Report on the Second Meeting of

The Lifelong Learning Network

Tokyo, Japan
13-14 January 2004

Organized by
RIKEN Brain Science Institute (RIKEN BSI) and
The OECD Center for Educational Research and Innovation (OECD/CERI)

with the support of
The Japanese Ministry of Education, Culture, Sport, Science and Technology (MEXT)

This report was prepared by Michael Miller RIKEN BSI,
with Bonnie-Lee La Madeleine RIKEN BSI and Cassandra Davis (CERI-OECD)

Table of Contents

Introduction	2
Project Background	2
Summary of opening comments	3
Short summaries of the presentations	5
Discussion synopses (including panel discussions)	11
Progress reports on other activities	15
Summary of closing remarks	15

Introduction

On the 13th and 14th of January 2004, the second meeting of the Lifelong Learning Network was held at The New Otani Hotel in Tokyo, Japan. The network's purpose is to facilitate more dialogue between brain scientists and education professionals that will lead to new learning approaches and methods based on brain science. Over 40 people attended this year's meeting, including representatives from OECD, the 10 member network laboratories and observers from MEXT.

The meeting was divided into four sessions. Findings from the network laboratories were presented and discussed in the first three sessions: "Learning in Infancy", "Learning in Childhood", and "Learning Across Life". Session four included two special lectures. One introduced a novel project in Germany that has established a new learning institute to facilitate transfer of brain science findings into education; the other addressed emerging ethical issues in neuroscience and potential impact for education.

To provide a summary of the key findings and issues addressed at the second meeting, this report is divided into eight sections:

1. Introduction
2. Project background
3. Summary of opening comments
4. Short summaries of the presentations
5. Discussion synopses (including panel discussion)
6. Progress reports on other activities
7. Summary of closing remarks
8. Conclusion

Project background

The Lifelong Learning Network is one of three networks that comprise Phase II of the OECD-CERI's "Brain and Learning Sciences" project. Together with the Literacy and Numeracy Networks, it aims to integrate findings from basic brain research into educational policy and practice. Phase II started in 2002 and will be complete by end-2006. For the LLL Network, scientists from ten laboratories conduct research into learning and brain development throughout life, and share their findings at annual meetings in Japan.

At the first meeting in Yokohama on the 11th and 12th of December 2002, approximately 40 people gathered to learn about the research and to establish a strategic plan to meet its goals. English language versions of reports from Phase I, as well as from the network meeting, can be found on the OECD web site at:

www.oecd.org/edu/brain

download the Yokohama report: http://www.oecd.org/dataoecd/40/37/15303991.pdf

An update of the activities of the other two networks was presented at the second meeting of the Lifelong Learning Network. Nearly two decades of investigation into reading and computational development has identified common ground shared by these two networks.

Summary of opening comments

The Lifelong Learning Network meeting began with remarks from speakers representing the three major organizations involved in the network: Masao Ito (RIKEN BSI), Tom Schuller (OECD-CERI), and Masayuki Inoue (MEXT).

Masao Ito, RIKEN BSI.

Masao Ito welcomed everyone and reminded the participants of the meeting's purpose: to answer three basic questions regarding lifelong learning.

1. How does environment influence the early stages of brain development in terms of neuronal structure, sensory function, and behaviour?
2. How do children grow in terms of speech, sensorimotor and cortical function, and learning of art and music?
3. How can learning be sustained in the aged, function be restored to damaged brains, and quality of life be enhanced in an increasingly information driven society?

Then, he reviewed key events in the programme. Stressing the educational and social importance of the network's research, he expressed the hope that it would lead to the publication of a book based on its activity. For this reason, discussion of the new email network of scientists and educationists was scheduled in session three. To link education policy and ethics with brain science, two special lectures were included in Session IV.

Tom Schuller emphasized the challenge of synthesizing and disseminating the diverse research of this network to a larger audience of policy makers, before providing an update on the continuing efforts at OECD and CERI. He then highlighted CERI's expectations for the brain and learning.

