A Report of the

# LEARNING SCIENCES AND BRAIN RESEARCH

## Emotions, Learning and Education Seminar

**Hosted by**
**Learning Lab Denmark**

**8-9 November 2004**
**Carlsberg Foundation**
**Copenhagen, Denmark**

**Report prepared by**
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Organisation for Economic Co-operation and Development

OECD CERI

Centre for Educational Research and Innovation

## INTRODUCTION

Since its launch in the 1999 programme of work for the OECD's Centre for Educational Research and Innovation (CERI), the Project on Brain Research and Learning Science has outlined how the activity of "emotions and learning" could, in the future, fit into the broader context of the project. It began as an informal activity addressed within the three existing networks: Literacy, Numeracy and Lifelong Learning. However, it became evident in the second phase of the project that the networks were not placing much emphasis on the issue, and so, rather than create another network (which would impose too rigid a structure for this horizontal theme), it was decided instead to create another theme to run parallel to the project's other network activities.

To this end, a first symposium on the subject of "Emotions and Learning" was held in Ulm in 2003, to establish how the OECD "Brain and Learning" project would focus its future agenda to accommodate this theme. Several aspects of emotions and learning were covered at this planning symposium: looking at the brain and how it processes emotion (including the involvement of the amygdala – which is closely linked to fear and other emotions – in learning); the history of emotions in education; the role of environmental factors, such as sleep and nutrition; and programmes that train the brain to be open to and motivated for learning.

The planning symposium made it clear that there are already enough data and interventions on this subject currently available. The next step was to decide upon which ones to focus our attention, in order to draw up a sensible programme that would explore the most effective ways of training emotional intelligence and ensure a positive emotional balance for the enhancement of the learning capacity of the brain, by looking at both the sociological and physiological factors that influence these two activities.

In the ongoing effort to meet these goals, an OECD-CERI meeting on the subject of Emotions, Learning and Education took place 8-9 November 2004 at the Carlsberg Academy, Copenhagen, in collaboration with (and hosted by) the Learning Lab Denmark. This meeting was attended by forty experts, ranging from neuroscientists to education specialists (including practitioners). The goal of the "Emotions, Learning and Education" seminar was to focus on the educational implications of the relationship between emotions and learning – hence the title Emotions, Learning, and *Education* – and by so doing, help formulate a state-of-the art chapter on the neuroscientific aspects of emotions and learning, particularly in relation to education in practice. The chapter will be part of the upcoming OECD publication describing the phase 2 results of the CERI project: "Learning Science and Brain Research". The publication is due in 2006.

## Prefatory remarks

The introduction of the term “education” into the title Emotions, Learning, and *Education* is meant to emphasise a clear relationship with everyday learning issues. By stressing this aspect, the hope was to stimulate the neuroscience field – which does not normally address questions at the level of everyday learning – into delivering ground-breaking contributions.

All participants were requested to submit a “position paper” (comprising one to two pages) before the conference.[1] (The position papers are available for download from the website, see: *http://www.oecd.org/dataoecd/41/26/34097347.pdf*. It is important to note that it was specifically requested that the position papers need not necessarily be based on the writer’s own research. Rather, the purpose of the position papers was to state an opinion on the theme “Emotion, Learning, and Education” from the perspective of the fields in which the different participants work. This was to ensure that we would arrive at qualified discussions on possible real-life paths of didactic development and future research, rather than cautious peer review manoeuvres amongst researchers.

A few selected position papers were chosen for keynote presentations, but all of them were discussed in detail within the four workshops under the themes: Training emotional competencies; Motivation and learning with a brain perspective; Environment, sociality, emotions and learning; and, Emotions in education: stress and mastery. The brainstorming focused on questions such as: “How can we remedy the collective, emotionally distraught brain state, which is inhibiting learning in the classroom today?” This was done by exploring a) the best ways of putting the current knowledge of emotions into use in a learning environment; and b) methods of teaching the management of emotions (by reflecting and acting on one’s own feelings, as well as the feelings of others).

This report will firstly provide a summary of the first planning meeting. The report will then focus on the Emotions, Learning and Education seminar held in Copenhagen, Denmark, under the above mentioned themes as they were discussed in the workshops, and will seek to deliver a full record and synthesis of both the workshop dialogue and the plenary discussions.

***Disclaimer:***
It should be noted that the implications for educators drawn from the research presented in this report is early supposition, and serves at the current time to guide research, but not yet policy. At this stage it must be borne in mind that we are not yet ready to prescribe specific methods, but we can suggest general guidelines.

[1] As not all the participants to this meeting were scientists, and as the subject of emotions is not necessarily the main focus of the research of those scientists that were present, position papers could draw from scientific research (past and/or current research, and from various scientific disciplines) in order for the writer to state his/her viewpoint.

## SUMMARY OF PERCEPTIONS FROM THE 2003 PLANNING MEETING

The planning meeting on the subject of Emotions and Learning, held in December 2003, in Ulm, Germany, left no doubt that role of emotions on learning is of extreme relevance to the OECD Brain project.

The meeting made it evident that there are three groups of influences that we know directly affect the brain's ability to perform, learn and pay attention.

The first of these groups are the physical influences on the brain, the fact that the brain is part of the body, and that what we do to our bodies directly affects its ability to pay attention and learn. The importance of nutrition was highlighted. Twenty percent of the brain is made up of essential fatty acids, which the body is incapable of manufacturing (hence, these have to come from what we eat). More should be done to ensure that children are provided with the elements that make up the brain, otherwise there is a reduced chance that their brains will be able to do their jobs properly. The importance of physical exercise and play being integrated with learning was also emphasised. Children at school only tend to move around during recess periods. The body should not only be used as a vehicle of transportation or something that is mechanically maintained to be fit, it should also be recognised as an entity with which one learns things. The knowledge of the body should therefore not be restricted to merely cognitive, academic, or abstract representations.

Secondly, there are important social influences on the brain, social interaction, etc., which have a direct impact on its ability to work. The importance of positive social influences and nurturing on physiology and behaviour was demonstrated.

Thirdly, there are the external emotional influences for which schools may not necessarily be directly responsible but which can cause havoc on the emotional stability of children. In order to understand students' emotionally related learning problems, parental and teacher training on emotional management, conflict, etc. is recommended. Projects to raise emotional literacy standards in schools were demonstrated to be effective in improving performance in schools, as it appears insufficient simply to focus on behaviour. Behaviour is often difficult to change. In order to achieve a measurable, sustainable change in behaviour and performance, it is necessary to go beyond ideas of behavioural change, and even beyond interventions that target cognition and feelings. It is necessary to work directly with emotions and their underlying constituents – an individual's physiology. Presented at this meeting was the ExPRESS Project in the UK, whose approach is to work with the physiology first, and then with emotions to create a State of Optimum Unconditional Learning in which other cognitive and behavioural strategies can be more effective. Emotional Intelligence is achieved by enabling individuals to control their own brain function to become aware and actually experience, manage and direct their own emotional energy.

