New directions in brain training – Effectiveness, methodology, and application of cognitive interventions

Workshop, October 11-13 2012
Humboldt University, Berlin

Program and Abstracts

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HUMBOLDT-UNIVERSITÄT ZU BERLIN

UNIVERSITÄT DES SAARLANDES

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New directions in brain training – Effectiveness, methodology, and application of cognitive interventions

Dear participants and guests,

We are happy to welcome you to the workshop “New directions in brain training” held at the Humboldt University, Berlin. The workshop features presentations by leading experts in the field of cognitive training research, a poster session, and a discussion forum that will provide the opportunity for scientific exchange. We hope the event will give you the opportunity to discuss the latest research, get in touch with experts or junior scientists in the field and to extend your scientific network. We wish you a nice stay in Berlin!

Thanks to the excellent set of international speakers as well as the numerous poster contributions from different fields of cognitive training research, we are happy to present a multidisciplinary and diverse program that covers state of the art research on brain training on the highest scientific level.

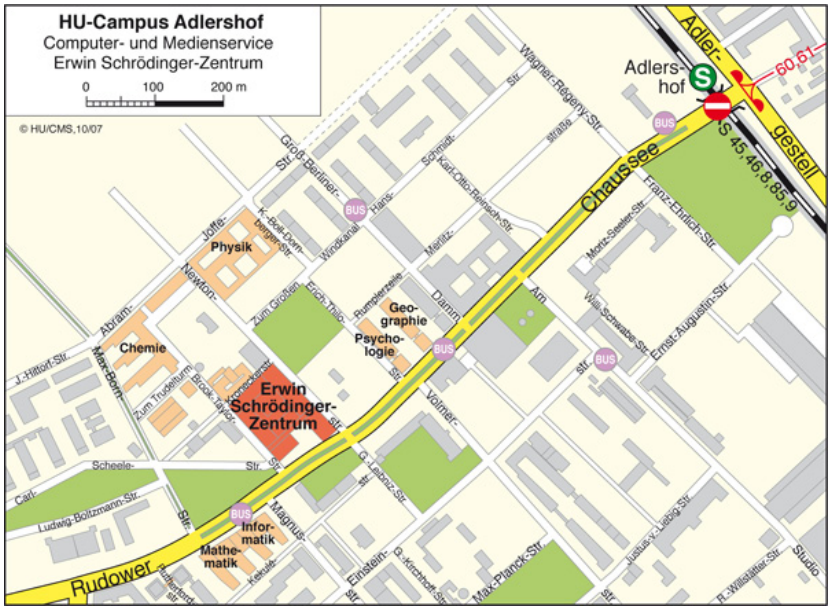
Aside from the scientific program, we also invite you to enjoy the sights of the German capital Berlin. You are very welcome to join us for Dinner on Friday night and for a boat ride through the city on Saturday afternoon.

We would like to thank the numerous sponsors that have supported the event as well as everyone contributing to the scientific program and the organization of the workshop.

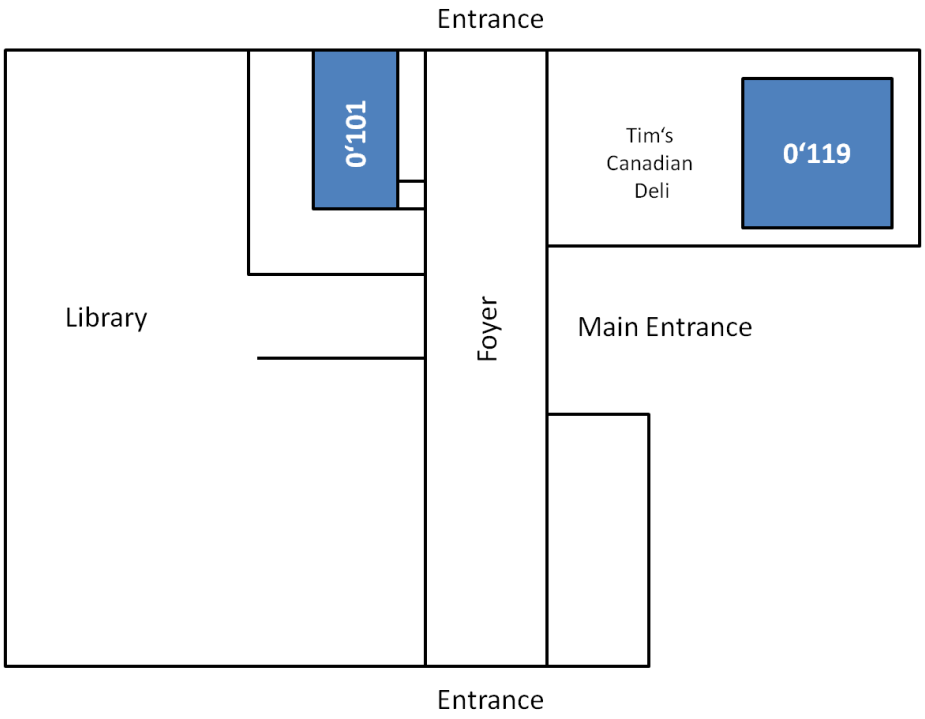
Tilo Strobach, Torsten Schubert, & Julia Karbach

Workshop venue

Erwin-Schrödinger-Zentrum
Rudower Chaussee 26
12489 Berlin-Adlershof



The oral presentations will be held at room 0‘119 and the poster session at room 0‘101 of the Erwin-Schrödinger-Zentrum.



General information

Workshop office

For any questions or assistance during the workshop please find us in front of the conference room 0’119.

Meals

Coffee breaks

There will be several coffee breaks with coffee, tea, small snacks and soft drinks, which will be served in front of room 0’119. In addition, a finger food buffet, coffee, and drinks will be served in room 0’101 during the poster session.

Lunch

There are several restaurants on the Adlershof campus. *Wista Restaurant, Esswirtschaft*, and the organic food restaurant *Jouis Nour* (behind the Airport Hotel, entrance at Groß-Berliner-Damm) serve meals at approximately 5 Euros (please see map on the campus flyer).