He hoped to encourage open discussion about network progress and information dissemination and requested that more effort be made to establish links to education policy and practice. To facilitate this, he introduced a provisional four-part framework.

A. Periodicity: marking discreet biological, socio-cultural, and chronological periods in the lifespan of a human being.
B. Skills and competences: identifying the basic functional elements that need to be acquired such as language acquisition and numeracy.
C. Conditioning factors, such as nutrition, sleep, and environment that have significant impact on learning.
D. Neuronal plasticity, and its relevance for education and learning.

Masayuki Inoue acknowledged the potential impact of recent advances in neuroscience to contribute to the development of new, more effective

educational practices. But, he added that while neuroscience has become increasingly vocal, education has remained relatively quiet. He encouraged more dialogue and urged those representing education to challenge the brain researchers.

Presentation summaries

Session I: Learning in Infancy

Janet Werker (left), University of British Columbia, and Helene Deacon (Dalhousie University)

"Listening to speech in infancy sets the stage for later language acquisition"

Infants use speech perceptual categories of native phonetic contrasts developed in the first year of life for language development. And the skillful use of these categories for word learning at 17 months can predict extent of vocabulary acquisition at 2 years and phonological awareness (rhyming, alliteration, etc.) at 3 and 4 years. Preliminary data showing that children also strategically employ learned morpheme categories to assist in language acquisition was also presented.

Marie Cheour (left), University of Miami and Risto Nätäänen, University of Helsinki.

"Infant Sleep: Learning and Brain Maturation"

Newborns can learn to discriminate sounds while sleeping, but the properties of infant sleep that enable learning are not known. However, cortico-thalamic connections, which gate learning and memory during sleeping and waking stages in adults, are immature in the very young infant brain. This lack of development may enable learning during sleep and is the subject of investigation for this laboratory.

Michael J. Meaney, McGill University.

"Maternal care, environmental enrichment and hippocampal development"

Variations in mother-offspring interaction in rats affect brain development to produce significant differences in mature offspring, including performance in learning and memory tasks. Animals that received more tactile stimulation produced more receptors for glutamate, which contribute to neuronal survival and synaptogenesis. The effects of maternal care, however, can be reversed by cross-fostering the pups, or by raising pups that received less tactile stimulation in enriched environments, which may have broad effects on cognitive development and education.

Takao K. Hensch (RIKEN BSI, Japan)

"Critical period plasticity and sleep: reciprocal interaction in the visual system"

Sleep, which consolidates memory and facilitates learning, is involved in, and shaped by, synaptic changes in the developing brain. The effects of experience and plasticity on sleep states were demonstrated in animal models. Research on the development of the visual system in transgenic animal models showed that sleep is plastic in this development. In addition, slow-wave sleep is regulated locally in the brain by NMDA receptors, which are regulated by REM sleep.

Session II: Learning in Childhood

Manfred Spitzer, University of Ulm, Germany.

"Music, learning and memory"

Positive mental states, such as those created by music, trigger dopamine release that might "prime" the brain for more efficient learning, and appear to improve memory recall. Given this, music might have a modulating effect on learning. Spitzer has done work looking at semantic priming, demonstrating that a tight focus in learning and problem solving limits creative thinking ability.

Rebecca Ray (left) for J.D.E. Gabrieli, Stanford University.

"It's all in how you look at it: the cognitive down- and up-regulation of negative emotion"

The expression of negative emotions is mediated by an individual's interpretation of events. Emotional experience can be up-regulated to receive input or down-regulated to deflect it. Cognitive reappraisal, which regulates emotion according to the story one tells oneself, affects different areas of the brain depending on increase or decrease in negative emotion. Furthermore, as children employ immature cognitive control strategies, they may not be able to effectively down-regulate an inappropriate, negative emotional response.

