PRELIMINARY SYNTHESIS

OF THE

THIRD HIGH LEVEL FORUM

ON

LEARNING SCIENCES AND BRAIN RESEARCH:

POTENTIAL IMPLICATIONS FOR
EDUCATION POLICIES AND PRACTICES

BRAIN MECHANISMS AND LEARNING IN AGEING

In co-operation with

RIKEN Brain Science Institute
Japanese Ministry of Education, Culture, Sport, Science and Technology

Tokyo, Japan
26 - 27 April 2001

Organisation for Economic Co-operation and Development

OECD CERI

Center for Educational Research and Innovation

Table of Contents:

The goal of this report from the Tokyo forum is to:

- Provide an overview of the content of the forum;
- Present emerging educational and policy issues in relation to the sequence of the three fora (especially relating to the Tokyo forum) on the brain and education.

The three fora

- 16-17 June 2000, New York City, USA
  With Sackler Institute - Weill Medical College of Cornell University
  First high-level forum on "Brain Mechanisms and Early Learning";

- 1-3 February 2001, Granada, Spain
  With the University and the City of Granada
  Second high-level forum, on "Brain Mechanisms and Youth Learning";

- 26-27 April 2001, Tokyo, Japan
  With RIKEN Brain Science Institute and
  Japanese Ministry of Education, Culture, Sport, Science and Technology
  Third high-level forum, on "Brain Mechanisms and Learning in Ageing."

This report was prepared by Dr. Anthony E. Kelly (Professor of Instructional Technology at George Mason University, USA and former Program Director at National Science Foundation, USA) with assistance from the OECD-CERI Secretariat.

N.B. This project on "Learning Sciences and Brain Research" was introduced to the OECD's CERI Governing Board on 23 November 1999, outlining proposed work for the future. The purpose of this novel project was to create collaboration between learning sciences and brain research on the one hand, and researchers and policy-makers on the other hand. The CERI Governing Board recognised this as a risk venture, as most innovative programmes are, but with a high potential pay-off. The CERI Secretariat and Governing Board particularly agreed that the project had excellent potential for better understanding learning processes over the lifecycle, but that ethical questions also existed. Together these potentials and concerns highlighted the need for dialogue between the different stakeholders. Once the conceptual basis of the project had been established, initial discussions began with major research and funding institutions: Sackler Institute, NYC (USA), University of Granada (Spain), RIKEN Brain Science Institute (Japan); National Science Foundation (USA), The Lifelong Learning Foundation (UK), The City of Granada (Spain); and INSERM (France).

Introduction

Researchers pointed to promising areas of research (particularly related to attentional functions) that could serve as warning signals of cognitive decline

The Tokyo forum was created to address questions and issues about brain mechanisms in the adult population as a whole. Interestingly, among the themes that were addressed, the central ones focused on the elderly, particularly regarding extending and enhancing cognitive functioning into old age.

The more important issues in brain research[1] presented at the Tokyo forum included:

1. Neurodegenerative Diseases and Ageing;
2. Arresting Decline and Enhancing Capacity;
3. Plasticity and Language;
4. Memory and Attention;
5. Methodological Issues;
6. The Role of Culture.

"Ageing and cognition" is a topic that has special significance not only to the OECD member countries in general, but to Japan specifically. Numerous socio-economic reports[2], especially from Japan, have shown that large segments of the working population are ageing and that these adults have age-related health issues that will affect not only their work but also later retirement[3]. As the population world-wide ages, research institutes (such as RIKEN, National Institutes for Ageing) are establishing research protocols designed to delay or slow the onset of age-related decline.

Two central findings of this forum were that: (a) there is insufficient research on the cumulative and positive effects of intellectual and physical training across the life-span; and (b) we do not understand sufficiently the normal trajectory of cognitive development across the entire life-span to warn us earlier in life about impending cognitive declines, not only due to normal processes of ageing, but more importantly declines due to neuro-degenerative diseases.

Researchers pointed to promising areas of research (particularly related to attentional functions) that could serve as warning signals of cognitive decline. They also introduced potential ameliorative strategies may either arrest decline, or in some cases enhance cognitive functions. These strategies, while tentatively proposed, included physical fitness programs, intellectual training, and structured socio-cultural support systems.

Other researchers extended the range of topics and reported positive data on ageing related to topics such as creativity, culture, and gender.

[1] The strategy throughout these fora has been to ask scientists to report on the most up-to-date information available on a particular topic. As such, the viewpoints expressed in all three fora do not necessarily reflect scientific consensus. This strategy has its weakness in that reported findings may change with additional research, however, the organisers balance this against the necessity of providing a forum where new research can be introduced, presented, and discussed.

[2] See also *Reforms for an ageing society*, OECD 2000.

[3] Dr Bengtsson's presentation in Tokyo.

The topics of the forum, taken together, demonstrated that more work is needed to fully understand how science and education can work together to extend the cognitive vitality of the older adult, and to deepen our understanding of adult learning, generally.

At least two important policy issues were raised by this forum:

(a) How to support research efforts aimed at identifying early cognitive indicators of debilitating neuro-degenerative diseases in their pre-clinical stages; and

(b) How to support research into remedial efforts so that decline may be prevented, or its progress slowed, and existing cognitive functioning enhanced.

1. Disorders Associated with Ageing

Because there are fewer young people of working age, there will be less economic support for this growing ageing population

While general declines in most cognitive capacities have been documented in the healthy ageing brain, some cognitive abilities were reported to increase onwards toward the 6th decade of life[4]. However, two frequent brain disorders associated with ageing, Alzheimer's disease and senile depression, exacerbate cognitive declines.

1.1. Alzheimer's disease

In his presentation, Dr. Parasuraman brought attention to the steadily growing cost of neuro-degenerative illnesses for society, world-wide (this was also addressed by Dr. Bengtsson, but from a policy perspective). The impact of neuro-degenerative disorders is most acutely felt in the area of cognitive function with ageing. The cost to society of neuro-degenerative disorders such as Alzheimer's disease along with associated medical costs is staggering[5]. With the continued ageing of populations world-wide, these costs will only increase. In addition, because there are fewer young people of working age, there will be less economic support for this growing ageing population.

Not only do neuro-degenerative illnesses rob society of accumulated expertise and wisdom, they also rob the individual of his or her sense of self. Alzheimer's disease is a severe type of senility whose symptoms include defects in cognitive functioning, memory, language and perceptual abilities.

Given the costs of neuro-degenerative illnesses[6], and their potential for early onset in some middle-aged adults,[7] Parasuraman called for reliable cognitive methods for the early detection and treatment of Alzheimer's Disease. In the absence of early detection methods, it is difficult to assess the impact of potentially ameliorating techniques and factors.

