are 41) and the posterior transverse temporal gyral cortex (Brodmann's area 42) of the left human cerebral hemisphere in successive increase of the postnatal brain weight-group in both sexes

Age group in year / Item: Area / Sex		Cortical thickness (in mm)				Relative total neuronal density (in cell)				Relative total glial density (in cell)			
		n.	Area 41	n.	Area 42	n.	Area 41	n.	Area 42	n.	Area 41	n.	Area 42
300 — 499	m	2	2.04 —	2	2.03 —	2	1200 —	2	1215 —	2	540 —	2	790 —
	f	4	2.08±0.28	4	2.13±0.29	4	1160±143	4	1110± 92	4	574± 87	4	655±78
500 — 699	m	4	2.13±0.30	5	2.21±0.36	4	885±142	5	1002±100	4	500± 83	5	643±90
	f	2	2.18 —	1	2.26 —	2	840 —	1	850 —	2	540 —	1	585 —
700 — 899	m	2	2.25 —	2	2.29 —	2	800 —	2	830 —	2	480 —	2	600 —
	f	6	2.33±0.28	6	2.34±0.36	6	831±123	6	708± 90	6	526± 93	6	550±70
900 — 1099	m	13	2.36±0.33	12	2.47±0.29	13	714±121	12	551± 70	13	539± 75	12	540±62
	f	14	2.42±0.35	15	2.45±0.36	14	629± 92	15	466± 58	14	585± 73	15	576±74
1100 — 1199	m	14	2.54±0.36	12	2.59±0.41	14	585± 86	12	403± 52	14	581± 82	12	545±61
	f	14	2.48±0.44	13	2.55±0.39	14	614±105	13	392± 49	14	616± 92	13	559±72
1200 — 1299	m	15	2.54±0.44	17	2.56±0.36	15	585± 72	17	410± 60	15	653± 96	17	657±70
	f	9	2.56±0.36	8	2.55±0.29	9	630± 82	8	438± 51	9	643±108	8	633±58
1300 — 1399	m	16	2.60±0.43	16	2.59±0.39	16	595± 85	16	398± 48	16	654± 83	16	634±80
	f	6	2.59±0.42	6	2.63±0.29	6	543± 74	6	363± 44	6	620±109	6	550±80
1400 — 1499	m	10	2.59±0.37	12	2.57±0.36	10	538± 76	12	446± 66	10	652± 88	12	647±80
	f	4	2.60±0.38	3	2.61±2.63	4	503± 83	3	405± 56	4	633±104	3	599±82
1500 — 1599	m	4	2.60±0.32	5	2.61±0.36	4	486± 65	5	426± 51	4	632± 89	5	590±60
	f	1	2.65 —	1	2.65 —	1	490 —	1	365 —	1	615 —	1	580 —
1600···	m	2	2.57 —	2	2.57 —	2	490 —	2	392 —	2	610 —	2	685 —
	f	—	—	—	—	—	—	—	—	—	—	—	—
Adult average (21—50)	m	27	2.54±0.39	29	2.49±0.30	27	588± 89	29	412± 55	27	700±132	29	627±71
	f	18	2.52±0.37	19	2.52±0.29	18	589±102	19	409± 55	18	684±128	19	606±74

DISCUSSION

Our investigation of the cerebral cytoarchitectonics for 20 years has triggered the studies on comparative cytoarchitectonics of various cortical areas of cerebral hemispheres (Kwun *et al.* 1984).

In man, the audiotory area is located on the two transverse gyri which lie on the dorsal surface of the superior transverse convolution. The primary auditory area is buried in the floor of the lateral sulcus. The middle part of the anterior transverse temporal gyrus constitute the primary auditory center (Brodmann's cortical area 41). Remaining parts of the posterior transverse temporal gyrus and adjacent portions of the superior temporal gyrus compose Brodmann's area 42, which is largely called the secondary auditory center. The auditory area receives geniculotemporal fibers (auditory radiation) from the medial geniculate body. The auditory radiation reaches its cortical projection site by passing through the sublenticular portion of the internal capsule. The greater part of the auditory radiation projects to area 41, although fibers also project to area 42.