Daniel M. Wolpert, Institute of Neurology, U.K.

"Motor skill learning"

Memory is fragile, so learning is not hard wired. Memory is a storage system that enables refinement, modification, and destruction of learning. For learning to be effective, it is essential to know what tasks interfere with memory and how to facilitate better learning, especially when uncertainty and noise affect quality of sensory input. The brain manages this uncertainty by combining sensory feedback (current evidence) and task statistics (prior experience) to "describe" the outside world statistically within an awareness of its own sensory uncertainty.

Jellemer Jolles (left) for H.B.M. Uylings, University of Maastricht, The Netherlands.

"Executive functioning, prefrontal cortex and learning in a developmental and aging perspective: findings from a large cross-sectional/longitudinal study in the Netherlands"

Data from studies investigating the differences in cognitive performance throughout adult years indicate that age-related memory decline is not the same for all adults (25 to 85), or for all aspects of learning. Differences in ability and rate of decline were apparent across education levels and between sexes, but the reasons were not known. Individual differences in brain activation were also reported.

Geoff Masters, Australian Council for Education Research, Australia.

"Learning in school and lifelong learning"

This was a brief introduction to the three principles of education that currently guide lifelong learning practice.

1. Learning is more successful if the educator understands the journey of each individual learner and the sum of her current knowledge and beliefs.
2. Material should be presented in a way that builds connections between concepts and constructs a conceptual framework. First locate where the learner is on a map of concepts and ideas then teach within that domain.
3. Having established solid conceptual frameworks, the learner is able to direct her own learning based on personal interests throughout life.

Session III: Learning Across Life

Hideaki Koizumi, Hitachi Ltd.

"Functional reorganization in damaged elderly brains (II)"

Using non-invasive imaging techniques, evidence that damaged adult brains exhibit plasticity was presented. Language capacity in the dominant hemisphere, lost following stroke, re-emerged in the contra-lateral hemisphere. In some cases, language specific activation was restored to the dominant hemisphere about one year

following injury. In a separate series of studies examining the recovery of movement after stroke-induced paralysis, brain re-organisation occurred within 2 months of the injury. These studies were followed by gene expression studies in rats.

Stan Colcombe (left) for A.F. Kramer, University of Illinois, U.S.A.)

"Offsetting neurocognitive decline in older adults"

Improving cardiovascular fitness increases brain connection activity and reduces stress markers; and evidence presented here show that more fit individuals perform better across the board in all cognitive tests, with the most significant difference seen in executive functions. Systematic differences in brains of subjects indicate that those of fit subjects lose brain structure less rapidly. In cross-sectional and longitudinal studies, they found that exercise improved cognitive efficiency.

Post-meeting: Colcombe suggested that educators develop a life-long approach to physical activity in schools, and foster interest in activities such as badminton, golf, and racquetball that can be played later in life, rather than, for example, basketball and football, which are less age-friendly. This might have long-term health benefits in communities.

Eric Hamilton, Air Force Institute for Information Technology Applications.

"Enhancing critical thinking and strategic problem-solving competencies through the life cycle"

As adults get older they are better able to employ strategic planning and problem solving. Yet, children use and adapt to new technology, such as the animated agents that assist them in on-line tasks, faster. His challenge will be to develop learning paradigms that improve these deficits in both groups and enhance overall performance. He asked brain researchers about possible neural correlates for the development and acquisition of such skills. It was suggested in the discussion that followed that the relationship

between mental rehearsal and performance might be the critical issue, and that Hamilton might be able to extract this relationship experimentally in video game performance.

Session IV: Issues in Integrating Brain Science and Education

Manfred Spitzer, University of Ulm, Germany.