The first and most obvious symptom of this disease is the loss of recent memory, particularly the ability to place new information into long-term storage. According to Dr. Takashima, the major pathological features of Alzheimer's disease are the formation of senile plaques[8], and the loss of neurons. This loss is one of the contributing factors responsible for dementia in Alzheimer's Disease.

---

[4] Drs. Kramer and Whang both presented data from Dr. Denise Park at the University of Michigan showing a general decline in most cognitive capacities from 20-80 years of age (http://www.ageingmind.isr.umich.edu).

[5] According to Dr. Parasuraman, in the United States, Alzheimer's Disease affects approximately 4 million adults and costs the economy about $100 billion, both in terms of medical care and attrition of the working population.

[6] See Ernst, R. L., & Hays, J. W. (1994*).* The US economic and social costs of Alzheimer's disease revisited*. American Journal of Public Health*, 84, 1261-1264

[7] Associated neurofibrillary tangle and amyloid plaques can occur decades before clinical symptoms appear. See *Braak, H., & Braak, E. (1991). Neuropathological stageing of Alzheimer-related changes. Acta Neuropathologica, 82, 239-259*

[8] Senile plaques are clusters of abnormal cell processes surrounding masses of protein neurofibrillary tangles (NFTs), which are tangles of neurofilaments inside neurons. More specifically, senile plaques are composed of extracellular Aß fibril deposits. It is believed that NFTs are the most common pathway leading to neural loss.

The progression of dementia is mainly divided into three stages[9]. The early stage occurs predominantly in relatively young individuals, while the more advanced stage gradually appears with increasing age. Development of neurofibrillary tangles[7] is an ageing dependent–process, and development of dementia is closely correlated with a continuation of intraneuronal changes starting with the first NFTs and advancing to cortical destruction.

1.2 Senile Depression

Dr. Kanba spoke about depression in the elderly and described it as an illness associated with brain deterioration. Symptoms include lack of energy, concentration, and interest, insomnia, loss of appetite, and anhedonia (the incapacity to experience pleasure). While these symptoms are similar to those in younger people with depression, older adults present a more complicated etiology (due to cardiovascular-type diseases and cases of blocked blood circulation in deep brain areas[10]) and are more difficult to treat. As with other age-related disorders, senile depression will impose major health and societal burdens in the future. In a 1990 study conducted by the World Health Organization and other research organisations, losses due to depression in the USA were reported to total $44 billion. The same study projected that by 2020 depression will be the second highest economic burden, following heart disease. Currently, senile depression is the second most frequent mental disease following Alzheimer's related dementia.

According to Dr. Kanba, in the elderly, chronic depression can result from disuse atrophy (failure to engage in meaningful cognitive stimulation), which can then promote degeneration of the nerve cells and thus sustain and worsen depression.

A major difference between depression in the elderly and in younger adults is that there appears to be less of a genetic contribution to the disease in the elderly. In addition to the organic causes noted above, age-related depression can be traced in some cases to the sudden loss of social roles (retirement, for example), the loss of important and close family and friends, and a decline in economical, physical and psychological capacity. According to Dr. Kanba, deprivation of social stimuli is stressful to older adults and not only can exacerbate depression but may also facilitate deterioration of brain function, including nerve cell loss as the elderly become less resistant to stress.

[9] These stages are defined according to the affected areas of the brain: entorhinal territory to hippocampus to neocortex.

[10] Micro infarctions in basal ganglia. See Alexopoulos GS et al.: Clinically defined vascular depression. *Am J Psychiatry* 154: 562-565, 1997

2. Arresting Decline and Enhancing Capacity for Brain Diseases

First, attentional functions are found to be impaired even in very mildly affected individuals, providing, perhaps, valuable early warnings of the onset of Alzheimer's disease

In the case of both Alzheimer's Disease and senile depression, Dr. Kanba suggested that early detection of both disorders could lead to successful interventions or remediation. One such intervention is that of managed social support which can prevent and/or greatly minimise depression.

According to Dr. Takashima, one of the best ways to protect the brain from degeneration is to treat (or avoid) neurofibrillary tangles. This effort would involve some reliable method of detecting Alzheimer's disease in its preclinical stages. While there is some predictive power for Alzheimer's disease in the lack of early education or from previous head injury, early onset of Alzheimer's disease may be better diagnosed behaviourally or with genetic testing. It is difficult to behaviourally diagnose early onset of Alzheimer's disease since relatively little is known about cognitive changes associated with normal ageing as compared with ageing with disease. Some declines in cognitive functioning are expected with age (as noted in the introduction), and these age-related symptoms in normal ageing overlap with the preclinical symptoms of Alzheimer's disease. The identification and detection task, therefore, becomes one of disambiguating the signals being sent by this set of symptoms: what is indicative of normal ageing and what signifies a preclinical symptom?

According to Dr. Parasuraman, it may be productive to direct research resources to the study of attentional functions. There are at least two reasons to consider attentional functions as promising candidates for early detection of the onset of Alzheimer's disease. First, attentional functions are found to be impaired even in very mildly affected individuals, providing, perhaps, valuable early warnings. Second, a major area of dysfunction in Alzheimer's Disease is in memory pathways[11] which, according to Dr. Parasuraman, can be illuminated by the study of attentional functions.

Dr. Parasuraman noted that attentional functions can be recategorized into the functions of selective attention, vigilance, and attentional control. Of these, the neural systems mediating selective attention are fairly well understood and have been the object of much study. Importantly, two aspects of spatial selective attention—attentional shifting, and spatial scaling, are markedly impaired in the early stages of Alzheimer's disease, so that tasks that assess these functions can serve as useful markers for early diagnosis. Dr. Parasuraman described the results of studies[12], which indicate that attentional tasks indeed provide sensitive behavioral assays of early attentional dysfunction.

The second approach to early detection of Alzheimer's disease is to begin to identify normally-ageing adults who are at genetic risk for developing Alzheimer's disease. Dr. Parasuraman reported on studies that implicate the inheritance of the apolipoprotein E (APOE) gene in the development of Alzheimer's disease[13]. Carriers of the APOE gene (especially its e4 allele) exhibit spatial attention deficits

[11] Particularly in cholinergic brain systems. See Parasuraman, R., & Greenwood, P. M. (1998). Selective attention in aging and dementia, i*n R. Parasuraman (Ed.) The attentive brain. (pp. 461-488). Cambridge, MA: MIT Press.* And also: Parasuraman, R., & Martin, A. (1994). Cognition in Alzheimer's disease: Disorders of attention and semantic knowledge, in *Current Opinion in Neurobiology,* 4, 237-244.

[12] Involving event-related brain potential (ERP), positron emission tomography (PET), and functional magnetic resonance imageing (fMRI).