Wista Restaurant	**Esswirtschaft**	**Dorint Hotel**	**Jouis Nour**
Volmerstr. 2	Forum	Rudower Chaussee 15	Rudower Chaussee 14

WLAN

If you wish to use the WLAN for the period of the workshop please ask for your personal access code at the workshop office.

Social Program

Workshop Dinner

The workshop dinner will be held Friday evening at the restaurant “Die Turnhalle”, situated in Berlin- Friedrichshain, an area enclosing some of the most exciting evening and night locations of Berlin. Complimentary transportation by bus from the workshop venue to the restaurant will be provided for participants registered for the dinner (departure at 7.00 pm, Erwin-Schrödinger-Zentrum).

Address of the restaurant:
Die Turnhalle
Holteistraße 6-9
10245 Berlin

In case you wish to travel to the restaurant “Die Turnhalle” by public transport, the closest S-Bahn station is “Ostkreuz”. To get to the S-Bahn station “Ostkreuz” from the workshop venue take the S8 or S9 from S-Bahn station “Adlershof” (15-minute ride). Please find a city map with additional information on public transport in your workshop folder.

Boat ride through the city

Berlin - the exciting metropolis, with its ever-changing face and its lovely surroundings offers a lot to discover. Take the opportunity and join us on a boat ride to see the historical center of the city (Berliner Dom, Museumsinsel, Reichstag, and more) from a different perspective on Saturday, October 13, at 3.00 pm, while cruising on the Spree. On the boat, an audio guide will be available in six different languages.

Program Overview

Thursday, October 11, 2012		
Time	**Title**	**Speaker**
1.45 pm	Kick-off & welcome	**Organizers**
2.00 - 2.45 pm	Training of working memory	**Torkel Klingberg**
2.45 - 3.30 pm	Effects of working memory training on academic abilities in middle childhood	**Julia Karbach, Tilo Strobach, & Torsten Schubert**
3.30 - 4.00 pm	**Break**	
4.00 - 4.45 pm	Prospective memory training in healthy aging: Possibilities and limits	**Matthias Kliegel, Alexandra Hering, Nathan S. Rose, Fergus M. Craik, Peter G. Rendell, Sylvain Moreno, & Gavin M. Bidelman**
4.45 - 5.30 pm	Neural mechanisms of lifespan age differences in episodic memory formation and plasticity	**Yvonne Brehmer, Lars Bäckman, Hauke Heekeren, Ulman Lindenberger, & Yee Lee Shing**
5.30 - 7.00 pm	**Poster session & drinks**	

Friday, October 12, 2012		
Time	**Title**	**Speaker**
9.00 - 9.45 am	Can working memory be improved? Evidence from training studies based on the facet model of working memory capacity	**Claudia von Bastian & Klaus Oberauer**
9.45 - 10.30 am	Education affects older adults' focus switching performance, but not training gains	**Cora Titz & Lara Dorbath**
10.30 - 11.00 am	**Break**	
11.00 - 11.45 am	Adult neurogenesis as a neuronal investment loan	**Alexander Garthe & Gerd Kempermann**
11.45 - 12.30 am	The impact of action video gaming and working memory training on multi-tasking skills	**Torsten Schubert, Tiina Salminen, & Tilo Strobach**
12.30 am - 2.00 pm	**Lunch**	
2.00 - 2.45 pm	Brain training in progress	**K. Richard Ridderinkhof, Jessika I.V. Buitenweg, & Jaap M.J. Murre**
2.45 - 3.30 pm	Take a Walk: Physical activity, cognition and the brain	**Arthur F. Kramer**
3.30 - 4.00 pm	**Break**	
4.00 - 4.45 pm	Do concepts of latent factor transfer transfer to studies of transfer?	**Florian Schmiedek**, **Martin Lövdén, & Ulman Lindenberger**
4.45 - 5.30 pm	Fine-tuning cognitive-control parameters through neurofeedback and meditation	**Bernhard Hommel & Lorenza Colzato**
5.30 - 6.30 pm	**Discussion Forum: New directions in cognitive training research**	
7.30 pm	**Dinner**	

Saturday, October 13 2012		
Time	**Title**	**Speaker**
9.00 - 9.45 am	Genetic modulation of training and transfer in young adults: COMT Val^{158}Met polymorphism is associated with the flexible mind	**Lorenza Colzato, Wery van den Wildenberg, & Bernhard Hommel**
9.45 - 10.30 am	Age and individual differences in structural brain plasticity	**Elisabeth Wenger, Ulman Lindenberger, & Martin Lövdén**
10.30 - 11.00 am	**Break**	
11.00 - 11.45 am	Predictors of acquisition speed for surgical skills	**Guido Band Edward Spruit, Annamarie Piederiet, Daniel Santos, Jaap Hamming, & Bernhard Hommel**
11.45 - 12.30 am	Action video games and learning to learn	**Shawn Green**
12.30 am	**Closing remarks by workshop organizers & farewell**	
After-wards	**Boat ride through the city center**	

Abstracts of invited oral presentations

Predictors of acquisition speed for surgical skills

Guido P.H. Band, Edward Spruit, Annamarie Piederiet, Daniel Santos, Jaap Hamming, & Bernhard Hommel
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Laparoscopic surgery is one of the more complicated skills to learn as a medical student. From a psychologist's perspective it seems to require counterintuitive stimulus-response (SR) coupling, mental visuo-spatial transformations and several cognitive control skills. In a recently started three-year project, we aim to optimize the training procedure in view of future patient safety and the duration/expenses of the curriculum. Students receive skill training in the form of (digital) laparoscopy simulators and (analog) game-like motor tasks to perform with special pliers in a closed metal box, visible only through a monitor. In two studies (N= 2x32), we have investigated to what extent progress in these laparoscopic skills can be predicted by previously obtained measures of mental rotation, SR compatibility, task switching, inhibition and working memory span. Surprisingly the speed on a 2D mental rotation task has little, and task switching costs have large predictive value (R=0.4-0.6). These findings will be considered in developing personalized training plans.

