
Cohort Study of Brain-function Improvement in Elderly People and People with Learning Disability

Project Director, IDAC, Tohoku University

Ryuta Kawashima

Research goal

In this research, cohort studies related to (1) changes in brain function with aging of healthy elderly people and (2) impaired cognitive development of people with learning disability are carried out utilizing our knowledge and skills in brain science. On the basis of these research achievements, (1) we will propose forward-looking measures for an aging society with fewer children, to maintain and improve the mental and physical health of healthy elderly people, to clarify the attempts and intervention methods to improve daily-life productivity, and to reduce social insurance expenses, such as medical costs and care insurance fees. Also, (2) we develop methods to promote the healthy and spiritually rich development of the brain function of children with impaired cognitive development by examining the relationship among the brain and cognitive functions, habits in daily life, and other factors of people with learning disability, for the purpose of clarifying the pathogenic mechanism of learning disability.

Cohort study of elderly people

In the cohort study of elderly people, we carried out a survey of 665 healthy elderly subjects aged 65 years or older who live in their own homes in the local community. The cohort study comprised a questionnaire survey on the habits of daily life, such as the frequency of physical activities and food intake, as well as a cognitive-function test performed by interview. All the subjects were instructed to take a simple quiz on reading, writing, and calculation as active cohort tasks. The results of the longitudinal cohort study were analyzed in detail.

【Methods】

The survey items include those related to the habits of daily life (history of cardiovascular disease, health-related quality of life (QOL) measure, educational background, frequency of meals, physical activity, sleep, hobbies and others) and those related to cognitive function (brain function test). For items related to the habits of daily life, subjects were requested to respond to each item by writing their answer on the questionnaire sheet. For items related to cognitive function, each subject was interviewed. To examine the relationship between the maintenance and improvement of cognitive function and the scores obtained from the surveys on the habits of daily life (predictability), the following analysis was carried out. Among the scores of the cognitive function tests explained above, scores for the Stroop task (mainly frontal cortex function), word-memorization task (mainly temporal cortex function), and mental rotation

task (mainly parietal association area function) were selected as dependent variables. Each task was carried out twice. The difference in the scores of the first and second task runs was calculated for each subject. The subjects whose score in the second task is equal to or higher than that in the first task are classified into the maintenance and improvement group, and those whose score in the second task is lower than that of the first task are classified into the deterioration group. Regarding the habits of daily life of the subjects examined in this study, logistic regression analysis, in which scores are corrected using the subject's basic characteristics (gender, age, educational background, history of cardiovascular disease, energy intake by food, health-related QOL measure), was carried out to calculate the odds ratio of maintenance and improvement. If the odds ratio of maintenance and improvement is higher than 1, the possibility of maintenance and improvement is high. The basic characteristics used for correction were selected from among those suggested to have a strong correlation with brain function in previous studies. The independent variables used in the analysis were items related to the habits of daily life, including 1) seven items related to food intake (dairy products, meat, seafood, eggs, beans, vegetables, and fruits), 2) four items related to the frequency of cognitive activities in daily life (listening to the radio, reading magazines and books, playing games such as cards and shogi (Japanese chess)), 3) total hours of sleep per day, and 4) four items related to the presence or absence of hobbies (such as arts, sports, volunteer activities, and any other type of hobbies).

【Results】

In the logistic regression analysis of FAB, significant results were obtained for subjects with high physical and mental summary scores (high-physical-summary-score group and high-mental-summary-score group, respectively). Compared with the reference groups (low-physical-summary-score group and low-mental-summary-score group), the odds ratio of maintenance and improvement decreased by approximately 60% and 40% for the high-physical-summary-score group and high-mental-summary-score group, respectively. In the logistic regression analysis of MMSE, no significant effect of the habits of daily life on the scores was observed. There was a significant correlation between the Stroop task score and the intake of beans. As the intake of beans per day increased by 100 g, the odds ratio of maintenance and improvement increased by approximately 1.6 times. Also, a significant correlation was found between the score of the word-memorization task and the frequency of listening to the radio. The odds ratio of maintenance and improvement for subjects who listened to the radio only once or less per year decreased by approximately 40% compared with that for subjects who listened to the radio almost every day. In the logistic regression analysis of the scores of the mental rotation task, no significant effect of items related to the habits of daily life on the score was observed.

【Conclusion】

On the basis of these findings, it is considered that the deterioration of the performance (physical activities) of elderly people contradicts their sense of well-being, that is, those with reduced performance (physical activities) tend to highly evaluate their sense of well-being.

Cohort study of children with learning disabilities

In the cohort study of children with learning disabilities, we carried out a survey of 1,094 children with special needs. The cohort study comprised a questionnaire study on the habits of daily life and cognitive-function tests performed by interview. A total of 4,287 healthy children were also surveyed as a control group.