[13] The APOE gene is inherited as one of three alleles: e2, e3, and e4 with the e4 allele associated with the greater risk of developing Alzheimer's disease. See Greenwood, P. M., Sunderland, T., Friz, J., & Parasuraman, R. (2000). Genetics and visual attention: Selective deficits in healthy adult carriers of the e4 allele of the apolipoprotein E gene. Proceedings of the *National Academy of Sciences* USA, 97, 11661-11666.

that are qualitatively similar to those shown by clinically-diagnosed Alzheimer's Disease patients: (1) increased attentional disengagement and (2) reduced ability to scale spatial attention. These attentional deficits can appear in otherwise asymptomatic and healthy adults as early as those in their 50s.

Both the behavioral and genetic indicators can provide for the development and testing of new markers for predicting severe cognitive decline in older adults. Armed with improved diagnostic evidence, pharmacological and behavioral treatment/intervention strategies for enhancing cognitive function in adults can be developed and extended.

Finally, Dr. Parasuraman discussed a series of studies that demonstrated some benefits of attentional cueing and training on cognitive functioning in healthy adults and Alzheimer's disease patients. In short, alertness/vigilance training and other interventions can reduce selective attention deficits and enhance learning. Interventions such as these have the possibility of being useful because the fine structure of synaptic connections in the brain is not under direct genetic control but rather is shaped and reshaped throughout the lifespan by experience.

In regards to depression, Dr. Kanba strongly asserted that general depression, could be ameliorated and/or avoided. He suggested that society put in place niches in which the contributions of the aged to society (e.g., wisdom, expertise, knowledge, maturity of judgement) can be celebrated and used. In this regard, the spontaneous learning communities in Australia described by Dr. Ralph provide an example of such a system in which the elderly, with the support of modern computers, rediscover learning[14]. This method of learning is supported by Dr. Ito in his request for research on the possibility of "brain-friendly" learning technologies.

A study to examine the effects of ageing on creativity of Japanese adults ranging in age from 25 to 83, found no age differences on fluency, originality of thinking ability, productivity and application of creative ability

Concerning wisdom, we learned in the presentation by Dr. Shimonaka that wisdom, practical problem solving, and personality openness are positively correlated with creativity and well-being and last well into the later years. Traditionally, creativity is thought to be separate from intelligence so that while there may be a noted decline in higher-order cognitive functioning, this decline does not necessarily affect creativity. The goal of the study was to examine the effects of ageing on creativity of Japanese adults ranging in age from 25 to 83, as measured by the creativity tests developed by J. P. Guilford. No age differences were found on fluency, originality of thinking ability, productivity and application of creative ability. However, gender differences were found on fluency and productivity with women outscoring men. These results suggested that various abilities of creativity are maintained throughout the adult years. Psychologically-based depression in the elderly, therefore, may be ameliorated by encourageing the elderly to provide guidance to younger people, a process that could prove mutually beneficial. In his commentary, Dr. Koizumi extended these remarks to note how important life-long creativity is to the knowledge economy. In a similar vein, Dr. Arima[15] noted the need to inculcate a creative mindset among students from an early age.

In addition to the syndromes noted above, there is emerging work on decline in particular areas of the brain. Dr. Ito presented data to suggest that the cerebellum, which enables us to acquire skills to make smooth and precise movements even at fast speeds is due to synaptic plasticity incorporated in neuronal

[14] See here: Australian National Training Authority, *National Marketing Strategy for Skills and Lifelong Learning*, Report presented to Ministerial Committee, November 1999. URL: http://www.anta.gov.au (this report discusses attitudes and values to learning within the Australian community, motivation for involvement in learning and factors likely to influence participation in learning; it also identifies the types of learners that are interested in learning related to IT).

[15] Reviewing data from the Third International Mathematics and Science Study (TIMSS).

circuits of the cerebral cortex. Current thinking holds that, during voluntary movements using hands and arms, the cerebellum provides an internal model of the hand/arm system. In other words, movement can be performed by referring to the internal model, and does not necessarily rely on visual feedback from the actual hand/arm system.

Motor learning can be viewed as a process by which one forms an internal model and calibrates it through physical exercise. If the cerebellum is lesioned, the patient can no longer perform these functions. In this model, the cerebellum is implicated not only in movement, but also in thought processes (manipulation of ideas or concepts) and as such may play a role in implicit learning and memory in general[16]. Dr. Ito pointed out that there are popular beliefs about decline in the brain with age. Common knowledge asserts that our brain loses 100,000 neurons every day and smoking and/or drinking enhances this loss. However, this belief has been re-examined with new technologies. Terry et al [17] showed that if you count the *total number* of neurons in each area of the cerebral cortex, there is no age dependence. Age-dependence is a factor only when the number of large neurons in the cerebral cortex is counted. These large neurons shrink with the resulting consequence of increasing the number of small neurons, so the aggregate number remains the same. However, there is some decrease of neuronal circuitry as neurons get smaller. One can expect the number of synapses to be reduced and as such, information processing and general capacity of the brain network may decrease.

Dr. Ito reported on animal studies[18], which showed the Purkinje cells in the cerebellum exhibiting certain morphological deteriorations with motor learning delayed accordingly. Thus, relating these findings to humans, age-related decline in the cerebellum may be responsible, at least partly, for the diminishment of new skill acquisition from a sensorimotor or cognitive perspective, in the elderly.

[16] See the presentations by Dr. Pio Tudela at the Granada forum on "Brain Mechanisms and Youth Learning" (1-3 February 2001) and also in Tokyo.
[17] Terry RD, DeTeresa R, Hansen LA (1987). Neocortical cell counts in normal human adult ageing, in *Ann Neurol* Jun 21(6) 530-9.
[18] Studies using animals with similar brain morphology to that of human primates.

3. Lifelong Brain Plasticity

It may be the very plasticity of the brain that has led to the learning deficit, and it is to this plasticity that we can turn for amelioration and remediation

3.1. Plasticity and Hormonal Effects

Dr. Arai presented data from animal studies that suggested a link between synaptic plasticity and various gonadal hormone secretions. He reported that there is evidence of anatomical sex differences in the human brain, and that animal studies show that the development of a sexually dimorphic brain is dependent on the perinatal exposure of the brain to gonadal hormones. Brain studies show that sex steroid hormones exert very complex effects on the brain, including synaptogenesis[19]. Dr. Arai presented data, which demonstrated that in the aged rat, brain estrogen (a sex hormone) is capable of enhancing morphologic synaptic plasticity. Additionally, preliminary studies with postmenopausal women have shown that the visuo-spatial memory retention can be enhanced by this gonadal hormone. He concluded by saying that further research is needed to explore the possible association between synaptic plasticity and hormonal intervention.