At this meeting the importance of the role of the amygdala and the fear factor related to learning was also stressed. This means that whatever children are taught in our schools, it should be done in a positive context as much as possible, because a negative context produces a chain of negative effects on learning and causes brains to switch off and into a non problem-solving mode.

## FOUR FOCUS THEMES ON EMOTIONS LEARNING AND EDUCATION

Is emotional engagement a threat or a facilitator? How can or should we put our knowledge of emotions to use? Should students learn to control their emotions or should they be set free? Is it possible to develop courses and materials that are emotionally engaging?

One of the objectives for CERI's "Learning Sciences and Brain Research" project is to bridge the gap between brain research and learning sciences. Seen from the point of view of someone working outside the field of brain research, it may be difficult to understand the role of emotions in learning. On the one hand, it seems like emotional engagement – good or bad – is to be strived for because it enhances memory, etc. On the other hand, it also seems as if emotions are problematic and therefore must be controlled. The question thus arises: how might we present/develop a coherent framework for dealing with emotions in learning situations – a framework that does not produce confusion, and at what level can cognitive neuroscience contribute to the improvement of the educational system? The goals of the "Emotions, Learning and Education" meeting were to:

- Examine, develop and confirm the evidence for emotions as a key factor shaping successful learning.
- Build connections amongst neuroscientists working on this topic, and between them and educational researchers.
- Lay foundations for a substantive contribution to the final OECD report.

From the submitted position papers it was evident that emotions are important for the learning outcome, and there were four emergent themes that formed the workshop groupings and guided discussion:

*1. Training Emotional Competencies*

Classrooms are often frustrating environments for teachers and students alike. This workshop looked at external classroom disruption vs. internal diverted attention. The discussion revolved around several sub-themes: non-violent communication programs; emotional literacy programmes; motivation; puppetry as a skill for enhancing positive emotional teaching; and the neurological basis of emotions. It also discussed the hypothesis that there is a link between attentional and emotional processing.

*2. Motivation and Learning with a Brain Perspective*

The role of motivation kept popping up in all the position papers, and it is intimately related to 'understanding' and 'emotions'. That motivation is important has been known since before the rise of cognitive neuroscience. This workshop discussed what we know about the neural basis of motivation and whether neuroscience can provide us with new insights regarding motivation.

*3. Environment, Sociality and learning*

This workshop picked up this theme from the planning meeting where these issues were very strongly highlighted, and went on to explore further issues such as adolescent problems, emotional control, learning from peers and the emergence of social neuroscience.

*4. Emotions in Education: Stress and Mastery*

This workshop explored the ways in which stress can be managed in the classroom by learning from existing programmes and from athletes, etc. It examined the neural bases for strong emotions such as compassion and hatred and discussed how animal studies have shed new light on the question of enriched environments and individualistic learning.

## A TOUR OF THE WORKSHOPS

### 1. Training Emotional Competencies

*Workshop participants*

Thomas d'Ansembourg
Joanne Lobato
Bruce McCandliss
Keiko Momii
Jeffrey Peyton
Emile Servan-Schreiber
Hans Siggaard Jensen
Jørn Skovsgaard
Alan Watkins

*Mastering emotional control*

A frightening example of violence in Japan was cited, where a very young girl was recently reported to have stabbed another girl with a knife, because she said something bad about her on the internet. This is not an isolated incident, nor is it unique to Japan. All over the world, children are committing violent acts of aggression, and no-one knows what is really going on in these children's minds or how to solve these issues. Now imagine that little Japanese girl saying: "I am feeling so lonely in my family, my parents are always fighting and pay no attention to me. I want some attention and to find some identity in the eyes of someone. So, at school I am disruptive, I am restless, I'm trying to attract attention because I deeply need attention, and if I don't have attention I will do something tragic. I have to kill, because then I am recognised as someone that exists." Imagine if that little girl could express these feelings to her teacher, and get the attention she needs from her teacher, who understands how a human being's brain functions, as well as a child's needs as a whole.

Children are going to school with a lot of internalised pain and suffering, and they are unable to concentrate on their lessons because something is wrong at home and they are too busy trying to manage their emotions. According to one of the workshop participants, who teaches non-violent communication to street kids, for education to work it is necessary to develop a whole awareness of all our emotions, so we can describe with precision what we are feeling, and what each feeling the signals. This is because feelings signal either the fulfilment of some functions in the human being (when those feelings are good), or a lack of fulfilment (the feelings are negative). Children are taught how to gain a positive identity, or any kind of identity – even a negative one – without being judged. What his programs try to do is train emotional intelligence and gain knowledge of our needs and values. It was explained that when you are angry or sad and suppress your feelings, they build up inside you and you become like a pressure cooker that will, one day, explode aggressively, or implode into depression. The non-violent communication process is called a "process" because it is not magic; rather it is something that has to be practised all the time, and is based on the understanding that as human beings we all try to fulfil our needs all the time. Our life is more comfortable when we know our needs better and see how we can fulfil them ourselves, instead of just waiting for others to fulfil them; and we then stop judging, criticising and striking out at each other.

It was suggested that children should be allowed to be individuals, have the freedom to experiment with playing different roles, and relate more to adults. There exists a lot of research

on play, which enhances the connectedness between the adult world and the children's world, but there is little research on adult and child play interacting. There is a big difference between these worlds, and this needs to be explored.

The question of communication as being a one-to-one relationship (and how it is possible to regulate group emotions), was raised. What happens when there are 25 children in a classroom, which strategy should we rely on? It was suggested that with groups, there needs to be a feeling of respect for the group as a whole. Experience from working with delinquents shows that most of the time the children do not respect groups because they don't understand the "sense" of the group. Teachers spend too much energy trying to manage their groups, when they should rather be there to explain the sense and advantages of the group (and how it serves to help us lead a better life). There is a need to help teachers understand their own needs, in conjunction with those of the school and society in general, to help them clarify what they are teaching, why they are teaching, and then motivate them (by helping them to be more free, more responsible and more in charge of their own lives), as you cannot share motivation if you are not motivated yourself. It was speculated that if teaching makes sense to the pupils who experience it, we should end up with a much better image of learning.

*Motivation*

It was suggested that perhaps one of the elements missing in the world is the societal role of the learner, (that it might be lacking a motivational structure). For example if you take the seven or eight year old child, what is its role in society? Could it be that the structure of that role itself is missing the motivational element? When trying to understand the child's world and motivational structures, an example of factory workers was cited where games were introduced which they played with themselves in order to make their work more challenging and meaningful by constantly setting their goals a little bit harder. Studies cited looked at cultures in early human development where children were typically born four years apart and where the older children were needed to take care of their younger siblings – they had an active, continuous role. However, in the current stratification of the school system this has been eliminated. Children are simply consumers of knowledge and there is no reason for them to fulfil the needs of another. They are not supposed to have any needs other than the acquisition of knowledge. When adults socialise today children are not needed, and so they end up playing with their Play Stations (for example). A person needs to feel needed and valued: so if students feel more valued, and feel that what they are doing is of value to the world, they will be more motivated.