"Transfer center for neuroscience and learning"

Spitzer has just established the Transfer Centre for Neuroscience and Learning (CNL) bridging basic and applied research on learning with education. Teachers and brain scientists at CNL will develop hypotheses and conduct research together. Relevant findings will be developed into larger studies investigating applicability of findings to education and lead to new, brain-based, teaching methods. Teachers will also be trained at CNL to facilitate transfer of methods into schools. The most benefit appears to stem from regular conversations with education administrators and officials; and communication in the Lifelong Learning Network, via the e-mail list, may yield the same rewards.

Martha J. Farah, University of Pennsylvania, U.S.A.

Applying neuroscience to education: social and ethical issues.

Balancing quality of science, relevance of research, and immediacy of learning needs requires neuroscientists to reflect seriously on the emerging ethical issues involved in building a bridge between education and brain science. The direct social implications of two research areas: brain imaging and psychopharmacology, were discussed. While brain imaging provides a bigger window on the mind, these techniques could impact mental privacy and personal choice, if ability to type aptitudes and behavioral characteristics improved. Extending use of therapeutic drugs that improve memory, attention and energy for human enhancement was a real, social possibility, and may impact fairness and health. The benefits of such drugs need to be considered in light of the risks and their accessibility in light of the principles that we identify as fundamental to humanity.

Discussion synopses

The discussion after the first session on "Learning in Infancy" focused on developing links between research and educational policy:

The impact of Janet Werker's and Helene Deacon's work on literacy and reading development suggested a possible link between the LLL Network and the Literacy Network. Both Werker and Deacon were open to the idea and the latter commented that more neurobiological approaches to reading across the lifespan would be useful. The suggested use of morphemes to understand and develop language proficiency in children also had a connection with educational goals. One educationist said that he would need to review how morpheme knowledge is currently incorporated into reading studies.

The increasing trend toward standardized testing was discussed in relation to the framework. As the meaning of success varies over time and between cultures, Michael Meaney suggested that this discussion be expanded to include parental guidance that produces guidelines flexible enough to accommodate culturally specific outcomes. This suggestion was supported by Reijo Laukkanen, who said that a broader discussion was needed because the findings of this network would impact early education, social welfare and health policies. Extending the framework to reflect the long-term aspects of lifelong learning was recommended.

Michael Meaney's findings on cognitive development and the effects of environmental enrichment in rats triggered several human development application questions. While the enrichment paradigms in animal studies refer to stimulation, he said that comparable stimulation in humans varies from country to country; cross-culturally there are many forms of development and all are equally successful in providing ample, normal stimulation. Referring to child abuse, there appeared to be benefits from improved conditions, but more research was needed.

The issue of stimulation led to discussion about the effects of television on child development and quality of sleep. Data collected from the Maastricht Study indicated that children who watched TV late into the night were more detached and less motivated in school the next day.

The discussion following the second session focused on methodological approaches used to apply findings in educational practice or how to extend them into lifecycle research.

There followed a discussion on the role of teacher motivation. Teacher motivation to learn and incorporate brain science findings into education practice is essential to ensure that reliable, biologically based learning methods would be adapted. Manfred Spitzer found that teachers are receptive to brain science when presented in a way that is relevant to education. Professional educators (managers/administrators) were more reticent. He also cautioned against moving too quickly in applying these ideas in the classroom without first developing empirical methods to determine the overall benefits. Good empirical education research that is prescriptive, rather than descriptive, like the PISA study, would be beneficial.

A personal comment by a brain researcher emphasized the importance of the relationship between students and teacher. He said that the teacher must be able to empathize with the student. This led to a debate on the importance of teacher/learner interaction.
The German education system disregards educator-learner interaction, said Manfred Spitzer. This seems counter-intuitive when evidence shows patient/councilor interactions directly impact the outcome of psychotherapy treatment. He suggests that quality of teacher-learner interaction should be investigated as a potential measure of learning success.