3.2. Plasticity and Language

In his presentation, Dr. McCandliss presented data that directly questioned a long-held assumption about limitations in second-language learning among adults (in this case, Japanese adults).

Native speakers of Japanese face persistent difficulties in attempting to distinguish between the English liquids, /r/ and /l/. A large number of studies document the fact that Japanese natives exposed to English in adulthood have considerable difficulty classifying or even discriminating stimuli contrasting /r/ vs. /l/, such as in the words "road" and "load". The fact that such difficulties can persist in adults, even after many years of exposure to such contrasts in an English speaking country, has sometimes been taken as support for the view that there may be a "critical period" for the acquisition of phonetic contrasts, rendering adults unable to learn to hear such contrasts.

The hypothesis that there is this “window of opportunity” for learning languages generates the erroneous idea that learning deficits become permanent outside a narrow time frame. Dr. McCandliss suggested a strikingly different interpretation: it may be the very plasticity of the brain that has led to the learning deficit, and it is to this plasticity that we can turn for amelioration and remediation.

Dr. McCandliss argued that the brain modifies its connections based on Hebbian learning principles[20]: *strengthening* connections between units that are active together; *weakening* connections between units that are not, such that, connections are increased or decreased in proportion to the product of their activation. Thus, a native language environment that employs particular acoustic patterns (and not others) will reinforce some patterns while failing to reinforce others. When an adult is exposed to a second

[19] Refers to the production, formation, or development of new synapses.

[20] These learning principles come from Hebb’s postulate (Hebb, D. O. (1949). The Organization of Behavior: A neuropsychological theory. New York: Wiley, p. 62), which states, "*When an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes part in firing it, some growth process or metabolic change takes place in one or both cells such that A's efficiency, as one of the cells firing B, is increased."*

language that requires discrimination of unfamiliar acoustic patterns, the existing connections may tend to assign the unfamiliar patterns to the same precept, in this case, /r/ and /l/ sound “the same” to the adult Japanese brain. In other words, this "self-reinforcing" aspect of phoneme perception may contribute to the difficulties Japanese natives experience when attempting to learn English /r/ and /l/ speech contrasts. The research question then becomes: can the same Hebbian mechanism that might serve to build stable categorical representations in a first language impair the ability to learn new speech contrasts in adulthood, and is it open to modification?

If change is possible, then one could capitalize on the Hebbian mechanism via new training techniques to strengthen connections that distinguish /r/ and /l/ sounds. Dr. McCandliss and his colleagues presented /r/ and /l/ speech inputs modified to such an extent that Japanese natives were able to perceive them as distinct inputs. Results of experiments employing such manipulations demonstrated that most Japanese subjects were able to learn to discriminate and label /r/ and /l/ speech inputs accurately after short-term training, and were able to transfer this ability when listening to unmodified speech. Dr. McCandliss also presented fMRI neuro-imageing results that provided some preliminary confirmatory evidence to suggest that such training impacts the same general cortical regions implicated in native language speech perception. He showed how a dishabituation response to phonetic category changes vs. changes in acoustic information was detected by native English speakers, but not by Japanese natives. Additionally, this study showed changes in dishabituation responses associated with acoustically modified speech training

4. Fitness and Cognitive Vitality

Task improvement was shown to be positively correlated with cardio-vascular function within a limited range of "more is better" in terms of cognitive function

In his presentation, Dr. Kramer reviewed some of the literature relating physical fitness to mental health. This idea is an ancient one, expressed in Latin by the Roman poet, Juvenal, as "mens sana in corpore sano" (a sound mind in a sound body). Dr. Kramer described some of the known age-related declines in cognitive processing (e.g., in memory) and in perceptual and motor processes. Reviewing the animal literature, Dr. Kramer stated that cognitive functioning could be enhanced by looking at studies showing new growth in brain structures due to learning.[21]

Human research on cognitive vitality falls into three methodological categories: Cross-sectional, epidemiological, and longitudinal studies. Cross-sectional studies suggest large and robust cognitive benefits for fit older adults (but these studies are limited due to self-selection bias). Epidemiological studies list a number of factors associated with cognitive vitality including strenuous exercise (Albert et al., 1995[22]) and the findings from longitudinal studies are equivocal, some showing gains, some showing no differences (Dustman et al., 1993[23]).

A recent reanalysis of these longitudinal data by Dr. Kramer and his colleagues suggests a more positive and robust association between physical fitness and cognitive flexibility, particularly in executive processes. There are emerging data to suggest that the regions of the brain associated with executive processes (e.g., the frontal cortex and hippocampus see Raz et al., 2000[24]) show large and disproportionate age-related declines. These declines may be slowed by physical fitness. Task improvement was shown to be positively correlated with cardio-vascular function within a limited range of "more is better" in terms of cognitive function.[25]

Dr. Kramer also reported on some specific training studies to show that there are positive results for training in spatial orientation, inductive reasoning, and complex task-switching tasks. He concluded that behavioral, non-pharmacological, interventions including enhanced fitness can contribute to improvements in performance even into old age. These findings remain tentative, however, and their real-life applicability as well as how these performance improvements are made evident in brain changes should be the focus of further research.

---

[21] Dr. Kramer mentioned studies regarding angiogenesis, synaptogenesis and neurogenesis. Included in these were data associating positive biochemical changes with brain-derived neurotropic factor (BDNF), dopamine receptor density, and choline uptake.

[22] Albert MS, Jones K, Savage CR, Berkman L, Seeman T, Blazer D, & Rowe JW (1995). Predictors of cognitive change in older persons: MacAuthur studies of successful ageing. *Psychol Ageing* Dec 10(4) 578-89.

[23] Dustman RE, Shearer DE, & Emmerson RY (1993). EEG and event-related potentials in normal ageing. *Prog. Neurobiol* Sep 41(3) 369-401.

[24] Raz N, Williamson A, Gunning-Dixon F, Head D & Acher JD (2000). Neuroanatomical and cognitive correlates of adult age differences in acquisition of a perceptual-motor skill *Microsc Res Tech* Oct 1: 51(1) 85-93.

[25] Dr. Kramer stressed that adults used in this study are normally exercising adults, that is, adults who have had regular exposure to exercise over time.

5. Memory and Attention

Activated areas in the brains of elderly subjects were found to be generally smaller than those in the young subjects, or sometimes inactive. Moreover, areas that were not active in the young subjects were activated in the elderly

Presentations by Drs. Myashita and Cooper drew our attention to the mechanisms and features of human memory. Dr Myashita described how memories were stored, how internal representations were created and, how internal recall may involve a backward signal mechanism in the brain (in this respect, see the presentation on mental visualization by Dr. Kosslyn at the Granada Forum[26]).