In the present study, it was noted that no significant differences between the cortical thickness of the two areas were present. We found it interesting that the cortical thickness of both areas tended to increase gradually from birth and reach the peak level at age 20. After that age, it decreased slowly due to the cortical atrophy which is one of the aging phenomena of the cerebral cortex. Relative total neuronal density of area 41 was significantly higher than that of area 42 since age 2-5. In both areas neuronal density of 0-1 age group showed significantly higher value than that of other age groups (Suh *et al.* 1985). This was probably due to the incomplete parcellation of neurons in that age. Glial density was successively increasing since age 2-5 in both areas.

REFERENCES

Abercrombie M. Estimation of nuclear population from microtome section. Anat. Rec. 1946, 94:239-246

Alder HL, Roesler EB. Introduction to probability and statistics. Chapter 8. Random sampling. Freeman, San Francisco & London. 1960, pp. 96-106

Brodmann K. Beitrage zur histologischen Lokalisation der Grossirrinde. VI. Die Cortexgliedurung des Menschem. J. Psych. Neurol. (Lpz). 1908, 10:231-246

Brodmann K. Vergleichende Localisationslehre der Grosshirnde in ihren Prinzipien dargestellt auf Grund der Zellenbaus. Bath., Lpz. 1909

Brodmanm K. Feinere Anatomie des Grosshirns. Springer, Berlin. 1910, 1:207-307

Gennari G. De Peculari STructurea Cerebri Nonnullisque Ejus Morbis. Parma. 1782, Cited by Brazier.

Kang JC, Lee MB. Studies on the cytoarchitectonics of the precentral gyrus (motor cortex) of the Korean cerebral hemisphere. Seoul J. Med. 1968, 9:11-39

Kwun BD, Seoung KJ, Cha CI. Cytoarchiltectonics and aging effects between rostral and caudal sulcar walls of postcentral gyral cortex in man. Seoul J. Med. 1984, 25:293-320

Seooung KJ. Studies on cytoarchitectonics at sulcar cortex of insular lobe in human brain. Seoul J. Med. 1983, 24:22-42

Snedector GW. Statistical methods. Iowa College Press 1956

Suh JS, Lee BL, Seoung KJ. A Comparative study of cytoarchitectonics: Effects of Aging and Brain Weight Increase on Precentral Gyral and Insular Cortex of Human Brain. Seoul J. Med. 1985, 26:131-137

= 국문초록 =

加齡이 人大腦 前橫側頭回 및 後橫側頭回 各己皮質에 미치는 影響에 關한 比較細胞構築學的 硏究

서울大學校 醫科大學 解部學敎室 및 仁荷病院 皮膚科*

李勝澈*・李秉蘭・成耆畯

新生兒에서 老齡에 이르는 病變 및 畸形이 없는 人大腦 145例(男性의 것 85例, 女性의 것 60例)의 大腦半球 290側에서 얻은 前橫側頭回 (Brodmann 第41分野) 및 後橫側頭回 (Brodmann 第42分野)의 兩分野에서 그 峯部皮質間의 細胞構築相을 比較하고 加齡에 따른 影響을 追究하였다.

兩分野間 皮質厚徑과 膠質細胞密度差를 發見할 수 없었으나 神經細胞密度는 前橫側頭回皮質이 後橫側頭回皮質에 比하여 더 稠密하였다.

또한 兩分野 모두 神經細胞密度에 對한 加齡效果는 認定할 수 없었으나 膠質細胞는 出生後 年齡增加에 따라 그 數가 漸次 增加하였다. 皮質厚徑은 加齡에 따라 漸次 增加하며 20歲以後에는 減少傾向을 보였다.

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