Neural mechanisms of lifespan age differences in episodic memory formation and plasticity

Yvonne Brehmer[1], Lars Bäckman[1], Hauke Heekeren[2], Ulman Lindenberger[3], & Yee Lee Shing[3]
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[2]*Freie Universität Berlin, Berlin*
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Episodic memory functioning undergoes profound and continuous changes across the lifespan. In general, memory performance has been shown to increase sharply during childhood, and to decrease continuously during adulthood. The underlying age-related changes in functional brain activity of the memory network are, however, not well understood. We examined a sample of children (aged 10-12), younger adults (aged 20-25), and older adults (aged 63-68) in a multi-session training

procedure with fMRI assessments at baseline and posttest while participants were memorizing word pairs. Behavioral data showed that all age groups improved in the cued-recall task. We expect the contributions of strategic (mostly prefrontal-cortex based) and associative (mostly medio-temporal lobe based) components as neural mechanisms of memory formation to differ across the three age groups. We are currently testing this proposition by examining the changes in memory-related activation from pre- to post-training fMRI assessments.

Genetic modulation of training and transfer in young adults: COMT Val^{158}Met polymorphism is associated with the flexible mind

Lorenza Colzato, Wery van den Wildenberg, & Bernhard Hommel
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In the present study we investigated the possibility that successful transfer of game-based cognitive improvements to untrained tasks in young people is modulated by preexisting neuro-developmental factors as genetic variability related to the catechol-O-methyltransferase (COMT), an enzyme responsible for the degradation of dopamine. Recent evidence suggest that the COMT Val^{158}Met genotype may differentially affect cognitive stability and flexibility, in such a way that Val/Val homozygous individuals (who possess low prefrontal dopamine levels) show more pronounced cognitive flexibility than Met/-carriers (who possess high prefrontal dopamine levels). We trained participants, genotyped for the COMT Val^{158}Met polymorphism, on playing “Half-Life 2”, a first person shooter game which has been shown to improve cognitive flexibility. Pre-training (baseline) and post-training measures of cognitive flexibility were acquired by means of the task-switching paradigm. As expected, Val/Val homozygous individuals showed larger beneficial transfer effects than Met/-carriers. Our findings support the idea that genetic predisposition modulates transfer effects.

Adult neurogenesis as a neuronal investment loan

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Stem cells in the hippocampus give rise to new neurons throughout adulthood. The new cells differentiate into fully functional granule cells and become integrated into existing networks of the dentate gyrus. Functionally, adult hippocampal neurogenesis has been implicated in pattern separation by facilitating the orthogonalizition of information flooding into the hippocampus to be processed for long-term storage. The number of new neurons generated and their survival are modulated by physical training (RUN) and exposure to stimulus-rich environments (ENR), respectively. Whereas RUN boosts precursor cell proliferation and thus the pool of new neurons available for functional recruitment, ENR increases the likelihood of new granule cells to become functionally integrated and thus to survive. We assessed the functional relevance of adult hippocampal neurogenesis in the Morris water maze as the de-facto standard paradigm of spatial learning in rodents. Our data show specific gain- and loss-of-function effects after both suppressing adult neurogenesis and subjecting mice to either RUN or ENR conditions. Specifically, the new neurons improved task acquisition and increased functional plasticity when multiple similar goals had to be differentiated within an identical general context. The functional contributions of adult neurogenesis to performance in a spatial learning task critically depend on different functional brain systems and suggest a clear difference between a potential and the abilities needed to use that potential. To address the question of a functional role for adult born hippocampal neurons in humans, we tested human participants in a computer-based virtual water maze. The search strategies used to locate the hidden platform appear to be almost identical to the patterns observed in mice. This allows addressing the same set of parameters to analyze spatial learning in both mice and human subjects. Preliminary data from a treadmill intervention study indicate specific gain-of-function effects in aspects of spatial learning previously found to be improved by RUN in mice.

Action video games and learning to learn

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The enormous increase in video game use that has occurred over the past two decades has spurred considerable scientific interest in the behavioral and neural consequences of such experience. However, although popular treatments of the topic tend to consider video games to be a single unitary construct (i.e. "Are *video games* good for you?"), the scientific evidence clearly demonstrates that the effects of video games depend deeply on the characteristics and processing demands of the specific game types that are played. For instance, real-time strategy games have a very different set of cognitive demands than online role-playing games, and thus it should not be surprising that their effects on behavior are also quite different. One particular sub-genre of video games, so-called "action" video games, has been the focus of a considerable amount of study. These games have been shown to enhance a wide variety of abilities, from low-level perceptual skills, such as contrast sensitivity, to higher-level cognitive skills such as mental rotation or task-switching. The fact that action game experience benefits performance on tasks that are quite dissimilar from the training task stands in contrast with much of the literature on perceptual and cognitive training, wherein subjects tend show improvements on only the trained task, with little to no transfer of learning to even seemingly highly similar new tasks. Our current research focus is on the question of "why" action video games result in such broad enhancements in cognitive and perceptual function. The overarching hypothesis currently being tested is that rather than teaching myriad individual skills (i.e. one for each laboratory task that has been examined), what action video games "do" is teach individuals to quickly and efficiently perform new tasks – or in other words, to "learn to learn". Here I'll present data from two experiments that are consistent with such a hypothesis. In both experiments, action gamers and non-gamers show roughly equivalent performance on the first few trials of a new task. However, performance levels quickly diverge, with action gamers showing significantly sharper learning rates. Because it seems unlikely that any single training regimen could teach a sufficient number of individual skills to be beneficial for real-world applications, such an enhancement in the ability to learn new skills may be a marker of training regimens that are likely to have practical benefits.