5.1. Dissociable memory system.

In her presentation, Dr. Cooper spoke about dissociable memory systems. She echoed a theme expressed by other researchers; some systems decline while others survive (respectively, explicit vs. implicit tasks of memory). Dr. Copper presented data to show that global structural representational memory systems appeared more robust in the elderly than episodic memory systems. She emphasized the importance of building new memories explicitly on the foundation of the familiar, especially for the elderly. A similar observation (for learning at earlier ages) was made by Dr. Bruer in Granada[27].

5.2. Memory for proper nouns.

Professor Tatsumi reported on a study that compared language proficiency of young and elderly Japanese adults. Elderly people often complain about a difficulty in the retrieval of proper names of their acquaintances and of the names of famous people. In the reported recent study by Sakuma et al., young and elderly subjects were asked to say aloud as many words in a given category as they could (for semantic and phonological categories) within 30 seconds. The number of words the elderly subjects could retrieve was approximately 75% of the number retrieved by the young subjects, showing less word-fluency for the elderly. Additionally, retrieval of famous persons' names was difficult (their mean performance was about 55% to that of young subjects).

Going beyond psychophysical studies, Dr. Tatsumi reported on a PET (Positron Emission Tomography) activation study of elderly and young subjects observed during word-fluency tasks. In young subjects, during word retrieval of proper names, the left anterior temporal lobe and frontal pole were activated. During the retrieval of animate and inanimate names, and syllable fluency, the left inferoposterior temporal lobe and left inferior frontal lobe (Broca's area), were activated. By contrast, activated areas in the elderly subjects were found to be generally smaller than those in the young subjects, or sometimes inactive. Moreover, areas that were not active in the young subjects were activated in the elderly. Conclusions based on these findings are subject to further investigation as one could interpret the latter activations to reflect an effort to compensate for deficient word retrieval in the elderly subjects. Another conclusion, in favour of the vitality of the ageing brain is that fluency or experience with a task necessarily reduces activity levels. Presumably due to higher processing efficiency and use of brain mechanisms, these tasks can also be shuttled to different areas of the brain for processing. As Dr. Tatsumi further stressed, additional studies are required in this important area.

[26] See OECD's report on the Granada forum "Brain Mechanisms and Youth Learning" (1-3 February 2001).
[27] See OECD's report on the Granada forum "Brain Mechanisms and Youth Learning" (1-3 February 2001).

6. Methodological Issues

Gains in learning due to revolutions in cognitive neuroscience may be unsuitable for use if there is no corresponding change in the design and sensitivity of educational accountability measures

An important theme that arose in the Tokyo Forum was an awareness of the need for designing performance task protocols that could be used across the lifespan to help establish norms for normal ageing so as to be able to compare these to known norms of pathological ageing. Ideally, these protocols would allow researchers to understand which mechanisms and properties change with age. Dr. Tudela reported that there are ambiguous results concerning skill acquisition in normal ageing. Progress in this area is hampered due to a lack of a componential approach to the analysis of perceptual, motor and cognitive skills. In the literature on skill learning in normal ageing, there are many tasks in which young and older adults are compared; however, these research reports lack scientific rigor. Within these task sets, results are contradictory with younger adults scoring better than older adults and at other times, the data shows equal scoring across both populations. Additionally, separate and different skills (perceptual, conceptual and motor) are mixed together as if they were comparable to one another. Dr. Tudela insists that meaningful research goes beyond merely comparing people on how they do tasks, but includes tasks for which there is solid analysis in terms of their component processes as well as the involvement of their respective neural involvement. In other words, researchers must actively apply the analytical approach of cognitive neuroscience to the design of tasks used in understanding skill acquisition over the lifespan.

Dr. Cooper stressed the methodological necessity of testing for learning not only immediately after intervention, but also at certain intervals thereafter, especially in the case of age-related comparisons. This methodological point was bolstered by recommendations from Drs. Parasuraman and Kramer to take research projects out of the laboratory and into real-life situations, which will, of course, place additional challenges on the field to design cognitively illustrative tasks not only in cognitive neuroscience, but in educational practices more generally.

Following this point, Dr. McGaw pointed out that we must remain aware that the type of educational tasks favoured by society will remain more complex than the ones that would suit cognitive neuroscience. This theme arose, also, in Granada, that gains in learning due to revolutions in cognitive neuroscience may be unsuitable for use if there is no corresponding change in the design and sensitivity of educational accountability measures.

7. The Role of Culture and Ageing

There is a strong emphasis on framing gains in education using an economic model, where other models (particularly social ones) might have at least equal importance

In his presentation, Dr. Kitayama pointed out that some psychologists regard culture and the mind as separate entities and try to establish causal influences of culture on the mind and as such identify cultural universals. For example, if there are some systematic differences in norms and beliefs of culture, then human behaviours that are informed by such norms and beliefs may well differ accordingly. From this perspective, the emphasis on human universals in mental functioning would seem very reasonable and natural. In contrast, cultural psychologists often regard culture and the mind as interpenetrating each other to a much greater extent. And, as such, are interested in identifying cultural variations and on how mind and culture interact to form the other. However, as all cultures are different, the key agenda from the cultural perspective becomes understanding cultural variations rather than cultural universals.

The single most important project of cultural psychology, then, is to raise questions about the presumed validity of the universality of many mental processes, to show that possible alternatives exist, and to use appropriate analyses to broaden the empirical data base of the human and behavioural sciences. Biological ageing occurs necessarily in a particular cultural context. Depending on the specific nature of the context, it can have quite divergent consequences. The consequences of ageing on cognition must be examined in respect not only to a more holistic, encompassing, relation-centered, and wisdom-based cognition but merge with a more analytic, object-focused, and individual-centered cognition.

According to Dr. Kitayama, ageing cognition must be studied as a function of cultural and social belief systems surrounding the notion of ageing and related ones such as rationality and well-being. In his remarks, Dr. McGaw noted that there is a strong emphasis on framing gains in education using an economic model, where other models (particularly social ones) might have at least equal importance. In this regard, both Drs. McGaw and Ball noted that we need to pay attention to not only the development of skills and competencies, but additionally to the development of attitudes and dispositions. These challenges are complexified according to Mr. Schinagl, when we consider the changes and demands of the unfolding changes in learning and teaching provided by advances in technology[28].