This point was countered by Jarl Bengtsson, who said that the importance of these interactions in learning diminishes as the learner matures. Tom Schuller added that most education research had shown that impact of the peer environment was greater than that of the teacher. Denis Ralph disagreed. The quality of the relationship between teacher and learner is at the heart of the learning process and endures well beyond the early learning experience. This interaction affects the formation of self in the learner. And in Finland, the concept of constructive learning is used to help teachers find, and use, teaching methods that do not force feed learning into students' heads, but stimulates students to form ideas and learn independently. Eric Hamilton also felt that the role of the teacher is really the single greatest variable in learning. A good teacher with a bad method is more effective than a bad teacher using the constructivist approach.

A brief discussion on whether basic learning about how the brain works should be offered in primary schools generated two comments. At Stanford, researchers do go into the schools to teach on the brain, and researchers, teachers and students find it beneficial. However, just as health education appears not to deter children from smoking or drinking, there is no guarantee that knowing how one learns will improve learning behaviors or increase learning motivation.

In the final discussion session of the meeting, improving communication between network participants and dissemination of the network's efforts were discussed.

A suggestion, based on the research funding policy of the Netherlands, requiring all grant proposals demonstrate social relevance of research, was put forward. Developing a research plan constrains researchers to consider the tasks needed to develop and assess concepts and introduces other ways of thinking about the questions. Therefore, Helene Deacon suggested brain researchers and educationists create these plans together to make the social relevance clearer.

Creating two categories of educational implications might also be useful. In one, brain scientists could suggest implications of their research for both policy and practice, and they could pose relevant questions to practitioners in the other. Knowing the operating hypotheses of educators would be helpful for brain researchers to find relevant targets for investigation, suggested Masao Ito. More conversation about approaches and methods in education would clarify underlying assumptions more effectively, added Spitzer.

Science and Education Dialogue—Panel discussion
PANELISTS: Masao Ito (Japan), Reijo Laukkanen (Finland), Denis Ralph (Australia), W. Schinagl (Austria)

Each panel member was asked to answer three questions:

1. What have you learned over the past two days?
2. What recommendations would you make to increase collaboration between brain scientists and education researchers?
3. How could this meeting be improved?

Masao Ito replied that he learned a lot. He realized that neuroscience is conducted by combining solid evidence-based knowledge with novel hypotheses that, while they may lack a solid foundation, were useful in guiding predictions. For illustration, he referred to the internal model hypothesis in computational neuroscience, which now explains a broad range of issues in learning. Expecting that hypotheses from education might also contain useful guiding predictions for neuroscience, he urged education participants to use their hypotheses to challenge neuroscientists, and vice versa.

Focusing on concepts of immediate benefit to education, Reijo Laukkanen replied that many of the presentations did offer new insights on learning, and these required a broader definition of education: a definition with a wider range of developmental needs; not a definition confined to academic learning. For example, emotional control was a learning goal that encompassed social development and facilitated learning. Learning, according to the constructivist model, is an individual, internal process that selects and defines competencies. But practical advice about sleep and the arrangement of the school day are useful if policymakers choose to regard them. Laukkanen suggested that teacher trainers and special needs educators become involved in the work and that a review of educational research might also be useful in future meetings.

Denis Ralph remarked upon the importance of cardiovascular fitness to lifelong learning: we develop new skills as we get older, and dynamic, beneficial changes in adult brain are possible. He also believed that transfer of science to education was possible. He then suggested that educators be more vocal, contribute to building a framework and confront neuromyths in more creative ways. After reminding participants that, while being on the cutting edge of science was wonderful, findings from ten years ago had still not "trickled into mainstream consideration".

The final panel speaker, Wolfgang Schinagl, said that he would like to see more ways to design presentation of knowledge: techniques that contributed to the development of better applications for learners. The sessions had reinforced the primacy of motivation for learning and provided evidence of plasticity in adult brains. Developing a curriculum that was more brain-friendly and that used new technologies in the classroom was required.