Fine-tuning cognitive-control parameters through neurofeedback and meditation

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Functional and neuroscientific arguments suggest that human cognition and action is controlled by seeking a task- and context-sensitive state of balance between cognitive stability (e.g., keep going for the present goal) and flexibility (being open for goal changes), which is likely to involve interactions between prefrontal stability systems and striatal flexibility systems. I will discuss two training techniques that turned out to be suitable for biasing this stability-flexibility balance in systematic ways: neurofeedback and meditation. Neurofeedback studies from our lab have demonstrated that learning to maximize frontal activation in the gamma frequency band enhances control over irrelevant episodic information (in addition to enhancing IQ), suggesting that selection processes "speak gamma", so that cognitive stability control can benefit from learning to speak that functional language more fluently. In contrast, our meditation studies suggest that particular meditation techniques increase flexibility, suggesting that the "opponent" of cognitive stability is also sensitive to training.

Effects of working memory training on academic abilities in middle childhood

Julia Karbach[1], Tilo Strobach[2], & Torsten Schubert[2]
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Working memory (WM) capacity is highly correlated with general cognitive ability and has proven to be an excellent predictor for academic success in childhood. Given that WM can be improved by training, the aim of this research was to investigate whether training-related improvements in WM abilities transfer not only to new, untrained laboratory tasks, but also to measures of academic abilities in the domain of math and reading in middle childhood. We trained 32 healthy children in second and third grade elementary school (8-9 years of age) in a pretest - training - posttest - follow-up design. In the 14 training sessions, one group of children (training group, n = 14) received adaptive WM training and the other group (control group, n = 14) received constant, low-level practice on the same tasks. At pretest and posttest, participants performed a battery of cognitive tasks (WM, task switching, reasoning) and standardized tests for math and reading abilities in order to test for transfer of

WM training. To examine the maintenance of transfer effects, the same assessment was included at the follow-up session about three months after the posttest. Results showed larger training-related benefits in the adaptive training group than in the control group. In contrast to the control group, the training group showed improvements on a new, untrained WM task and most importantly, in terms of reading abilities. We found no transfer to measures of task switching, reasoning, and academic abilities in the domain of math. In sum, our findings show that WM training benefits performance on new, untrained tasks including not only laboratory measures, but also reading abilities in middle childhood. These findings are consistent with results from neuroscientific studies indicating that transfer occurs if the training task and the transfer task engage overlapping processing components and brain regions. On a more general level, they point to the usefulness of cognitive training interventions for educational and clinical applications.

Prospective memory training in healthy aging: Possibilities and limits

Kliegel, M.[1], Hering, A.[1], Rose, N. S.[2], Craik, F. I. M.[2], Rendell, P. G.[3], Moreno, S.[2], & Bidelman, G. M.[2]
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[2]*Rotman Research Institute at Baycrest, Toronto*
[3]*Australian Catholic University, Melbourne*
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Prospective memory (PM; i.e., memory for delayed intentions) declines with age and is important for functional independence, yet few studies have attempted to train these abilities in older adults. We developed a computerized prospective memory training based on the Virtual Week paradigm (Rendell & Craik, 2000). Training participants played the game in twelve, 1-hour sessions over one month. Measures of neuropsychological functions, lab-based PM, event-related potentials (ERPs) during performance on a lab-based PM task, activities of daily living, and real-world PM were assessed before and after training. Performance was compared to both no-contact and active control groups. PM on the Virtual Week game dramatically improved following training relative to controls, suggesting PM plasticity is preserved in older adults. Relative to control participants, training did not produce reliable transfer to other laboratory tasks, but was associated with a reduction of ERP components (N300 over occipital cortex and sustained positivity over frontal cortex) associated with processing PM cues, indicative of more automatic PM retrieval. Additionally, training produced far transfer to real-world outcomes including performance on activities of daily living and real-world PM.

Training of Working Memory

Torkel Klingberg
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Impaired working memory is associated with low academic performance and with distractability and inattention in clinically defined groups, such as in ADHD, but the same associations are also relevant in the general population. Klingberg and collaborators have developed and tested a computerized method for training working memory (Klingberg et al. 2002, 2005, Klingberg 2010), which showed, for the first time, that working memory capacity can be enhanced. Moreover, improving working memory also decreases the symptoms of inattention in everyday life. This has now been confirmed by several independent research groups using the same method, which also allows comparison of effect sizes across different ages and patient groups. The method can be used as an instrument for studying brain plasticity. Klingberg and collegues has shown that training of working memory changes brain activity in frontal and parietal regions, and is associated with changes in the density of dopamine D1-receptors in the cortex. Polymorphisms of the DAT-1 gene affects the relative benefit of cognitive training, which is consistent with a key role of dopamine for training related plasticity. Questions for future research includes: which tasks are more effective, what training paradigms are more effective and what are the factors promoting plasticity?

Take a Walk: Physical activity, cognition and the brain

Arthur F. Kramer
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Over the past several decades our society has become increasing sedentary. Whether this change is due, in part, to the rapid development technological development, economic challenges to our society, or a host of other factors, decreases in physical activity have been associated with diseases such as hypertension, diabetes, ostoporosis and a number of different cancers. In my presentation I will cover what we currently know about physical activity and exercise and their influence on healthy minds and brains. I'll briefly cover animal research which has elucidated the molecular and cellular mechanisms that relate physical activity to brain function and cognition. My main focus will be on human exercise research across the lifespan, covering both epidemiological and intervention studies.

Finally, I will conclude with a discussion of our knowledge gaps and how we might fill them with future research.

Do concepts of latent factor transfer transfer to studies of transfer?

Florian Schmiedek[1,2], Martin Lövdén[2, 3], & Ulman Lindenberger[2]
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In recent years, a growing number of studies of working memory training with samples of different ages have reported transfer to non-trained tasks of working memory and fluid intelligence, fostering hope that trainings of the core construct of working memory can benefit everyday cognitive competency across the lifespan. There are also a growing number of failed replications, skeptical reviews, and meta-analyses with mixed results that limit enthusiasm and denote calls for more conclusive research on this important topic. We hold that such research should be characterized by (a) a theoretical sharpening of the concept of plasticity, (b) investigations of transfer at the level of latent factors based on structures informed by psychometric research on cognitive abilities and working memory, and (c) experimental studies that investigate the role of motivation and strategies in working memory trainings. We illustrate these points with simulation work and results from the COGITO Study, in which 101 younger and 103 older adults practiced twelve cognitive tasks (perceptual speed, working memory, episodic memory) for 100 daily sessions and worked on a comprehensive battery of transfer tasks at pretest, posttest, and at a two-year follow-up.