[28] Schinagl, W. (2001). New Learning of Adults in the Information and Knowledge Society*, in: J.UCS: Journal of Universal Computer Science, see also: http://www.jucs.org/jucs_7_7/new_learning_of_adults* and Proceedings of I-KNOW 01, International Conference on Knowledge Management, *Opening Event of the Know-Center Graz, Austria, July 12-13, 2001, Editors: Klaus Tochtermann, Hermann Maurer, Springer, 2001*

8. Policy Reflections

Workers in the future will not only have to learn more, they will have to unlearn more

A central theme from the Tokyo forum was that much of the work in brain research is driven by models of disease and pathology. Dr. Ito stressed how important it is to separate the responsibilities of the health-care industry from those of schooling in this regard, particularly with regard to syndromes such as Alzheimer's Disease and senile depression. Gains for both sectors of society will flow from pathology-centered research agendas; however, current research agendas in ageing need to be more focused about how to better extend life-long learning for the entire population.

A clear policy and research challenge, therefore, is to institute new research agendas in ageing that are focused on learning. In this regard, the Tokyo forum provided some measure of reassurance concerning the plasticity of many brain functions and the robustness of other functions in the elderly. This is evident in the areas of creativity, and wisdom, and with some forms of physical and intellectual training, long-term higher-order functioning can be sustained.

This forum did not focus on the learning needs of healthy ageing adults in regards to learning new technologies. For example, Dr. Hamilton pointed out society's need to know how to retrain teachers, due to the proliferation of new technologies in the workplace. Dr. Whang noted the need for continuous education in adulthood (a trend that is seen among engineers almost to retirement age in the U.S.[29]), especially when one considers the data he presented on the limited "shelf-life" of new findings in the sciences (findings tend not to be cited after five years). Workers in the future will not only have to learn more, they will have to unlearn more. As we learned in presentations by Drs. McCandliss and Volfova, plasticity cuts both ways and can interfere with new learning in some cases.

Dr. Ito noted that this conference did not adequately address brain-based information regarding dispositions, attitudes or emotions[30]. He posited that conferences of this nature cannot afford to ignore the emotional brain or lose sight of factors that lead to satisfaction and resiliency in life.

Drs. Cocking and Koizumi both stated that advances in brain science and learning will occur only when there is a concerted trans-disciplinary effort and a call for institutions to carry out this type of collaborative research[31].

[29] See http://sestat.nsf.gov for more information

[30] For more information on these subjects, see the report of the New York forum on "Brain Mechanisms and Early Learning" (16-17 June 2000).

[31] See H. Koizumi, Trans-disciplinarity in Neuroendocrinology Letters, 22, 219-221 (2001). http://www.nel.edu/22_4/NEL22042001.htm

Conclusions by Sir Christopher Ball

Human behaviour at the start and end of life is (in part) inconsistent with the mammalian norm

This has been a remarkable and memorable conference: one so varied in content and rich in insight that it would be hard for anyone to provide an adequate summary. I will do my best – but what follows must inevitably be my own impressionistic, incomplete and personal reflections. Let me start by saying that it has been a privilege to be present, and by thanking the organisers – both OECD/CERI and the RIKEN Brain Science Institute – for bringing us all together to such good effect.

Reflecting on what I have learned over the past two days, I thought I would start by suggesting that humankind (our own species) is an eccentric mammal. If one were to imagine fancifully that, instead of this conference, other mammals (rats or sheep, for example) had held a seminar to discuss human behaviour, I suggest that they might be puzzled and interested by two particular features exemplified by *homo sapiens* in 2001: our practice of delegating mothering, and our remarkable care and concern for the aged. Of course, we know why we do this and we also know that our patterns of both childcare and care of the aged are culturally determined, not the result of evolutionary change, and that they vary across the various human cultures. Nonetheless, it many be worth noting at the conclusion of a series of conferences, starting with infants in New York last year and concluding with older people here in Tokyo, that human behaviour at the start and end of life is (in part) inconsistent with the mammalian norm.

I want to pay tribute to those who have organised and contributed to the three OECD conferences in New York, Granada and Tokyo. There can be no one present who has not recognised the value of, and gained personal and professional benefit from, the quality and depth of these debates. On each occasion we have moved 'from genes to skills': on each occasion, I suggest, we have given insufficient attention to questions of disposition – the development of attitudes and values. In future, I hope to see more attention paid to issues like the inheritance, development and learning of disposition. Educational curricula are often presented in terms of KSA (knowledge, skills and attitudes): my own view is that we would do better to reverse the order of KSA to give ASK (a neat acronym for a modern curriculum!) so as to emphasise the fundamental nature of attitudes in learning. For it is the case that only those with positive attitudes (like self-esteem and determination) find it easy to acquire the necessary skills (like reading and IT) which give convenient access to the world's store of knowledge.

The three fora have demonstrated a gradual advance from conversation towards cooperation. We all wondered at the outset whether it would be possible to engage in useful debate across such an interdisciplinary range as is exemplified by the people present today. We have done it successfully three times: it would be self-indulgent to do no more than repeat the exercise in the future. We should now move forward to co-operative research. I look forward to hearing Bruno's presentation shortly: I hope he will lead us forward into a discussion of the possibility of an interdisciplinary research programme. I am in no doubt that, in one way or another, this OECD initiative should be taken further. I believe I speak for everyone in recommending that it should continue – but advance from conversation to cooperation.

Throughout the three debates there have been contradictory voices and apparently opposing viewpoints urging caution on the one hand, and hope on the other. I belong to both parties and believe that the paradox of 'hope and caution' can be resolved by planning for the long term, and not expecting (or promising) short-term benefits or immediate results. We have done the easy bit. Now we need to plan seriously for the longer term. I hope we will.

Several of us have talked from time to time of being present at the birth of a new science. I think this is an apt description of what is happening. We might compare the gradual emergence of a 'brain and

learning science' to earlier scientific developments, such as the creation of Biochemistry or Linguistics. Sciences like these typically arise at the boundaries of disciplines. It is relevant to note here that others have been using the phrase: 'structural interdisciplinarity'. I argue that the first step in the creation of a new science is indeed the imposition of a new structure on the chaos at the boundaries of old disciplines.

We need to reflect on the disciplines contiguous with the 'brain and learning science'. Without claiming to have exhausted the list of possible candidates, I note that we have recognised at least five major partners in this new science: neuroscientists, psychologists, health professionals, educators and policy makers. These three fora have been designed in the belief – and have demonstrated – that if you bring these five partners together you will achieve beneficial outcomes which none of them can produce on their own.

But in the longer term we should expect the 'brain and learning science' (like any other mature science) to provide us with explanations, predictions, applications and benefits. And we would look for the development of enabling technologies, a theoretical base and distinctive methodology. There is still a long way to go. 'Brain and learning science' is an emergent discipline – not, as yet, a fully-fledged science in its own right.

I have been asked to report on policy issues. We need to recognise that our work inevitably creates policy issues for different audiences. For example, there are policy issues for the advancement of science, for the reform of education and for the development of health care. This may not complete the list. But earlier speakers have emphasised the need for a holistic approach, and I agree with them. Of course, a holistic approach will require holistic policy development and implementation. Governments will not find this easy.