An example was given of how children can be motivated to do standardised tests, consisting of 100 trials (that are otherwise incredibly boring to them), by making them into games and inventing little creatures whose needs these children have to fulfil (for example, feeding frogs to ensure they don't go hungry). Children will play these games for half an hour, working through 100 trials with no problem, and even children with Attention Deficit Hyperactivity Disorder (ADHD) are interested in this kind of motivational game (fulfilling a need).

Social factors may offer motivation the hand puppet model forms a bond between adult and young people, a critical factor in meeting the needs of children to feel close to an adult (mentor or coach) as opposed to a "teacher." The model also leads teachers to understand their own needs. When a teacher connects with children, the excitement and adrenalin kick in. Adults clearly want and need to connect. Often the tools to help them do that, and the permission to use them, are not available. In the puppet model, the aim is to alter the communication flow and chemistry. Teachers employing the flow of play both demonstrate (practical) and model (creative values and behavior). This is only one communicative play stratagem working with a large group.

It was hypothesised whether motivation can be developed through the use of imagination. One of the members of the group knew of a teacher who had a hand puppet koala bear in the classroom that was so mishandled that it was sent back to Australia. In order to get it back the children wrote letters of apology to it and it returned six weeks later, after the children had "learnt their lesson." This example illustrates that whether it is story telling, or something that harnesses the imagination of the group, it can make a big difference in terms of motivation.

But what is it about caring for another, caring for a puppet, or a cartoon character, or a younger child, that changes the motivational structure so much? What it all appears to boil down to is that, as was mentioned above, the person must feel needed and valued and students will feel more valued and motivated if what they are doing is of value to the world.

*Tuning into your emotional brain*

The question arose as to whether there is a coherent model of the brain that differentiates the emotional brain from the cerebral cortex.

A "ubiquitous learning phenomena" was described that may be applied to many different domains. There are domains of the human brain that can function as separable networks, however, these relate more specifically to "levels" of the brain. When attributing a "feeling" – deciding whether or not you are angry, for example – it encompasses both cortical and sub-cortical contributions. The "levels" of the brain are interacting, even though they are segregated. For example, when discriminating between different things – such as fear from anger, aggressive feelings from fearful feelings, hunger from thirst, and hunger for salty, sweet or fatty things – an amazing computation resource in the brain enables one to make finer and finer discriminations that become more and more accessible, so that one is then able to continue to make further and even finer discriminations. This is "first order processing" where information from the gut and the heart comes up into what we call the "emotional brain" where it is processed, integrated, and then this sensory data is integrated and projected forward for a corrective, finer interpretation. So, in terms of building up the neurocircuitry, as one focuses on these different things, finer and finer discriminations become possible, so that with practice a person is able to distinguish between different feelings, e.g. between anger and frustration. At the end of the day, one has the acquired the ability to tune into different sensory experiences in the body and interpret them to build up a more discriminate function in the brain.

*A connection between attentional and emotional processing*

Two participants in this workshop put forward a hypothesis that negative emotions might disrupt attention processing and emotional processing, and that perhaps training one of these could affect the other. These two participants have been studying how executive attention develops, and whether being able to train this might be linked to emotional control regulation. It was suggested that in the classroom the attention should be focussed on coordination and collaboration, to work in the classroom in such a way that the teacher and materials work together to create a focus.

An experiment undertaken by NASA was described, where monkeys were trained to fly a spaceship. These monkeys went through a type of computer attentional training for many weeks, and it was noticed that when the monkeys went back to their environment, their social aggression seemed to diminish and their emotional self-regulation seemed to have improved through conflict. Experiments with children have been conducted to see if they also possess this emotional self-regulation. It would be interesting to see if training up such emotional regulation could have a major impact on a child's ability to focus his/her mind on what it wants to do.

Emotions help glue and bind attention and memory; add narrative, meaning, identity, and self begins to take shape. This leads to speculation that there may indeed be a link between cognitive attentional focussing and emotional attentional focussing, and it would be interesting to explore this further.

## 2. Motivation and Learning with a Brain Perspective

*Workshop participants*

Vera Blau
Bruno della Chiesa
Peter Gärdenfors
Christian Gerlach
Katrin Hille
Walo Hutmacher
Morten Kringelbach
Evangelia Tigka

*What is motivation?*

Roughly, motivation can be defined as whatever causes to act. As such, motivation reflects states in which the organism is prepared to act physically and mentally in a focussed manner, that is, in states characterised by raised levels of arousal. Accordingly, motivation is intimately related to emotions as emotions constitute the brain's way of evaluating whether things should be acted upon; approached if pleasant or avoided if unpleasant. Thus, the emotional system (associated with the amygdala and the orbitofrontal cortex) is tapping directly into motivation by affecting our level of arousal (which again is controlled by structures in the brain stem). It is worthwhile to distinguish between external and internal (intrinsic) motivation. Both are dependant on emotions, but whereas external motivation is achieved by affecting the behaviour of the organism from the outside (through punishment and reward) intrinsic motivation reflects the organism's wishes to fulfill internal needs and desires (e.g., hunger, thirst, sex). A lot of the important things neuroscience has to say about motivation in the context of learning thus concerns emotions; and often the part that relates external motivation through punishment and reward. Nevertheless, there is also fairly good neuroscientific evidence suggesting that curiosity can be considered as an intrinsic motivational drive. Accordingly, novelty in the learning environment is probably an important element in motivation as novelty awakes curiosity. Interestingly, detection of novelty is associated with the hippocampus which, as we know, is an important structure in memory encoding and memory consolidation.

Humans like other animals have “motivational drives” which are linked to our emotions, and it has been proposed that one of these drives is curiosity. There are also strong indications that motivation and emotion affect the memory system. To a large extent, all animals including human beings are driven by unconscious desires that are not fully understood by them, except when they go wrong (and you end up with people with addictions to alcohol, gambling, drugs, etc.), yet it is these very same mechanisms driving most of our behaviour. The impetus for this may be external stimuli such as rewards and punishers, but at the same time there are also internal drives, which drive those truly pleasurable things that you do just for the pleasure of it. Most people will have experienced this from something they did actively (usually using motor

skills), like learning to ride a bicycle for the first time, but without external reward. The mechanisms of these internal drives are not well understood, and are presently difficult to study with neuroimaging techniques.

