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## Neurobiology of Trust

**A recent** PNAS publication by Peter Bos, David Terburg and Jack van Honk from the Experimental Psychology division of the Helmholtz Institute provides unique insights in the hormonal regulation of human sociality. The publication describes a study where they investigated the neurobiological substrate of trust.

Trust is a social construct that underlies all social interactions. Trusting individuals are more likely to be “sharing and caring”. However, trust is not always adaptive. Individuals who are highly trusting are also more easily influenced by others who may not have their best interests at heart. Thus, trust has two faces: levels of interpersonal trust are beneficial in social interactions, but may place individuals at great personal risk. Despite the importance of trust for human sociality, little is known about its neurobiological substrate.

Bos and colleagues show that two hormones are related to the two faces of trust. On the one hand, oxytocin, also known as the ‘cuddle hormone’ has been frequently associated with increased personal trust. Oxytocin is released in large quantities during labour and breastfeeding, and is thought to mediate attachment between the mother and her newborn baby. It also seems to play a role in formation and maintenance of other types of interpersonal interactions, such as pair bonding.

For such trust to be adaptive it also has to be counteracted in encounters where others do not have one’s best interests at heart. Testosterone is associated with success in competition for

resources and dominance. Bos and colleagues investigated whether testosterone may counteract interpersonal trust.

To measure the effect of testosterone, either a water solution of 0.5 mg testosterone or a placebo was administered to female students. The hormonal effect of testosterone administration was measured by salivary sampling where a polyclonal testosterone antibody was used as a marker. In addition, they measured vaginal pulse amplitude, a centrally driven response evoked by erotic material. This pulse is the only physiological measure known to possess a non-habitual nature, allowing multiple measures throughout the day. Because such a method is not available in males, Bos and colleagues chose to study only females. Trust was measured with trustworthiness ratings of unfamiliar faces.



*How trustworthy would you rate this person?*

After testosterone administration, trustworthiness ratings were lowered in some individuals but not all. Inspection for individual differences between subjects

showed that testosterone lowered trustworthiness ratings only for subjects with high initial trustworthiness. However, initial levels of testosterone had no effect on the results, showing that the results were not due to testosterone alone but to the interaction of testosterone with another trust hormones.

The finding that trust can be hormonally affected has controversial political and ethical implications and the article raised a lot of media attention. Asked whether concerned parents should now administer testosterone to their naïve daughters, Peter Bos laughs and answers that they should have had a son.

## Beyond Reaching Distance

**Spatial behaviour** refers to all interaction humans have with objects in the environment and is a crucial aspect of human cognition. After brain damage, spatial behaviour can be selectively disrupted. For instance, in hemispatial neglect, patients ignore one half of space. Such patients generally eat food from only the right side of their plate or shave only the right side of their face. Both fundamental and rehabilitation studies on neglect have typically focused on spatial behaviour within reaching distance. Dr. Tanja Nijboer from the Experimental Psychology group of the Helmholtz Institute was awarded a NWO VENI grant for a



*Participant in a prism adaptation setting*

three-year research project where she will study the neuropsychology of space not as a unitary entity but by making a distinction between near and far space. Near space is within reaching distance whereas far space is the space that extends beyond reaching distance. Cognition of near space is necessary for tasks such as picking up a cup of coffee, whereas cognition of far space is crucial to navigation. In the literature different cortical areas have been associated with the processing of near and far space. Processing of information within near space is linked to activity in the parietal cortex and processing of information in far space with activity in the temporal cortex. This dissociation may be the key to solving a controversy on the neuropsychology of neglect, Nijboer proposes.

In search for the substrate of hemispatial neglect some studies found that neglect was associated with lesions in the inferior parietal lobe whereas others contradicted these findings with results showing that neglect was associated with lesions in the superior temporal gyrus. These different results may be due to these patients neglecting different regions of space. Parietal patients would then display deficits in near space and temporal patients in far space. By collaboration with the UMC hospital, Nijboer has access to a large group of neurological patients with both temporal and parietal lesions. In this heterogeneous patient group she will test perception, attention and cross-modal integration within both near and far space.

An additional research question encompasses the rehabilitation methods, such as tool use and prism adaptation. Tool use has been found to adapt the borders of near and far space, enlarging near space. Patients with intact processing of near space, but impaired processing of far space might benefit from the use of tools. Prism adaptation is a very common method to ameliorate symptoms of neglect, but the procedure is always performed in near space. Patients wear prism glasses while pointing to visual stimuli presented on the left and right. The prism glasses induce a right lateral displacement of visual field. The standard adaptation procedure will be adapted to a far space procedure, to test whether patients with temporal lesions can also benefit from this procedure.

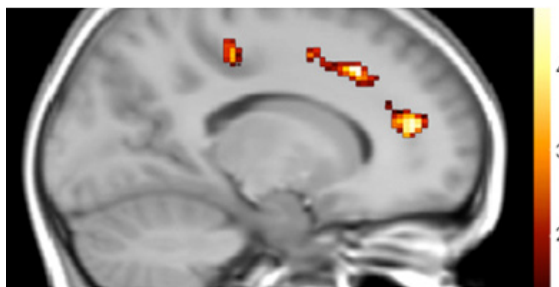
## A Psychoendocrine Outlook on Impulsive Behaviour

**What if you** would get an once-in-a-lifetime opportunity, and have to decide right now whether you go for it? Would you do it? To take the opportunity, you have to act on impulse, a normal behaviour in this case. However, when impulsivity reaches excessive levels, it can cause severe problems. During development, extreme impulsivity is related to school dropout, substance abuse, and disorders like ADHD. Dr. Jiska Peper, of the Biological Psychology group of the Helmholtz Institute at Utrecht University, received a NWO VENI grant to address what neurobiological factors might underlie changes in impulsive behaviour in teenagers.