The following matrix attempts to set out some major findings from each of the three fora, arranged in such a way as to suggest where policy makers need to take action to *inform, promote* or *provide*.

	INFORM	**PROMOTE**	**PROVIDE**
New York	importance of early learning	competent parenting (attachment)	- high quality early learning (3-7); - appropriate curriculum
Granada	model of brain development	- 'how we learn governs what we learn'; - feelings are the key to learning	- brain friendly schooling; - curriculum of essentials; - resolve the tension between 'sorting' and 'skilling'
Tokyo	nature of ageing process of the brain (risks, diagnosis, deferment)	self-help	- learning vouchers for elderly; - appropriate 'brain-training' and check-ups

From the New York forum we learned of the importance of the early years in determining our life chances. Perhaps we may guess that a third of life is determined by genes, a third by our experiences in the early years, and a third by our own choices as life progresses? Policy markers can do nothing about our genes (as yet!), but they can certainly help to improve the quality of people's early experiences and learning.

The best way of achieving this is to promote competent parenting and help in the process of effective attachment. In many countries policies are now being developed to provide good opportunities for 'centre-based' early learning from the age of three. It is one of the oddities of the growth of western education systems that good nursery education – which is probably more important than higher education – has been the last part of the system to be put in place. In the UK I have advised our government that we should consider adopting the 'RSA rule' for funding a public education service: namely, double the age of the learner to calculate the appropriate class size and fund accordingly. By this rule, three-year-olds would be in classes of six, six-year-olds in classes of twelve, and twelve-year-olds in classes of twenty-four, and so on. The idea is to substantially front-load the system because of the overriding importance of successful early learning to the quality of people's lives. It will not be easy to transform 'back-loaded' systems in this way.

From the Granada conference we learned that there was a lack of public understanding of the process of brain development. The teenage brain is 'work in progress'. Teenagers are not to be seen as just troublesome adults: their brains are immature. What is needed is a comprehensible model of brain development. We also concluded that *how people learn* is more important than *what people learn* in the achievement of successful learning. The implications of this idea are far-reaching. Governments need to be persuaded to shift the terms of debate in education from 'curriculum-led thinking' to a 'pedagogy-led approach'. Put simply, when people enjoy learning, they learn well. How we feel governs how successfully we learn. This suggests renewed attention to new concepts like Emotional Intelligence and old ideas like IQ to enable us to develop a more holistic and scientific theory of intelligence.

What should policy makers seek to provide? I suggest, for a start, we might consider the idea of brain-friendly schooling. In the UK one in six of our young pupils fail to achieve an adequate standard of literacy and numeracy by the time they leave school; one in six tell us that they 'hate school' – and go on feeling like this throughout their lives; one in six disrupt classes, play truant or practise 'intellectual truancy' (pretending to attend while allowing their thoughts to wander – we are all experts in this survival skill!). The 'one in six rule' has been in force for more than a century in British education: are other countries very different? I wonder why this happens. Could it be that traditional formal education is brain-unfriendly?

Many nations are attempting to redefine the national curriculum. Too often the result is an overloaded programme containing as much as possible of what has proved useful in the past (trigonometry and Latin, for example). What is needed, I suggest, is a 'curriculum of essentials' – what we really must know to function efficiently in today's and tomorrow's world. Slow learners need a curriculum which gives them a reasonable hope of success, not certainty of failure. Failure is an excellent learning strategy – but a disastrous learning outcome.

Granada also made us think about the tension inherent in our systems of formal education between the two objectives of providing people with useful skills (reading, calculation, IT, driving, problem-solving, and so on) and sorting them by ability and aptitude for the employment market. I question the value of the latter. Education has never done this job well, and the 'sorting function' seriously interferes with the 'skilling function'. Some say that education can sort and skill people, just as sheep produce wool and mutton. But every farmer knows that, if you want the wool, you can't have the mutton – and, if you want the mutton, you can't have the wool!

Tokyo has provided many insights: I select just a few.

We all need regular check-ups on our brains as life progresses, in much the same way as we are getting used to regular medical checks on our bodies

Perhaps the most important is the need to inform people and governments of the nature of the ageing brain. It has become clear that scientists know quite a lot about what happens as the brain ages, the risks inherent in the process, the possibilities of diagnosis and effective treatment at least to postpone the onset of dementia. We should encourage policy makers to promote self-help among older people, who need to be advised about appropriate exercise (both physical and mental) – for example, walk a mile and solve a crossword each day. 'Use it or lose it.' Governments might help by offering learning vouchers to the elderly to enable them freely to choose learning activities that appealed to them. I suggest that we all need regular check-ups on our brains as life progresses, in much the same way as we are getting used to regular medical checks on our bodies. Those that require help could then be identified in good time to benefit from the 'brain-training' that can help defer dementia.

My own view is that (sadly) it will be easier to interest governments in the programme of adult education sketched above than to persuade them to make fundamental changes to the formal education of the young. The formal education system is inherently conservative and inflexible. I fear we shall have to wait for many years before the insights derived from these fora make any real difference to what happens in schools. (I hope I am wrong about this.)

To conclude, let me identify three general issues and four specific opportunities for the future. Of the former, the first is the clarification of the twin concepts of 'plasticity and periodicity'. We need both to understand better ourselves, and explain clearly to the public, the balance and interplay between these principles. Secondly, we need to develop a clearer view on the balance of importance to people's life chances of our genes, our early years experiences, and our individual choices as life progresses. At the start of this summary I guessed that these factors might be roughly equally balanced, each contributing a one-third influence on our lives. Is that true? How could we know? What is certain is that there is a great thirst for information about these questions. The third general issue is to find a way of 'explaining the brain' to the general public. People have no real understanding of how their brain works: they need help. This is an urgent task of scientific education.

As for specific opportunities for the future, I identify five: reading, mathematics, gender, the measurement of ability, and the development and formation of a new teaching profession. This group, together with the OECD initiative in general, could if we chose make a substantial contribution to advancing knowledge and improving practice in each of these five areas.

As a final note, allow me to remind you of the inspiring statement made in Granada: 'learning is learnable'. And I invite you to balance this idea against one that is equally true: 'learning creates inhibition'. These poised insights remind us how complex our task is and how careful we need to be not to fall into oversimplification. Nonetheless, I have no doubt that the OECD initiative offers us the best hope of finding good answers to the two great challenges I began with: how may we best raise our young? – how may we best care for the aged? These are already among the fundamental questions for the 21st century. We must continue to try to answer them.