Most will agree that school is not always fun, and some would argue that it acts as a constraint and can in fact be demotivating. What is needed is to find out how the brain becomes motivated: what turns the brain on. When trying to interpret what happens in the brain when it is turned on, it appears there is an interaction between inside and outside influences on the brain. A study investigated the underlying pain mechanisms in the brain by giving some subjects opiates and others placebos (pills with no therapeutic value). Interestingly, the placebo responders had similar brain responses to those given opiates which in turn could be a correlate of larger degree of learning than the placebo non-responders. The placebo responders appeared to be able to "turn on" their own brain mechanisms for coping with pain. Further research could help us understand if and how this capability can be harnessed, so that we can learn how to help those of us who are placebo non-responders.

Strong basic drives for e.g. hunger, thirst, sex drive much of our behaviour, but we also possess curiosity. Some have argued that curiosity is strongest in humans compared to other animals, yet such claims are quite controversial. Just satisfying your curiosity is motivational: however, the mechanics of this are not yet fully understood. It seems clear that there must be a strong correlation between play and curiosity.

Why is school not fun and why is play fun? The school system is traditionally based on a system of punishment (punishment for not attending, not doing lessons, not following the rules etc.), rather than on reward. If play is motivating, then this gives rise to the question of whether school systems should be based more on play. Much seems to indicate that the brain is made for action; our bodies are not designed for sitting still and receiving passive information. This sort of evidence and information needs to be used in a constructive manner in order to see how we might then do things better. For example, if play is a good thing, perhaps more teaching material based on role play should be introduced, and then this needs to be measured to see if it actually works better than traditional methods.

A hypothesis was presented at this meeting relating internal motivation to hedonic states. An experiment has been undertaken where hungry subjects were put in a brain scanner and fed on both sips of chocolate milk and tomato juice. The subjects were scanned twice; first in a hungry state and then sated on one of the stimuli and were asked to rate the pleasantness of the stimuli. This enabled conclusions to be drawn about the neural correlates of subjective pleasantness. Although exposed to two quite different tastes, something a bit salty like tomato juice, and something a bit sweet like chocolate milk, the common subjective pleasantness was found in the orbitofrontal cortex in the prefrontal part of the brain. The idea was put forward that a type of "fluid absorption" occurs when you are doing things as you would do them in play, things you do that are intrinsically motivating, and that "hedonic experiences" are intimately linked with this internal motivation and learning. The challenge is to find out how to give purpose to learning, and how to encourage the internal drive to want to learn something. This is an area where more directed focus research could yield very important direct benefit for education.

One participant explained intrinsic motivation: "it is not necessary to generate motivation in people; you just need to tap the source. We have the motivation of being hungry or thirsty, being curious and we like to be together as people. Sometimes things we don't normally like are made enjoyable, and we like to prove to ourselves that we can do them...". We do not need to implement motivation in human beings; we just need to tap into the right sources of motivation. In

order to tap these motivational factors, and to make them applicable to everyday learning, communication needs to be possible from all sides, i.e. brain scientists need to know what the questions are in education, and education practitioners, as well as education scientists, need to know what can be answered by the new methodology in science, etc.

*Finding the link from brain science to learning*

It is probably very difficult to find experts who know what is happening in the classroom, and at the same time understand what is happening in a brain scanner. This workshop discussed forming a methodology to cross the bridge between neuroscience and education. Although it is a bit difficult to see how we can apply brain research directly, it is more obvious how it can be used indirectly to phrase new questions and find new directions, in order to find the inspiration for doing something new.

Neuroscience can also be very useful in bridging the gap between theoretical and applied science. One participant felt strongly that the link from brain research to learning in real life has to proceed through cognitive theories, stating that brain research could potentially provide some ammunition for supporting new ways of doing things, and that cognitive neuroscience might provide some guidelines for consideration when developing teaching courses. The human being, as characterised in neuroscience, is not the same human being characterised in the school system. Although children are taught from a very early age to sit still, things that they ought to learn are not really put in a practical context, even though we know that it is much easier to learn something that can be used. In this sense, cognitive neuroscience could be used to focus on the way people learn. It was further suggested that the problem is that there is no one giving neuroscientists the motivation to take the next step, to hand over their input to cognitive psychologists, and that is why so many resources are wasted. Scientists in general have the tendency to dig deeper and deeper and get into more and more detail, which results in the relevance becoming somewhat lost.

An example of the situation in Sweden was given, where educational research is confined to looking at what exists in school, where only very prescriptive work is performed, and where there is never any attempt to try and change things. Very seldom are there any interesting questions raised concerning ways of changing the system of education. Education can be summarised as an intervention discipline (concerned with efficiency), as opposed to neuroscience, which is a descriptive science (concerned with factual truth). The only way forward in getting these two worlds to work together effectively is through communication. There are no figures in the educational field who can act as go-betweens between science and practice. It was suggested that perhaps teachers could be more active in this area. At the Ulm Transfer Centre for Neuroscience and Learning, teachers are actively involved in the Centre's research program. Another brain scientist said that it was important to have an idea of how teachers think; otherwise it would be impossible to come up with anything interesting or relevant. Teachers who have been in the business for over twenty-five years can probably tell scientists what works and how they motivate children, and then scientists can go back and frame teachers' questions in a research context.

Brain research should move away from the current focus on brain imaging, and incorporate other areas of science. The brain is still a very new object in the educational sciences, paradoxically, and brain science in educational science is not yet properly established. However, brain science is about getting out of constraints – what is possible or not possible. Neuroscience can provide new notions and inspiration to do things differently. Only by continuing to probe neuroscience for new answers, and by reinterpreting these constantly, will it eventually be possible to actually use these results in an applied way.

*Deep understanding patterns and testing understanding*

What is understanding and can it be taught? Understanding cannot be taught, it can only be trained. Understanding was described as being like seeing a pattern (this idea is derived from Gestalt psychology) For example, you know certain facts about the world and then suddenly the pieces of knowledge fall into a new pattern, and that is when you understand. We have all experienced the sudden moment of insight when all the pieces fall into place in the pattern, when you have the urge to cry out "Aha!" When we understand, there is also a very positive emotional feeling, which is in turn rewarding and drives you to continue in that direction and use the pattern for new kinds of problems. In addition when you understand things, then that knowledge stays with you, it is sustainable. You do not forget it the next week, or after having completed the test for which you studied.

However, there do not appear to be many studies about what happens in the brain when we understand. The big question is how to decide on an educational system that generates understanding. It was suggested that new methods are necessary in order to help children see patterns. In most traditional schoolbooks we see things such as pictures, drawings of molecules, graphs, etc., which give us a very abstract experience. These experiences need to be more practical, and this should be explored through different methods such as role playing, modern technology (virtual experiences), etc. What is needed is interplay between somebody presenting a theoretical pattern and actual experience.

This gave rise to an interesting debate amongst the group: if you consider understanding as the key element of education, then a lot of testing can be thrown away. Of course, some kind of testing should be retained, namely testing whether someone is able to apply his/her knowledge to new, previously unseen problems. This is in fact the theory behind the PISA testing, where essentially what is being tested is the students' understanding.