Brain training in progress

K. Richard Ridderinkhof, Jessika I.V. Buitenweg, & Jaap M.J. Murre
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The cognitive deterioration associated with aging is accompanied by structural alterations and loss of functionality of the frontostriatal dopamine system. The question arises how such deleterious cognitive effects could be countered. Brain training, currently highly popular among young and old alike, promises that users will improve on certain neurocognitive skills, and this has indeed been confirmed in a

number of studies. Based on these results, it seems reasonable to expect beneficial effects of brain training in the elderly as well. A selective review of the existing literature suggests, however, that the results are neither robust nor consistent, and that transfer and sustained effects thus far appear limited. Based on this review, we argue for a series of elements that hold potential for progress in successful types of brain training: (i) including flexibility and novelty as features of the training, (ii) focusing on a number of promising, yet largely unexplored domains, such as decision-making and memory strategy training, and (iii) tailoring the training adaptively to the level and progress of the individual. We also emphasize the need for covariance-based MRI methods in linking structural and functional changes in the aging brain to individual differences in neurocognitive efficiency and trainability in order to further uncover the underlying mechanisms.

The impact of action video gaming and working memory training on multi-tasking skills

Torsten Schubert, Tiina Salminen, & Tilo Strobach
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Task-non-specific training approaches have occurred in the last time and are stimulated by studies suggesting that complex mental trainings can lead to cognitive changes which generalize to other non-trained tasks. In our research we asked whether, and if so then how two prototypically complex trainings – action video gaming and working memory training - influence multi-tasking performance. While these trainings have been shown to improve performance in single task situations, their specific impact on multi-tasking has not systematically been investigated so far. According to Schmidt and Bjork (1992) we assumed that the generalization of training effects after task-non-specific training depends on the overlap between the processing requirements in multi-tasking and the particular training, i.e. action video and working memory training. A task analysis shows that action video gaming involves the fast focusing of attention on selected objects and to-be-executed actions just as the fast re-allocation of attention; working memory training improves rather the efficiency of working memory up-dating processes under increasing memory load. We report the findings of three experiments in which we investigated the effects of action video gaming and working memory training on the performance in dual-task and task-switching paradigms. These paradigms allow the distinction between conditions requiring focusing of attention on two tasks or the fast switching between tasks and conditions involving increased memory load because of pro-active interference from the previous task. As a result, action video gaming improved

multi-tasking in those conditions of the dual-task and the task-switching paradigms, which required the focusing of attention on the task at hand; working memory training improved multi-tasking only in the task switching situation, and here in trials, in which increased costs occur because of pro-active memory interference from previous trials. These findings imply the occurrence of task-non-specific training effects after working memory training and action video gaming on multi-tasking skills; they show further, that the effects of both training types differ because of the different overlap between the trained mechanisms in both trainings and the processing demands in the multi-tasking situation.

Education affects older adults' focus switching performance, but not training gains

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A recent training study on focus switching suggests that active interventions can reduce age-related losses in executive functions (Dorbath, Hasselhorn, & Titz, 2011). Not only interventions, but also protective factors, such as high education, have been shown to slow down age-related losses. However, empirical results about protective effects of education on executive functions are ambiguous. Moreover, little is known about the interplay of preserving and intervening factors for cognitive functioning in advanced age. The first goal of the given study is to examine whether education has a protective effect on older adults' focus-switching performance. The second question is whether education affects trainability of focus-switching. To this end, extreme groups of high education (18 years and more) and low education (14 years and less) were considered in a sample of older adults (N = 64, mean age = 66.20 years, SD 4.55). The results reveal that highly educated older adults had significantly lower switch costs and error rates than less educated adults. The effect of education was not significant for training gains, although a compensatory tendency with larger training gains for less educated adults could be assumed.

Can working memory be improved? Evidence from training studies based on the facet model of working memory capacity

Claudia von Bastian & Klaus Oberauer
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We conducted two working memory (WM) training studies based on the facet model of WM capacity, which comprises the functional categories storage-processing, relational-integration, and supervision. In Study 1, we compared three experimental groups, each training one functional category, to an active control group practicing tasks with low WM demand. Before and after four weeks of adaptive computer-based training, transfer was measured with a broad test battery. For storage-processing and supervision training, we found transfer effects to tasks measuring the construct trained as well as to reasoning. Following the rationale that transfer is driven by functional overlap between training and transfer tasks, training all three functional categories at once could lead to even broader transfer. This hypothesis was investigated in Study 2 within an age-comparative setting including younger and older adults. As in Study 1, four weeks of intensive WM-training were compared to an alternative intervention with low WM demand. Both age groups showed increased performance in trained tasks and in one structurally similar, but non-trained task. However, there was no transfer to reasoning in neither age group. We conclude that WM can be improved, but broad transfer occurs only if the training intervention specifically focuses on storage-processing or supervision.

Age and individual differences in adult structural brain plasticity

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There is accumulating evidence for the existence of brain plasticity in adulthood, that is, adaptive changes of the brain structure in response to altered environmental demands. So far, however, it remains to be understood in how far age poses as a limiting factor for this malleability of the brain. We have investigated changes in hippocampal volume and cortical thickness evoked by four months of spatial navigation training in 91 men aged 20-30 or 60-70 years. Younger as well as older navigators evidenced large improvements in navigation performance. Both age groups showed stable hippocampal volumes in the navigation group, whereas control groups displayed volume decrements consistent with longitudinal estimates

of age-related decline. In contrast, training-related cortical thickening was observed in young navigators only. Thus, spatial navigation training seems to affect hippocampal volume in a similar way for both younger and older adults, but there is reduced potential for cortical alterations in old age as compared to young adulthood. It is therefore crucial to acknowledge the different potentials for plastic changes in subcortical regions and cortical regions, as different mechanisms might be at work. In a next step, we are now interested in individual differences in training-induced plasticity over time. We have trained 15 younger adults for 7 weeks to draw and write with their non-dominant hand and have acquired magnetic resonance (MR) images every other day, resulting in approximately 20 MR sessions per person. We strive to continuously observe the ongoing structural alterations accompanying motor skill acquisition.