Annex

LEARNING SCIENCES AND BRAIN RESEARCH:

POTENTIAL IMPLICATIONS FOR EDUCATION POLICIES AND PRACTICES

Third High Level Forum

Tokyo, Japan, 26/27 April 2001

Brain Mechanisms and Learning in Ageing

Agenda

Venue: RIKEN Brain Science Institute, WAKO Campus, Japan

Thursday, 26 April 2001

Session 1: 09:00 - 10:45 / Introduction and Scientific Overview
Chair: Jarl Bengtsson

09:00 - 09:15	Teiichi Sato, Director General, JSPS, Japan, CERI Governing Board Member Masao Ito, Professor and Director of RIKEN-Brain Science Institute, Japan Jarl Bengtsson, Head of CERI/OECD Opening - Welcome
09:15 - 09:30	Eamonn Kelly Professor George Mason University, Fairfax VA, USA Consultant CERI / OECD on "Synthesis of the Main Results of the two First Fora"
09:30 - 10:15	Raja Parasuraman Professor Catholic University of America, Washington, DC, USA on "Attention, Ageing, and Dementia: Extending and Enhancing Cognitive Function in Adulthood"
10:15 – 10:35	Plenary discussion
10:35 - 10:45	*Break*

Session 2: 10:45 - 12:45 / Interdisciplinary Issues related to Learning in Ageing
Chair: Sir Christopher Ball

10:45 – 11:05	Jarl Bengtsson Head of CERI / OECD on "Ageing Populations: New Policy Challenges"
11:05 - 11:25	Shinobu Kitayama Professor University of Kyoto, Japan on "Cultural Variations in Cognition: Implications for Ageing Research"
11:25 - 11:45	Yasumasa Arai Professor Juntendo University, Tokyo, Japan on " Gender issues: is there a sexual brain?"
11:45 - 12:05	Rod Cocking Program Director, Human Cognition and Perception National Science Foundation, Arlington, USA on "Crossing Disciplinary Boundaries to Understand the Cognitive Neuroscience of Ageing"
12:05 – 12:35	Plenary discussion
12:35 - 12:45	Hideaki Koizumi Senior Chief Scientist, Research Director Advanced Research Laboratory, Hitachi, Ltd. on "Reflections on Sessions 1 &2 "
12:45 - 14:00	*Lunch break*

Session 3: 14:00 - 16:00 /Brain Plasticity over the Life Cycle, Memory & Lifelong Learning
Chair: Hans Stegeman

14:00 - 14:20	Andrea Volfova Cognitive Neuroscience Laboratory Harvard University, USA	Bruno della Chiesa Administrator OECD / CERI
	on "What could Brain Plasticity mean for Lifelong Learning?"	
14:20 – 14:40	Yasushi Miyashita Professor University of Tokyo, Hongo, Bunkyoku, Japan on "Memory: Encoding and Retrieval"	
14:40 – 15:00	Itaru Tatsumi Professor Tokyo Metropolitan Institute of Gerontology, Japan on "A PET Activation Study on Retrieval of Proper & Common Nouns in Young and Elderly People"	
15:00 - 15:20	Lynn Cooper Professor University of Columbia, USA on "Age-related Effects on Dynamic Properties of Dissociable Memory Systems "	
15:20 – 15:50	Plenary discussion	
15:50 - 16:00	*Break*	

Session 4: 16:00 - 18:00 / Skills Acquisition, Later in Life
Chair: Yasushi Miyashita

16:00 – 16:20	Masao Ito Professor, Director RIKEN-BSI, Japan on "Roles of the Cerebellum in Skills Acquisition & its Dependence of Age "
16:20 – 16:40	Pio Tudela Professor University of Granada, Spain on "Cognitive Skills Acquisition, Later in life: Attention and Automaticity"
16:40 – 17:00	Wolfgang Schinagl Professor IHK Steiermark, Austria on "New Learning of Adults in the Information and Knowledge Society "
17:00 – 17:20	Bruce McCandliss Assistant Professor Sackler Institute, New York, USA on "Brain Mechanisms Influencing Adult Learning: the Case of Persistent Difficulties in Learning Non-native Speech Sounds"
17:20 – 17:50	Plenary discussion
17:50 - 18:00	Kenneth Whang Program Offcial National Science Foundation on "Reflections on Sessions 3 & 4"
18:15 - 20:00	*Welcome Reception* *Hirosawa Club at RIKEN*

Friday, 27 April 2001

Session 5: 09:00 - 11:00 / Diseases, Learning and the Power of the Ageing Brain
Chair: Masao Ito

09:00 - 09:20	Shigenobu Kanba Professor Yamanashi Medical School Japan on “Characteristics of Senile Depression: Importance of Prevention and Treatment"
09:20 - 09:40	Akihiko Takashima Professor RIKEN Brain Science Institute on “Understanding the Ageing Brain from Studies of Alzheimer’s Disease”
09:40 - 10:00	Art Kramer Professor Beckmann Institute - University of Illinois on "Enhancing the Cognitive Vitality of Older Adults: The Role of Fitness and Cognitive Training "
10:00 – 10:20	Yoshiko Shimonaka Professor Bunkyo Women's University, Faculty of Humanity, Japan on “Creativity and Ageing: Does Creativity Decline in the Adult Life Span?”
10:20 – 10:50	Plenary discussion
10:50 - 11:00	*Break*

Session 6: 11:00 - 12:40 / Learning and Education: research policy perspectives
Chair: Eamonn Kelly

11:00 - 11:30	Akito Arima Professor Former Japanese Minister of Education and Science on "Education and Research in Japan"
11:30 – 11:50	Denis Ralph Professor, Executive Director South Australian Centre for Lifelong Learning and Development on "Learning Across the Lifespan - Linking Research, Policy and Practice: An Australian Perspective"
11:50 - 12:10	Eric Hamilton Director Research, Evaluation and Communication / Education Division National Science Foundation on "NSF Policy and Programmes on Brain Research and Learning Sciences"
12:10 - 12:30	Plenary discussion
12:30 - 12:40	Barry McGaw Deputy Director DEELSA/OECD on "Reflections on Sessions 5 & 6"
12:40 - 14:00	*Lunch break*

Concluding Session: 14:00 - 16:00
Chair: Jarl Bengtsson

14:00 - 14:20	Masao Ito Professor Director RIKEN Brain Science Institute, Japan on "Scientific Reflections on the Work"
14:20 - 14:50	Sir Christopher Ball Chancellor of the University of Derby, UK on " Policy Reflections on the Work and General Conclusions of the "Phase 1" Fora"
14:50 - 15:20	Plenary discussion
15:20 - 15:40	Bruno della Chiesa Administrator OECD / CERI on "Next Steps: Towards "Phase 2"
15:40 - 16:00	Plenary discussion
16:00-17:00	*Brain Science Institute Laboratory Tour*
18:00-20:00	*Dinner hosted by the Brain Science Institute*