The idea of "patterns" being an economical way of representing things was put forward. The brain takes similarities and makes all of them rules, so that in a sense there is a certain economy of understanding in the brain. Seeing a pattern is good for us, because it shapes our memory and makes our thinking more economical. Evolutionary psychology tries to bring out exactly those considerations, explaining our thinking mechanism by giving it evolutionary backing. Neuroscience could be explored further in an evolutionary context to offer explanations on how the brain forms patterns of understanding.

At the end of the day it seems that learning is about getting to a state where everything makes sense, and most importantly it appears to be a state that it is possible to get to. However, whether understanding is a key motivational factor in education is something that still needs to be validated by neuroscience.

## 3. Environment, Sociality and learning

*Workshop participants*

Cassandra Davis
Michael Fritz
Jellemer Jolles
Eamonn Kelly
Simon Nørby
Andreas Olsson
Tom Schuller
David Servan-Schreiber

*Adolescence*

In many countries there is a strong policy drive towards keeping adolescents in formal schooling for as long as possible. Adolescence is an extremely sensitive period from a brain perspective, and also due to a surge of hormones in the body. It is a period when children are especially open to social developments, but less open to learning at school, and it is also a time when violent behaviour usually starts. Although there is a vast amount of cognitive research on adolescence, there is not much available from neuroscience, and this gap needs to be bridged.

There is circumstantial evidence that children have an enhanced ability to learn social skills between the ages of 12 and 18. There appears to be a window of opportunity at this age for social learning. Socially, the major focus of the adolescent's life is his/her peers. It was suggested that this should be examined neurologically, to invent other types of knowledge transfer for schools so that adolescent students are not just in the classroom listening to the teacher, but also further developing their interest in social communication.

The adolescent attitude towards learning is typically that it is considered "nerdish" and unimportant. Somehow a change of attitude needs to be cultivated. It was stated that it is necessary firstly to attach value to the role of study, to make it "sexier" so it appeals to this age group, and secondly, to cultivate and facilitate learning. However, the risk remains that no matter what the social norms are, adolescents might still feel the need to rebel and reject these methods as well; in other words, no matter what you <u>say</u> is "cool", it won't <u>be</u> "cool". The answer to this problem is that you have to appeal to the intrinsic motivation that exists in each individual (see workshop 2, section "What is motivation?"). The value teenagers give to peer group demands needs to be tapped into: it needs to be the students that make learning "sexy", not the teachers. At the end of the day, it all depends who is attaching the value to study. There is data showing that peer learning (from someone two years older) is more effective than learning from a teacher. However, it is hard to find brain data on whether peers are actually better teachers than teachers. Looking at examples in pre-human primates (where, in their hierarchy, apes are taught their positions within the group), could also provide an example of transfer for our system.

Of course we have to be careful to avoid offering folkloric or personal solutions, but there are important questions here on which neuroscience can shed light, in terms of the as yet unexplored adolescent brain: What instructional approaches capitalise on peer groups? Is it beneficial for adolescents to be sitting still in buildings? Do they need more sleep? Do they benefit from sporting programmes? How much responsibility should they be given for learning and decision making?, etc.

*Identifying emotions*

There are 34,000 states of emotion (an estimate by Tibetan monks as quoted in the book by Daneil Goleman: "*Destructive Emotions: How Can We Overcome Them? A Scientific Dialogue with the Dalai Lama*"). Emotions evolve before language does, and even though the language for describing every single emotional state does not exist, emotions themselves are there constantly.

A programme in the UK to improve emotional literacy in schools emphasises the importance of recognising the proper parent for emotions. So, if a child is reporting frustration, and wants to change this negative emotional state, he has to identify a positive substitution in order to move over to the other side. For frustration, the opposite is patience, so the child needs to learn to develop patience. This programme first starts with teachers and by training them to understand their own interior states they can help identify and label those of a child. This is not only so that emotions become language, but so that teachers can draw on the functional response to recognise that a child who is, for example, depressed needs something different to a child who is frustrated. The metaphor of a mirror is used to help a child try and find the emotional substitution in its reflection. Language becomes the "mediator" and the basis for a programme of strategies used to then help control emotions. This programme specifically deals with teachers first, because if the teacher is agitated, then the child has no hope of being relaxed. Thus far, pilot data from work in five schools using this programme has shown a marked improvement in school attendance, behavioural disruption, reduction of teacher stress levels and increase in staff morale and academic performance.

As we know that negative emotions and stress disrupt optimum learning, it is therefore important to come up with concrete methods that can be used in the classroom to help regulate emotions and manage conflict. There are studies on young children who are born with superior emotional intelligence; they don't have to learn it. Procedures for acquiring this kind of intelligence need to be explored, so that it could be taught in the classroom. There is much literature on conflict resolution techniques, but the primary question is to see if there is a neuroscientific basis for it and if something can come out of this to suggest how to combat conflict problems in a more effective manner.

*The development of the pre-frontal cortex*

There is evidence that the pre-frontal cortex (the part of the brain that is responsible for planning and decision-making) continues to develop into the mid-twenties. One of the functions of the pre-frontal cortex is to seek novelty. Novelty in this context means curiosity, and all children (nearly 99%) are born with a natural curiosity, something that is, apparently, often discouraged in our current school system. There is a continuum between curiosity, novelty-seeking and impulse inhibition in the developing pre-frontal cortex. As this region is not yet mature, there is a tendency for this delicate equilibrium to turn to violence and aggression in teenagers. It was suggested that what is needed is an "external motivator", and that it should be the responsibility of the teaching body to assure an environment where the subject is able to use his/her curiosity and make use of those stimuli that are important for development. One possible explanation was given for the current day problems as being due to the lack of moral education, because nobody wants to take responsibility for it any longer by imposing values. However, the brain is not yet mature enough, so that it is necessary to have teachers set examples, stimulate and make the laws.

In adults, it has been suggested that decisions involving long-term rewards involves mainly the pre-frontal cortex, whereas decisions related to immediate rewards depends more heavily on areas of the brain known to be associated with emotional processing (i.e. the limbic system). Interestingly, previous behavioral research on childrens' ability to resist a smaller immediate

reward for a larger reward at a later point has demonstrated that the ability to delay gratification is positively related to both economic and social success later in life.

It is important to differentiate learning and performance. We know from brain research and other research that what you learn now may not be performed immediately, but that there can be a long time lag until you see the learnt behaviour emerge. We also know that this kind of learning is context-dependent (what I learn from my parents right now might not show up in my peer group for several years, but it might come out in a similar context when other adults are around). So, it is important to bear in mind that there is a difference between learning and performance.

Thus far brain research is unable to provide the answers; it only helps to pose the questions. Brain research says that the brain continues to develop until somewhere in the twenties, and that there are different periods in which particular brain functions are more prominent, and when curiosity for particular things is enhanced.