[Methods]

The survey items include those related to the habits of daily life [background data (family structure and residential environment), basic habits of daily life, daily activities, communication activities, and sociality] and those related to cognitive function (brain function test). For the items related to the habits of daily life, subjects were requested to respond to each item by writing their answer on the questionnaire sheet. For items related to cognitive function, children with special needs were interviewed one-on-one, and the control group took a test as a class. Cross-sectional analysis was carried out for 150 children with special needs, who were diagnosed as having learning disabilities, attention-deficit hyperactivity disorder or high-functioning autism at medical institutions and with full medical data. Over the next year, all 150 children participated in the second test, and longitudinal analysis was carried out. Regarding the control-group children, among the 2,392 children who participated in the first test, cross-sectional analysis was carried out for 1,416 children with full medical data. Furthermore, among these 1,416 children, longitudinal analysis was carried out for 954 children who participated in the second test over the next year. For the data of children with special needs, correlation analysis of the results obtained in the first cognitive-function test (cross-sectional analysis) and correlation analysis between the change in the scores of the cognitive-function test for the first and second tests and habits of daily life (longitudinal analysis) were carried out. For the data of healthy children, only the latter correlation analysis was carried out.

[Results]

1. Hours of sleep. For the children with special needs, no significant correlation was found between hours of sleep and the δZ value in the longitudinal analysis. In the cross-sectional analysis, there were significant negative correlations between hours of sleep during weeknights and $Z1$ values of the digit symbol test, concept test, picture arrangement test, and 2D mental rotation test, and between hours of sleep during weekends and $Z1$ values of the number recall test and 2D mental rotation test. For the healthy children, there were significant positive correlations between hours of sleep during weeknights and the δZ value of the matching test, and between hours of sleep during weekends and δZ values of the digit symbol test and number recall test. In contrast, there were significant negative correlations between hours of sleep during weeknights and δZ values of the digit symbol test and number recall test.
2. Dietary habits. In the longitudinal analysis for children with special needs, there was a significant positive correlation between the frequency of snacks between meals and the δZ value of the 3D mental rotation test. There was a significant negative correlation between the frequency of eating breakfast and the δZ value of the matching test ($p=0.04$). In the cross-sectional analysis of children with special needs,

there were significant positive correlations between the following three relationships: 1) the frequency of eating breakfast and the $Z1$ value for the picture arrangement test, 2) the number of side dishes and the $Z1$ value of the picture arrangement test, and 3) eating breakfast as a family and the $Z1$ value of the 2D mental rotation test. For healthy children, there were significant positive correlations between the number of side dishes and the δZ value of the digit symbol test and between eating breakfast as a family and δZ values of the digit symbol test and number recall test.

3. Parent and child relationship. In the longitudinal analysis of children with special needs, there were significant positive correlations between hours spent with parents during weekends and the δZ value of the number recall test, and between the frequency of playing sports with parents and the δZ value of the concept test. In the cross-sectional analysis, there were significant negative correlations between the following three relationships: 1) hours spent with parents during weekdays and the δZ value of the digit symbol test, 2) hours spent with parents during weekends and the δZ value of the concept test, and 3) the frequency of playing sports with parents and the δZ value of the number recall test. For healthy children, there were significant positive correlations between hours spent with parents during weekdays and the δZ value of the number recall test and between the frequency of cooking with parents and the δZ value of the digit symbol test.
4. Human relationships. In the longitudinal analysis for children with special needs, no test showed a significant positive correlation with items related to human relationships. There was a significant negative correlation between the frequency of playing with friends and the δZ value of the matching test. In the cross-sectional analysis, there were significant positive correlations between the frequency of extracurricular activities and δZ values of the digit symbol test, picture arrangement test, and 2D mental rotation test; there was a significant negative correlation between the frequency of playing with friends and the δZ value of the digit symbol test. For healthy children, there were significant positive correlations between the frequency of playing with friends and δZ values of the digit symbol test and number recall test. In contrast, there were significant negative correlations between the following three items and δZ values of the tests: 1) the frequency of chatting with friends and δZ values of the digit symbol test, number recall test, and labyrinth test, 2) the frequency of extracurricular activities and δZ values of the digit symbol test, number recall test, picture arrangement test, labyrinth test, and 2D mental rotation test, and 3) the level of relationships with friends and the δZ value of the number recall test.

【Conclusion】

On the basis of the results of this study, it was found that most of the experiences and habits of daily life that may have favorable effects on the cognitive functions of children are essential in daily life throughout childhood and adolescence and are necessary from the viewpoint of development. In that context, we must also improve the social and cultural environment to support and promote the development of children with special needs.