Progress reports in other activities

Bruno della-Chiesa provided a brief overview of the work in the other two networks and in the planning meeting for the new project. More information on both of these can be found on the OECD web-page. He then talked about some of the challenges in creating and guiding these networks within a trans-disciplinary approach to integration. There are several questions that they are thinking about with this project:

1. How is it possible to best maintain the momentum of discussion between meetings?
2. How is it possible to have more input from educators and policy makers into the networks?
3. Is the discussion too broad or too narrow?
4. How can we ensure that when we translate research findings into public discussion we avoid creating "neuromyths"?

Bruno della-chiesa stressed that this OECD project is research-driven as opposed to policy-driven: rather than trying to find the best way to get from point A (where we are, as defined by analyses) to B (where we want to go, as defined by a policy-decision), CERI is taking the "Columbus Approach" (by using the vector of transdisciplinarity as the driving force, without having a pre-determined goal, except to find "spices"), i.e. "Let's let the wind blow through our sails, go West, and see what we find."

He added that: "CERI does not necessarily aim at producing recommendations (in the classic form) for policy-makers' use, but rather expects to present them with a set of education-relevant findings (information), things that one should know before making a decision on one or the other aspect of policy-practice".

Summaries of closing remarks

The meeting was closed by Tom Schuller, speaking as Head of OECD-CERI and Masao Ito as Chairman of the LLL Network.

Tom Schuller posed two questions:

1. Is a multi-method approach more appropriate to education than to brain science research?

With reference to Koizumi's model of trans-disciplinary research: how was it possible to bridge the disciplines of neuroscience, education and educational policy? The development of a process of communication between these areas remains a challenging task. And it was possible, he thought, that a multi-methodological approach was more important to educational research than to neuroscience. He had the view that brain research, although impressive, was fragmented – reductive – and less interested than education in taking a "wider range of angles" in approaching problems.

2. How can brain science "encompass" whole-person questions?

He suspected that if there were more educators at the meeting they would be resistant to some of the presented research as being relevant to education. It would be seen as reductionist, as going against the educational principle of being concerned with "whole people" rather than just "bits of them".

He discussed the necessity of keeping the dialogue going after the meeting. Publication was also necessary: possibly in special editions of journals. The OECD would be pursuing this from a policy related angle. He then returned to a point made earlier by Jarl Bengtsson: to identify – "bullet point fashion" the implications for education of brain research. Finally he wanted neuroscientists to think what issues their work was identifying that educationists should be addressing. It was necessary to work towards some "fused, joint" research agenda.

Masao Ito believed that the meeting had been "fruitful" in bringing together heterogeneous concepts and ideas. He evaluated various aspects of the network. Although some people might feel the network's focus was "too broad", he did not agree. He thought it very well focused on integrating first-hand knowledge emerging from ten world class laboratories which were all deeply interested in the brain's learning mechanisms across the lifespan.

Some people may consider the knowledge gathered by neuroscientists to be sufficiently large. They might say "OK, just choose something from the big bag, cook it and make it edible: educate us; educate society". However, in reality, approximately sixty per cent of contemporary neuroscientific research is done in rodents, and to apply this knowledge to humans a new experimental approach is needed. Furthermore, there were still many mysteries, many pitfalls, in our understanding of learning mechanisms of the brain. This network, therefore, is keen to support cutting-edge neuroscientific research. Providing such support needs much effort because mysteries that inspire scientists often discourage funding agencies. We are fortunate in having OECD instigate this project initiative, and the support of MEXT, and he hoped the network would continue to provide both scientists and educators with new opportunities.

Dr. Ito then recalled the proverb: "If you chase two rabbits, both will escape". But we were not chasing two rabbits (brain and education); we were chasing a single, elusive rabbit. Once found and caught, we would be able to advise society. Such advice may not always be constructive: " do this or that"; it may suggest that some traditional practices be stopped: "do not do this or that". The effects of such advice on education will be observable many (even twenty) years later. Ensuring that such approaches are effective, with longitudinal studies or computer simulations, is a matter of great concern for this network.