*Learning through social observation*

The processes of learning through social observation based on animal research was described, which gives rise to the hypothesis that learning by observation seems to be a viable complement to the attainment of emotionally relevant knowledge. Visualisation, it was explained, is a powerful tool, and weak learners are known to improve more by observing other weak models, whereas strong learners profit more by observing other high performance models.

The theory on how the acquisition of emotionally relevant knowledge about others can be affected by social group membership was put forward. An interesting example of a study was given where racial prejudices were examined using a Pavlovian conditioning paradigm, which shows that white and black subjects display an extended resistance to the extinction of faces of other group members, but not to own-group faces. This suggests that subjects learn aversive responses quicker and that these are subsequently very hard to unlearn.

As these points are of significance for both education and society at large, it was suggested that they should be explored further from a neuroscientific perspective and using human subjects. The emergence of a social neuroscience was mentioned and deemed as an encouraging sign for the future. (The assumption in social neuroscience is that the mechanisms underlying mind and behaviour are not be fully explicable by a biological or a social approach alone, that a multi-level integrative analysis may be required, and that a common scientific language, grounded in the structure and function of the brain, can contribute to this endpoint).

## 4. Emotions in Education: Stress and Mastery

*Workshop participants*

Jarl Bengtsson
Brian Butterworth
Emily Groves
Søren Kjær Jensen
Hideaki Koizumi
Reijo Laukkanen
Hana Malà
Ulrike Rimmele

*Stress*

Stress is not only an environmentally-stimulated process, but an interactive one. A person has certain cognitive strategies to deal with stress, and depending on which strategies the person uses, the stress-related activity can be different. For example: in a strategy known as emotional coping, a person first evaluates his/her stress to see if it poses a threat or a challenge, or something else. If it is evaluated as being a threat, emotional resolution strategy is used in order to down-regulate stressful emotions. However, if it is seen as a challenge, a problem-based coping strategy is more likely to be used, for which it is not as necessary to exert oneself, but rather to focus on how the stressor might be altered (by actively reappraising the stressor). There is an fMRI study whereby pictures are shown to people and they have to reappraise them, so as to increase or decrease their fear on viewing the pictures. The results show that the subjects' brains are more active when they increase their fear, and less active when they decrease their fear.

One of the workshop participants (who is performing research studies looking at sports and stress), has found that elite sportsmen's brains show less activity than those of non-sportsmen. Studies are currently examining why this is so, to see whether it is due to their coping strategies, the actual physical activity, or both of them that leads to decreased stress. It is to be hoped that, if the answer can be established, it might be possible to come up with a general emotional regulation strategy.

As stress is an interactive process, it might be safe to say that there are a number of things from brain research that could be disseminated to teaching professionals. For example, that contact is important, fear is not bad in itself, and that too much stress, or the wrong stress, is bad.

*Stress related to brain disorders in the classroom*

It is not irrelevant that the children who are most violent are those that do least well at school. Many of these, at least from data statistics in British prisons, also have dyslexia. In some countries today there is a trend towards parents wanting to have their children classified as "not normal" (even if this might cause stress), because it gives them rights to money for special support and so on. In the UK, where they have developed a behavioural screening method for dyscalculia, the general opinion is that it is better for these children to be classified as dyscalculic, than to be classified as stupid and disruptive. In England, one of the reasons why dyscalculic children fall behind and have such a bad time in their daily maths lesson is because their lack of competence is on show on a daily basis for everybody to see. This is the main cause of stress for these children.

Studies on dyslexia are much further advanced than the field of dyscalculia. Current research shows that there are two completely different types of dyslexia, one that is chromologically based and one that is visually based, and that the prevalence of the dyslexia genotype across all cultures will be expressed differently according to the orthography of that culture. This has given rise to a cultural hypothesis that dyslexia is much more likely to be expressed in a language, and in an orthography that requires you to map phonetics onto letters rather than syllables onto characters. For maths, figures show that Chinese and Japanese children perform better at arithmetic tests because their counting system is regular (you count 1 to 10 and then 10 1; 10 2, etc.) as opposed to English (11; 12) or German where some units are reversed. However, it may be that there something positive in the cultures themselves that makes that Chinese and Japanese children do well in mathematics, and this should be further explored with cross-cultural studies.

What can brain studies on brain disorders such as dyslexia and dyscalculia tell us about learning and emotions for normal children? We can definitely see an immediate practical application in the areas of cognitive deficits like dyscalculia or dyslexia. It is in these areas where brain research can tell teachers a great deal, and teachers can also raise the right sorts of questions to ask brain scientists to look into.

It was stated that it is vitally important to first improve the understanding of maths. It is not the bad experience of the subject, or the emotion that needs to be focussed on, something must be done to improve the understanding. If children understand, their attitudes will change, they won't think of themselves as stupid, so it will instil a positive emotional circle.

A lot of research is also demonstrating the importance of play among children for developing different senses, and it appears that at around the ages of seven or eight the element of play is taken away in class subjects. Play with numbers (e.g., traditional board games such as "snakes and ladders") is known to strengthen the number sense. It was suggested that alternative methods to traditional bio-feedback, such as props like puppets, would certainly be more effective and emotion-friendly, but more research is needed in this area. In the UK, they are exploring the use of more computer-assisted learning (e-learning) and developing pedagogically-sound e-learning tools, so that children can practise in private without having the teacher or other children saying, "You've got it wrong."

The Lancaster model in England was referred to, where a shortage of teachers brought about the recruitment of older children to teach the younger ones in the same classroom (see also workshop 3, section on "adolescence", referring to studies on primates). However, in the current schooling bureaucracies this would be impossible, as teaching is strictly for qualified persons. In the light of this, it was asked whether the consequences could not be a factor for increasing stress levels in classrooms. In the UK emotional literacy programme (see workshop 3, section on "identifying emotions") the stress is on the synergy between teacher and pupil, which contributes to better results when teachers are less stressed. The theory is that as soon as you have a positive relationship between the teachers and the pupil, the pupil is then able to control his/her heart rate and emotional state. The result is that suddenly school is no longer perceived as such a bad thing. However, this group warned that it was vital to bear in mind that if a pupil does not understand what the subject is about in the first place, programmes that strive to help manage the emotional state will not be effective.

*Evoking strong emotions such as passion and hatred*

In Japan at the present time, emotion and education are main issues, new cohort studies have recently been launched in order to gather various kinds of objective data on children to see what

will happen to them, especially in relation to their changing environment (television, mobile phones etc.).