Abstracts of poster presentations

1. Does Working Memory training improve Proactive Interference Management?

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OBJECTIVE: Previous studies have suggested that proactive interference(PI) management may underlie the correlation between working memory(WM) capacity and fluid Intelligence(Fg). We postulated that WM training demanding resolution of PI might improve performance on items in a Fg test which requires PI resolution. METHODS: 45 participants were matched according to their university entrance scores, and assigned to either PI training group, a control group for whom training involved low PI control demand (active control) and a no contact group. The main outcome measures were operation span (OSPAN) and the ETS-kit's Locations test, a Fg measure. RESULTS: PI training group did not improve neither in the OSPAN task, nor in the Locations test. Interestingly, on the low PI items of the Locations test, the mixed control group showed an improvement relative to the PI training group. CONCLUSIONS: Contrary to our prediction, PI training did not result in a better ability to resolve PI. We suggest that our PI trainees might have increased their tendency to reject familiarity-based information which hindered their performance on the low PI ETS-Location items.

2. Can school children's ability to overcome intuitive interference in geometry be improved: mode and order of presentation?

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In mathematical reasoning, overcoming intuitive interference is a key pedagogical challenge. Children intuit that geometrical shapes with larger areas have larger perimeters. In congruent condition, where correct response matches intuition (larger area–larger perimeter), accuracy is higher and reaction time is shorter than in incongruent (counterintuitive) conditions. We explored whether discrete representation of the shapes improves students ability to overcome intuitive interference as compared with continuous representation? And if yes, will discrete representation of the task before continuous representation result in improved

performance in the continuous one? Schoolchildren completed two computerized comparison of perimeter tests (discrete and continuous) 10 days apart. Success in discrete mode of representation was higher than in continuous mode, in the incongruent conditions. Representation mode had no effect on reaction time of correct responses. Success rate for continuous mode of representation increased when it followed discrete mode. No effect was evident for discrete mode when following continuous mode. Order of representation had no effect on reaction time of correct responses. Presenting the shapes discretely rather than continuously offers mental manipulation and counting of the discrete segments, hence encouraging appropriate solution strategies. Our findings indicate that this training effect is robust and transferred to continuous representation.

3. Hotel Plastisse: A new iPAD training software with a multidomain process approach in old adults

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Recent cognitive training research has demonstrated that multidomain trainings engaging participants in complex tasks are very effective in improving cognitive function in old adults and furthermore show larger transfer effects than other types of cognitive trainings. However, the mechanisms underlying multidomain trainings are not known since the trainings having been used have been very heterogeneous ranging from complex video games to group courses in creative problem solving or digital photography. The present study intends to contribute to a deeper understanding of the processes that lead to the superior efficacy of multidomain trainings by comparing the cognitive and neural effects of a multidomain training demanding the use of three cognitive functions simultaneously with the effects of three singledomain trainings. The first pilot study is running as a randomized controlled single-blind trial with a 4-group design consisting of 80 healthy old adults (65-80 years). The groups will take part in one of three singledomain trainings focusing on either visuomotor function, inhibition, or spatial orientation, or in the multidomain training engaging these three functions simultaneously. Subjects train for 50 days with a training session every day that is self-administered by the participants on iPads at their homes. The theoretical and empirical background and the design of the study will be introduced and first preliminary data of the pilot study will be presented.

4. Brain training in progress: a review of trainability in healthy seniors

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The cognitive deterioration associated with aging is accompanied by structural alterations and loss of functionality of the frontostriatal dopamine system. The question arises how such deleterious cognitive effects could be countered. Brain training, currently highly popular among young and old alike, promises that users will improve on certain neurocognitive skills, and this has indeed been confirmed in a number of studies. Based on these results, it seems reasonable to expect beneficial effects of brain training in the elderly as well. A selective review of the existing literature suggests, however, that the results are neither robust nor consistent, and that transfer and sustained effects thus far appear limited. Based on this review, we argue for a series of elements that hold potential for progress in successful types of brain training: (1) including flexibility and novelty as features of the training, (2) focusing on a number of promising, yet largely unexplored domains, such as decision-making and memory strategy training, and (3) tailoring the training adaptively to the level and progress of the individual. We also emphasize the need for covariance-based MRI methods in linking structural and functional changes in the aging brain to individual differences in neurocognitive efficiency and trainability in order to further uncover the underlying mechanisms.

5. Training Components of Face Cognition Ability

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The quality of human interaction often depends on the individual's ability to recognise his conspecies' faces. Based on the three component skills of face cognition ability described by Wilhelm et al. [Wilhelm, O., Herzmann, G., Kunina, O., Danthiir, V., Schacht, A., & Sommer, W. (2010). Individual differences in perceiving and recognizing faces—One element of social cognition. Journal of Personality and Social Psychology, 99(3), 530-548.], the aim of this study was to develop and validate training procedures for two specific facial abilities: face memory and speed of face cognition. Two groups of middle-aged healthy participants trained for 29 days on

one of the two component abilities. Training effects were studies with structural equation modelling. Only the training of facial speed led to significant improvements of the ability aimed at. It also enhanced performance on other indicators of speed of processing. Thus, this training was not face specific. The training induced improvements persisted over a 3-months interval.

