Senior Behavioral Scientist
Dagfinn Moe, SINTEF Technology and Society

The abstract is based on a study done by the following persons and institutes:

Myoung Soo Kwon1*, Victor Vorobyev1, Dagfinn Moe2, Riitta Parkkola3, Heikki Hämäläinen1

1 Centre for Cognitive Neuroscience, Department of Psychology, University of Turku, Turku, Finland,
2 Department of Transport Research, SINTEF Technology and Society,
Trondheim, Norway,
3 Department of Radiology, University Hospital of Tampere, Tampere, Finland

Abstract

It takes brains to take risks

There exists a lot of empirical research on the risk of young drivers, and it is well known that many young drivers tend to have a risky driving style. Previous research on the field has resulted in findings on certain factors that seem to be common for many drivers with risky behavior, both in terms of individual and socio-demographic variables. Theories on brain development are applied to explain adolescent drivers' behavior, and the implications for driver training are important.

In the adolescent brain, the limbic system matures earlier than the frontal lobes, to the extent that emotional responses play the greater role in governing behavior while the capacity to control such responses remains under-developed. Simultaneously, there seems to be a change in biochemical systems according to the release of dopamine (reward system) and oxytocin (social bonding) during puberty. As a consequence, teens respond strongly to social contexts. The understanding of the brain development processes in adolescents must be implemented in driver education programs around the world, so that young drivers will be better equipped to assess risks correctly.

In a MRI-study we discriminated 17 high and 17 low risk-taking male adolescents aged 18-19 years by assessing their propensity for risky behavior with personality tests, and compared structural differences in gray and white matter of the brain with voxel-based morphometry (VBM) and diffusion tensor imaging (DTI), respectively.

We also verified participants' actual risk-taking behavior using a simulated driving task in two different social conditions making up a peer competition situation. There was a discrepancy between the self-reported personality test results and risky driving behavior (running through an intersection with traffic lights turning yellow, chancing a collision with another

vehicle). Comparison between high and low risk-taking adolescents according to personality test results revealed no significant difference in gray matter volume and white matter integrity. However, comparison according to actual risk-taking behavior during task performance revealed significantly higher white matter integrity in the high risk-taking group, suggesting that increased risky behavior during adolescence is not necessarily attributed to the immature brain as conventional wisdom says.

In addition to the DTI analysis we also did a functional magnetic resonance (fMRI) study of the adolescence brain activation in an emulated driving task both when making decisions on whether to take a risk at intersection crossings and when facing an outcome (pass or crash).

In adolescents, the immature cognitive control system does not effectively regulate their risky
behavior, including reckless driving, particularly under social (peer) pressure.
Groups of low and high risk takers were defined using either questionnaire or task performance data. Effects of peer competition were also studied. Group differences in brain activation were found only for performance-based grouping.

Risk-taking activated two areas in the left medial prefrontal cortex (PFC) much more in the low than the high risk-takers, whereas the right lateral PFC was equally activated by either decision and by either group. In the entire sample, activation specific to risky decision-making was found in the anterior and dorsal cingulate, superior parietal cortex, basal ganglia including nucleus accumbens, midbrain, thalamus, and hypothalamus.

The results indicate that the neural network and white matter integrity are more matured among the high risk-taking group than the low risk-taking group. Comparison according to actual risk-taking behavior during task performance revealed significantly higher WM integrity in the high risk-taking group. These results are consistent with previous findings that engaging in risky behavior was associated with more mature WM and greater impulse control was associated with lower WM integrity. These findings are contrary to conventional wisdom that increased risky behavior during adolescence is attributed to the immature brain.

It was also observed that a decision to take a risk activated the adolescent brain much more than a decision to stay safe. Thus, higher MPFC activation in low than in high risk-takers appeared to reflect a stronger conflict, related to making a risky decision. Contrary to our expectation, the lateral PFC was equally activated when making either decision.

The study gives us a better understanding of what happens during the decision-making related to risky situations among young drivers. This will be useful knowledge for teachers, examiners and others involved in road safety work.

Author's CV

Dagfinn Moe, Senior Behavioral Scientist, SINTEF Technology and Society

- Studies in psychology, neuroscience, pedagogics and sociology at the Norwegian University of Science and Technology
- Educated as a Driving Instructor at Nord-Trøndelag University college in Norway, and practiced as a Driving Instructor for eight years
- The main research activities include Accident- and Risk analysis
- In depth studies of fatal Accidents, Risk taking behavior, Brain, Mind and behavior, Evaluations of Driver Education Systems and research connected to the concept Mind, Brain and Education
- Working with Driving Simulators, evaluation of Traffic Safety countermeasures, traffic Medicine and Intelligent Transportation Systems (ITS).