Emotion is a very new subject for neuroscience, and there are not yet many studies available on strong emotions such as love, compassion and hatred. Hatred is also an extremely difficult emotion to study. This is an emotion unique to human beings, chimpanzees do not appear to possess it, and it is something that is related to the evolution of the human brain. Cognitive functions are associated with the neo-cortex, and the limbic system that lies beneath it (which relates to emotion). However, a word of warning was sounded: distinctions should be made clear. Neuroscience today tends to be much more "maverick" with respect to its ideas of how much emotional processing we should allocate exclusively to one part or another of the brain. Rather, there is a very pronounced tendency to relate these systems and investigate the way they interact in general. It was suggested that in order to gain a better understanding of the interaction between the neo-cortex and the limbic system, it would be very beneficial to examine the brain over the lifecyle divided into three phases, as this might alter the hypotheses for learning and motivation within each phase, and to see which mental capacities are affected by the ageing process.

The ideas that Marie Curie brought to education in the late 1800's was highlighted. Curie believed that gymnastics and the arts were the most important things to cultivate in education and her example also stimulated a unique and new emphasis on emotion and passion in teaching. "Passion" as an emotion is a very important issue, and seems to be closely linked to motivation. The question arose whether passion could be acquired through teaching. The group agreed that it was possible through observation and learning. If you have a very passionate teacher, there is a basis for the students to also become passionate, whereas with a very dull teacher students are less likely to develop their passions. However, if one person is, by nature, passionate, how does another person learn that passion? In this respect, early infancy is apparently crucial for cultivating passion, an example was given where in Japan, various nursery schools work on cultivating passion. The hypothesis is that once passion is cultivated, students can go on and learn to think.

*Rich environments and individualistic learning*

Recent research on animal models appears to have very marked implications for the area of learning and education. Although studies with rats in enriched environments is not something new, recent studies make it evident that the way the environment is structured has a pronounced importance for neuro-mechanisms involved in task solutions. If you change the way the outer environment is structured, a problem is solved by a different mechanism. For example, for spatial problems a number of strategies are presented, and the outcome depends on what is being offered in the situation. Although inferences from such studies must be made with caution, it can be speculated that what a student learns can be influenced by what kind of cues are presented, and by the way the cues are structured. In humans there are also other factors, such as unconscious information that might be different from conscious cues that one is aware of. There are also many existing studies showing that nurturing in animals has an important influence, so all these areas require further study and validation in the human arena. However, there is hard evidence that the environment affects the neuro material of the brain, per se. Emotional experiences also affect the way neurons are organised and the way they are communicated, so from that point of view it would also be beneficial to know and better understand the processes at a neural level. However, it must also be borne in mind that there are some things that are to date impossible to experiment with humans.

Studies undertaken on rats also show that the way you are trained throughout your upbringing biases you with respect to the selection of cognitive strategies that you then go and use when solving new problems. This infers that, in a way, experience decides which kind of strategy you will adapt when faced with a new problem.

## CONCLUSIONS

### Some reflections from the final Plenary Session

*Walo Hutmacher* offered some insights from the perspective of an educational sociologist. He firstly made the point that human beings learn through experience and interaction, they always learn; they actually cannot not learn. He warned that looking at learning from a neuroscientific perspective should not be restricted to the classroom context. The concept of learning should be expanded to include, for example, what is learnt through other experiences and interactions, within families, with peers and with media particularly.

Hutmacher then underlined that the education system is not only a learning place but also a system of distributing goods. Although the formal expectations of the adults in schools may be that students strive to learn for the ”pleasure of learning” or the “beauty of knowledge”, the students are actually caught up in a competitive system of assessment, testing, success or failure, etc. Coping with this situation confronts each student individually with a set of very diverse experiences and interactions through which something else and more is learned than the curriculum. Some students e.g. understand quite rapidly they better “learn to play the game”, others need more time, and some never learn to cope or to catch up. But they all experience something that has strong positive or negative emotional components that interact with the intended curricular learning.

The advent of neuroscience and brain research among the educational sciences is in itself a remarkable event, the importance of which we should not underestimate. Something like a culture shock lies ahead. Here come indeed prestigious ”hard sciences” with their highly sophisticated machinery capable of looking into the anatomy of knowledge, emotions and preferences, with a very materialistic approach which some will refuse. It will be interesting to compare the findings of neuroscience with knowledge already accumulated by the traditional education sciences. Will they differ from, invalidate what psychology or sociology already tell us about learning and emotions, or will they confirm it, in terms of theory and in terms of practical consequences ?

It may be useful under this latter viewpoint to alert the neuroscientists. Unlike what they may be used to with the medical field, scientific research is hardly recognised as the major source of knowledge in education systems. There is actually quite an epistemological gap between the education and the science field. In science, when observations contradict theory, the theory is considered false, whereas in education, when the reality contradicts theory, the reality is considered wrong. Maybe the advent of the prestigious neuroscience and brain research will enhance the credibility of scientific knowledge in education policy and teacher circles, and who knows, even the acceptability of long-held theories about learning.

Education systems are very large organisations, for many reasons among the most complex to manage. To bridge the epistemological gap just mentioned, it will be necessary to invent the role of knowledge brokers who work between the scientific and the educational systems. These

should be highly knowledgeable persons who fully understand the results of scientific research – their promises and their limits – and who are able to interpret, translate or transpose them into knowledge and know-how that is useful for education policy makers, managers and teachers.

*Eamonn Kelly* considers that the advances in technology – which allow for the accommodation of more than one person in a brain scanner – are very encouraging for the future, as this now makes it possible to conduct new studies for looking at some of the social issues. When looking only at single brains, some systemic issues are left out. A lot of classroom research has just assumed that societal factors, stress hormones, diet, etc., are having an effect, however, it has taken a long time for that view to get into education research at large. It is important to look not just at individual brains but at brains within a system.

As the neuroscientific world of research is very complex and keeps looking for smaller and smaller pieces, he welcomed the idea, heard at this meeting, of cognitive neuroscientists working together with neuroscientists. He said that simple tests, if well designed, can shed a lot of light on conceptual models which, together with the cognitive input, can provide us with new information.

It may be that the brain has certain developmental phases. Studying these in detail could provide arguments for either exploiting them or going against them. This poses a challenge for the current education system, which is composed of artificial structures, demands and unnatural environments.

The evidence demonstrated at the meeting showing how the transfer of action through puppets can relieve emotions, as well as aiding observational learning, offered interesting pragmatic models for research to explore further in order to develop new models for practice.

*David Servan-Schreiber* stressed that positive emotion matters in learning because negative emotions shut down the prefrontal cortex and hence the ability to learn. The key issue is to explore how to improve and strengthen the prefrontal cortex by closely examining the interaction between the prefrontal cortex and the limbic system. He was encouraged by the programmes for mastering emotions that exist in the UK and the ideas for the management of relationships and non-violent communication, which were presented at this meeting. He pointed out that the inclusion of psychology is vital for providing input on the management of relationships. His final point was to stress the importance of nutrition for the functioning of a healthy brain for optimum learning.