6. Modulation of frontal-midline theta by neurofeedback

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Cortical oscillations clearly bear upon cognition. They also exhibit associations with task performance and psychiatric mental disorders. Given these relationships, the modification of oscillations has become the focus of neuroscientific approaches for cognitive enhancement. Neurofeedback (NF) of brain activity constitutes a promising tool for such alterations. For specific higher cognitive functions frontal-midline theta (fm-theta) has been suggested as important indicator of relevant brain processes. We present a novel approach of an individualized, eight-session NF training to enhance fm-theta. The individual fm-theta frequency was determined in four experiments tapping executive functions. Effects of the actual NF training were compared to a pseudo-NF training. Participants of the pseudo-NF training experienced a comparable degree of motivation and commitment as compared to the subject of the actual NF training, but experienced the training slightly easier. In comparison to the pseudo-NF training, proper NF training significantly enhanced fm-theta power in the actual training sessions.

7. Cognitive and brain changes induced by a process-based spatial episodic memory training in old age

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So far, episodic memory trainings in old adults have involved teaching *strategies* for *verbal* memory. These trainings have been found to lead to small improvements in the trained and to little transfer to other cognitive abilities. Recently, *process-based* trainings for executive processes have been shown to produce larger gains in the trained and greater transfer to untrained cognitive abilities, but their efficacy for memory processes is unclear. A few studies indicate that strategy- and process-based trainings induce functional and structural brain changes in old adults, but the findings are diverse and the trajectory of these changes during the course of the trainings is largely unknown. Therefore, we plan to investigate the effects of a *process-based spatial* episodic memory training on cognition, brain function and structure in old adults as well as the trajectories of these changes during the course and after the training. Sixty right-handed healthy adults aged 60-75 years will participate in the study: half will complete 30 sessions of the spatial episodic memory training within six weeks, while the other half will participate in a control training. Cognitive, fMRI, MRI, and DTI measures will be collected before, in the middle, immediately and four months after the training period.

8. Learning to search – simplification of task processing transfers within and across tasks

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Theoretical as well as practical concerns render it highly relevant to understand whether people can be trained to search for and apply shortcut strategies. Here we report skill acquisition research with adults as well as eyetracking data on mental calculation in children to make the case that the notion that shortcuts can be found and applied in task material can (a) be picked up easily and (b) transfer very broadly. Similar to the concept of “learning to learn” we argue for “learning to search” as a key means in (a) understanding top-down contributions to strategy change in skill acquisition and (b) foster or impede the spontaneous application of shortcut

strategies depending on practical goals. The results show that simplification of task processing transfers across items within a task as well as across tasks involving different stimuli, responses and operation rules. In many cases strategy change seems to be driven by a conscious and voluntary decision to apply the knowledge about task regularities acquired incidentally. In primary school mathematics, offering material with regularities that can be found and exploited rather easily seems to be an effective intervention to spark a general search for efficient ways of calculation.

9. Working Memory Training and Transfer in Aging – an fMRI study

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Age-related decline in working memory was found to correlate with alterations in blood-oxygen-level-dependent (BOLD) contrast in prefrontal cortex (PFC). In this study, functional Magnetic Resonance Imaging (fMRI) was used to compare BOLD contrast between younger and older participants, and to investigate training-related changes. 34 healthy older participants (60-75 years) were included in the study and randomly assigned to old training (OTG, N=16) or control group (OCG, N=18). 18 healthy younger participants (20-35 years) served as a young control group (YCG). The training group participated in a 4-week adaptive n-back working memory training. Before (t1) and after (t2) training/waiting period, neuropsychological tests and fMRI was conducted. When comparing older and younger participants at t1, the older ones showed stronger recruitment of right PFC and right inferior parietal cortex (IPC), $p<.001$. At t2, n-back performance increased ($p< .01$), and BOLD signal in right PFC decreased in OTG ($p<.001$). A behavioral transfer to digit span, d2, stroop, and LPS ($p<.05$) was found. Older subjects improved their working memory performance after 4 weeks of training. Performance gains in non-trained tasks suggest that transfer to other cognitive domains remains possible in aging. FMRI findings indicate a training-related increase in processing efficiency of working memory networks.

10. What's best for healthy elderly and MCI patients: training or stimulation?

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Introduction: This study aims at investigating cognitive improvements induced by structured cognitive training or comprehensive cognitive stimulation in healthy elderly individuals (HE) as well as patients with Mild Cognitive Impairment (MCI).
Methods: 46 HE and 46 MCI-patients were randomly assigned to one of two treatments: The NEURO*vitalis*® training program (NV) or a stimulation program ("Mental fit", MF), each consisting of twelve 90-minute training sessions within six weeks. Neuropsychological tests were administered before and after the training period. Results: Groups did not differ significantly in their demographic characteristics [HE/NV: 16♂, age 70.6(5.5), education 13.7(4.1), DemTect 16.6(1.5); HE/MF: 8♂, age 70.2(7.6), education 13.2(3.9), DemTect 15.9(1.9), MCI/NV: 14♂, age 71.8(6.5), education 14.7(3.3), DemTect 11.9(1.8); MCI/MF: 10♂, age 70.7(8.4), education 14.5(3.9), DemTect 12.1(1.8)]. While HE/MF showed no significant improvements, HE benefited from NV in general cognitive state, memory and executive functions. In comparison, HE/NV achieved significantly stronger effects in memory (DemTect direct recall p=.00; Memo delayed recall p=.04) and attention (BTA p=.02). For MCI, both trainings supported executive functions, while with NV, additional effects were evident for general cognitive state and memory. Neither manifested significantly stronger effects. Discussion: In HE, structured cognitive training should be preferred, while for MCI-patients both interventions appear useful.