Brain areas related to controlled and impulsive behaviour lie within the frontal cortex, striatum and the amygdala, areas that especially develop during adolescence. High impulsivity has been associated with abnormal connections between those brain areas, which are for instance found in persons with ADHD. In addition, sex hormones like testosterone and oestradiol play an important role in mediating impulsivity. In her PhD studies, Peper showed that very early in puberty the production of sex hormones is implicated in the growth of white matter: the anatomical basis of brain connections.

During adolescence, major changes occur in impulsivity, but also in the prefrontal cortex, and in sex hormone production. This makes teenagers an ideal group for studying the relation between all these factors. In her new project, entitled 'Acting on impulse: tracking sex hormones in the developing brain', Peper proposes to study exactly this age-group: she will investigate whether the relation between levels of sex hormones and white matter connections can be used to predict impulsive behaviour. Furthermore, she will provide insight into the development of the neural substrate of impulsivity by studying not only

teenagers but also pre- and post-pubescent adolescents. The combination of important areas of research, investigating both psychopharmacological and structural factors to study pathology in development, is a hallmark feature of the proposal.



*Higher LH levels are related to higher white matter density in the cingulum (connecting the frontal and temporal areas) early in puberty*

Peper will first determine levels of testosterone, oestradiol, and LH (Luteinizing hormone), in the saliva and urine of 138 teenagers, and measure white matter connectivity using Diffusion Tensor Imaging (DTI) and Magnetic Transfer Ratio (MTR). In addition, participants will perform computer tasks, where behavioural inhibition and impulsive aggression will be investigated. With these data the predictive power of sex-hormone values and white matter connectivity for impulsive behaviour can be tested. She will then examine whether this relationship is different in individuals who show extreme levels of impulsivity.

The study will hopefully lead to insights into the neural and hormonal underpinnings of impulsive behaviour, and will shed light on age ranges during which there is a high association between changes in biological factors and impulsivity. This may improve treatment of impulsive behaviour, and will provide important information for treatments in which sex hormones are administered during adolescence.

## News & agenda

### Symposia & Lectures

- October 6-8, Helmholtz Retreat, Bergen, the Netherlands.

### Grands and awards

- Frans Verstraten (Experimental Psychology, UU) has been chosen as a member of the Board of Directors of the Vision Sciences Society.
- Maartje de Jong (Physics of Man, UU) received a travel grant from the Dutch Society for Biophysics & Biomedical Technology for a stay at Vanderbilt Vision Research Center, Nashville, Tennessee.
- Maartje de Jong (Physics of Man, UU), Mirela Kahrimanovic (Physics of Man, UU), Femke Maij (Human Movement Sciences, VU) and Rita de Sousa (Human Movement Sciences, VU) received a ECVF 2010 student award.
- Stefan van der Stigchel and Tanja Nijboer (Experimental Psychology, UU) received a 42000 Euro grant from Stichting Uitzicht to investigate eye-movement patterns in patients with maculade-degeneration.
- Esther van den Berg (Experimental Psychology, UU) received a 2000 Euro Award for scientific purposes from the Girard de Miellet van Coehoorn Stichting.
- Jack van Honk (Experimental Psychology, UU) was awarded the Honorary Professor status at the University of Capetown in South Africa.
- Jiska Peper (Experimental Psychology, UU) received an NWO VENI grant for a project entitled 'Acting on impulse: tracking sex hormones in the developing brain'
- Tanja Nijboer (Experimental Psychology, UU) received an NWO VENI Grant for a project entitled 'Neuropsychology of space: dissociations and interactions between near and far space'.

### Retirement

- On August 1st, 2010, Harald Kunst (Experimental Psychology, UU) retired.

### New people

- Esther Eijlers, PhD student (Experimental Psychology, UU). Project: 'I see what you mean: the basics of social processing'.
- Marieke de Graaff (PhD student), Ramon van der List (PhD student) and Maria Matziridi (PhD) student will all be working on the VICI project of Jeroen Smeets (Human Movement Sciences, VU).
- Ineke van der Ham, assistant professor (Experimental Psychology, UU).
- Neeltje Kant, PhD student (Experimental Psychology, UU). Project: 'Time, Space and the Future: the Neuropsychology of Prospective Memory.'
- Rudmer Menger, PhD student (Experimental Psychology, UU). Project: 'The influence of perceptual features and on obstacle avoidance and goal-directed behaviour.'
- Meron Vermaas (PhD student) and Wietske Zuiderbaan (PhD student) will both be working on the VIDI project by Serge Dumoulin (Experimental Psychology, UU).

### PhD defences

- September 28, 2010. Hinze Hogendoorn (Experimental Psychology, UU). Time insight: the Matter of Time in Visual Perception.
- October 13, 2010. Katinka van der Kooij (Experimental Psychology, UU). Perception of 3D Shape in Complex Scenes.
- October 15, 2010. Ineke van der Ham (Experimental Psychology, UU). Thinking left and right, neurocognitive studies on spatial relation processing.

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