Finally, *Jarl Bengtsson* suggested that we all look to a new metaphor and methods for creating meaningful links between brain science and education. He referred to the new connection between Sweden and Denmark, which connects us via bridge, artificial island and tunnel, all built by very different specialists and disciplines.

**Take home messages gathered from the workshop participants**

Children in present day learning environments all over the world are expected to sit still, absorb and be taught, and they are supposed to have no needs other than the acquisition of knowledge. Teachers do not appear to have enough time to understand what individual students are feeling or what their needs are. The workshops identified these as serious issues. The big questions are then what in addition to knowledge will make a big difference to a group of children in a classroom, and how do we create a learning environment that is safe and good for children and yet make sure that we can justify and legitimise what is going on? And most importantly, what light can brain research shed on all this? Below is a list of non-exhaustive suggestions from the scientists and educationalists, which were heard over the two days of the Emotions, Learning and Education meeting, for policy-makers to ponder over:

*The key is understanding*

- If you don't understand something, it will cause emotional stress and anxiety. Understanding is the key to changing classroom attitudes from being negative to being positive.

*Mastering emotions*

- Children need to be taught not to control but to master their emotions by paying attention to (and not only being aware) of their emotional states. However, they should be given the opportunity to be able to express these emotions.
- Students also need to be taught how to manage conflict.

*Motivation*

- The intrinsic motivation in each individual needs to be tapped.

*Developing a sense of society*

- Students need to feel more valued (and that what they are doing is of value to the world). This is especially important during the adolescent phase.
- Adolescents, especially those from difficult backgrounds, need to be taught a sense of the value of working in a team.
- It is necessary from a very early age (already in preschools) to cultivate a passion for learning.
- Mentoring younger children and learning from peers is something that needs to be reconsidered.

*New learning environments with an emphasis on play*

- Create new learning environments by developing different, robust scenarios that will help educators to create an environment where children feel welcome (not to just to perform), they feel their capacity for retention, engagement and commitment, and by showing up they feel part of a community and are given a sense group identity.
- Modern technology methods need to be tapped into which will present "virtual" experience, generate understanding, enable practice in private (to avoid the emotional distress of making mistakes in front of peers), and encourage an element of play and motivation.
- Rich environments that support the development of multiple strategies and positive handling of stress should be explored.

*Teachers*

- A stressed teaching force has a big impact on the emotions of the students.
- There is the need to help teachers understand their own needs, to help them clarify what they are teaching, in conjunction with the school and society in general, and then to motivate them (by helping them to be more free, more responsible and more in charge of their own lives). It is impossible to share motivation if you are not motivated yourself.
- Teachers need to be the external motivators to help create more motivating learning environments, especially for adolescents.
- Teachers need to be given time to understand what the individual needs of their students are and what they are feeling.
- The theory of how brains work needs to be incorporated into teacher training.
- Dialogue between teachers and scientists is necessary in order for teachers to show scientists what works in the classroom, and to help teachers ask the right questions to which scientists can direct their focus.

*Integrating the sciences towards educational and social neuroscience*

- Brain science as in "educational science" is not as yet properly established. The gap needs to be bridged between the different sciences. We need a better knowledge of of the brain.
- The development of a new social neuroscience is seen as an encouraging sign.

*Suggestions for future research focus*

- Explore how executive attention develops, and how it is linked to emotional control regulation, in order to come up with programmes to regulate emotions.
- Undertake comparative brain studies to see whether children learn better from peer mentoring or teachers.
- Study in depth neural changes in adolescents and the role of emotions and motivation in this target group.
- Perform experiments in developmental work as far as the physical setting of teaching is concerned, with the aim of creating new types of learning environments.
- Gather data that summarises learning and how it can be seriously modulated by the emotional or physiological state of children.
- Execute neuroscientific studies to pinpoint understanding in the brain and emotional responses, in order to develop methods on how to train understanding.
- Research what turns the brain on, how to find "intrinsic motivation".
- Explore the brain correlates of why play is fun, how it motivates and its correlation to curiosity.
- Explore to see if there are brain-based gender differences and what should be the appropriate educational response to these.

**APPENDIX 1 - AGENDA**

# ELE: Emotions, Learning and Education

Seminar co-organised by

## Learning Lab Denmark and CERI

### 8-9 November 2004

Carlsberg Foundation
**Copenhagen, Denmark**

## *Monday, November 8*

12:00-12:30 Registration

12:30-13:00 Welcome/Introduction and Goal Setting
(Hans Siggaard Jensen & Søren Kjær Jensen, LLD; Tom Schuller, CERI)

13:00-14:00 Lunch

*Session 1 (chaired by Bruno della Chiesa, CERI)*

14:00-14:30 Emotional literacy improvements in the UK gained from the ExPRESS Project
(Alan Watkins – Cardiac Coherence Ltd)

14:30-15:00 First lessons on Emotions & Learning from the Ulm Project
(Katrin Hille – Forschungsleitung, Transferzentrum für Neurowissenschaften und Lernen)

*Session 2 (chaired by Eamonn Kelly)*

15:15-15:45 Stress, Education and Learning
(Ulrike Rimmele – Psychologisches Institut der Universität Zürich)

15:45-16:15 Cognitive performance & learning related to motivation, psychosocial & emotional factors
(Jellemer Jolles – Institute of Brain & Behavior, Faculty of Medicine & Faculty of Psychology, Maastricht University)

*Session 3 (chaired by Christian Gerlach)*

16:15-16:45 Factors of Evolution Revealed in Hand Puppet Behavior
(Jeffrey Peyton – Puppetools)

16:45-17:15 Food for thought: Linking education to emotion, motivation and learning
(Morten Kringelbach - University of Oxford)

*Session 4*

17:30-18:00 Presentations of themes extracted from the submitted position papers

*(presented by Christian Gerlach)*

19:30 Evening programme

## ***Tuesday, November 9***

08:30-09:00 Arrival and coffee

*Session 5*

09:00-12:00 Parallel workshop groups on the themes

1. Training emotional competencies
2. Motivation and learning with a brain perspective
3. Environment, sociality, emotions and learning
4. Emotions in education: stress and mastery

12:00-13:00 Lunch

*Session 6 (chaired by Jarl Bengtsson)*

13:00-15:00 Presentation and discussion of workshop ideas

15:00-15:15 Reflections on the workshop ideas
(Walo Hutmacher)

*Session 7 (chaired by Hans Siggaard Jensen and Søren Kjær Jensen)*

15:15-16:15 Plenum discussion of ideas and future directions of research and education practices based on emotions and learning

16:15-16:30 General conclusions
(Jarl Bengtsson, Bruno della Chiesa & Søren Kjær Jensen)

## APPENDIX II - PARTICIPANTS LIST

## ELE: EMOTIONS, LEARNING AND EDUCATION SEMINAR

**8-9 November 2004**

**Carlsberg Foundation**
**Copenhagen, Denmark**


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