11. Effects of physical activity on the senescent brain and cognition

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Several studies have shown that improvements in aerobic fitness in old adulthood have beneficial consequences for cognitive performances as well as brain structure and function (for reviews, see Colcombe & Kramer, 2003; Erickson & Kramer, 2009; Smith et al., 2010). One mechanism leading to these improvements might be

increases in brain perfusion, influencing the amount of blood, energy and oxygen that reaches the brain at a given point in time. Brain perfusion has been shown to decline with advancing age (Beason-Held et al., 2007). We present the design and some initial pretest results from a large intervention study with a sample of 60-75 year old sedentary but healthy individuals (N = 56). Participants were randomly assigned to an exercise intervention or a placebo exercise intervention group. While participants in the exercise intervention group exercise on bicycle ergometers three times a week at adaptive resistance levels which should lead to increases in their aerobic fitness, the placebo intervention group cycles at constant resistance levels of 10 Watts which are unlikely to lead to fitness improvements. The exercise training lasts for 6 months and is currently ongoing. Pre- and posttests assess a battery of different cognitive tests, brain perfusion (using arterial spin labeling), changes in brain volume and whiter matter, brain activation during two different cognitive tasks, fitness levels and several medical parameters (e.g., blood sugar, cholesterol, serum BDNF). A second posttest 6 months after the end of the exercise-training regime will assess the maintenance of gains. First results from the pretest indicate that there are no significant differences between the two training groups in their cognitive performances, and no correlations of cognitive performance and fitness level at pretest.

12. Testing memory athletes: Training in mnemonics leads to memory improvement beyond capacity

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Memory athletes use mnemonic techniques to memorize huge amount of data in short period of times. Mnemonics, in particular the method of loci, make use of meaningful encoding by encoding information into visual imagery that is associated with pre-learned retrieval structures, usually spatial locations. 25 memory athletes ranked at least Top50 in memory sports visited our lab. All of them trained mnemonics and credited their memory performance solely on them. In addition 25 matched controls underwent the same tests. The memory athletes in our study are very intelligent (131 ± 12) and also showed very high scores in a cognitive speed test (Zahlenverbindungstest), which correlated with their performance in memory sports. Cognitive test results show that memory athletes were less prone to false memories in the DRM paradigm in comparison to controls. In a Directed Forgetting paradigm,

they showed superior memory only in the remember condition but did not outperform controls in the forget condition. Comparing immediate and delayed recall we also found, that memory athletes could recall data with the same high level of accuracy on the next day. These findings show that memory athletes don't just have a higher memory capacity, but also a more accurate storage.

13. Transfer of cognitive training to everyday life in older adults

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While most training studies of working memory with elderly adults report medium to strong training effects and also near transfer effects, there are contrary results to which extent the training is transferable to distant abilities and everyday life performances. In an experimental design, subjects (60-75 years) were randomly assigned to one of three groups: the experimental group was trained with five adaptive tasks with different contents (verbal, numerical, spatial) and processes (updating, simultaneous storage and processing, task switching) for six weeks (12 x 60 minutes), the active control group worked for the same time amount with knowledge tasks and board games, whereas the passive control group had no contact at all. Post-test performances in working memory, short-term memory, mental speed, reasoning, and task switching as well as the number of cognitive failures measured by ambulatory assessment are compared. The study is still ongoing but first results show promising psychometric task properties, correlations, training effects, and moderate transfer effects. Although cognitive failures seem to be affected by training, the frequency of occurrence is generally low which may lead to a small power. The poster includes data of about 70 persons, but the desired complete sample size is at least 100.

14. "Denkspiele mit Elfe und Mathis" – the well-known "Denktraining" of K. Klauer also works as computer game

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Inductive reasoning is an important aspect of general intelligence. The computer game *Denkspiele mit Elfe und Mathis* (A. Lenhard, W. Lenhard & Klauer, 2012) is an adaptation of Klauer's exemplarily evaluated *Denktraining I* (Klauer, 1989) which addresses children from 5 to 8. To evaluate its effectiveness, 36 first graders and 32 second graders either completed the computer game (10 sessions à 45 min.) or had regular instruction instead. The ability of inductive reasoning was measured one week before and one week after the intervention with CFT 1 (Weiß & Osterland, in press). Children in the experimental group improved their abilities in inductive reasoning significantly more than children in the control group. Compared to regular instruction the intervention had a large effect size for the second graders (Cohen's d = .82) and a small effect size for the first graders (Cohen's d = .29). In accordance with previous studies (A. Lenhard & W. Lenhard, 2011), children with low abilities in inductive reasoning seemed to profit more than children with good abilities, indicating a compensating character of the intervention.

15. Body and mind: two enemies or an unbeatable duo?

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Some studies reveal that the time to mentally simulate one's action is often proportional to the time to perform the movement. Others, demonstrate that biomechanical constraints affect mental simulation of movements. Data from studies in people with Cerebral Palsy (CP) are inconsistent concerning whether they use motor imagery or visual imagery when solving mental rotation (MR) tasks. In this presentation we're presenting these data aiming on contributing to this debate. 45 participants wth CP and 45 motor able participants were given a MR task of photographs of hands and letters, according to different rotation degrees. CP

participants revealed a) ability to use motor imagery (more constrained hand postures showed an increase of time); b) motor imagery *deficits*, although (as longer reaction times were needed). Overall, outcomes argue for the involvement of motor representations (not just visual ones) in both tasks. Action and motor experiences appear to be important for MR generally, (not only for rotations concerning body parts), stressing the guidelines adopted by the new definition of CP. Moreover, the employment of motor imagery strategies by CP group pleads for the potential usefulness of motor imagery training and plasticity as a means to improve actual motor performance in CP participants.

16. The influence of working memory mechanisms when training shifting abilities

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OBJECTIVE: The task switching paradigm has been found to involve several executive functions including working memory updating, inhibition and shifting. Karbach & Kray (2009) showed that four sessions of Task Switching (TS) training resulted in a broad transfer to several measures of executive functions. We are currently trying to explore whether this transfer is caused by the working-memory (WM) ingredient of the training paradigm that required keeping-track of the currently relevant task (alternating runs, i.e. AA-BB-AA). METHOD: 65 participants were matched according to their university entrance scores and switching abilities, and assigned to either a switching training group (replicating Karbach & Kray's 2009 study) or a silent control group. The transfer measurements include high and low WM conditions; TS (cued vs. non-cued), Stroop (vocal vs. manual) and choice reaction (arbitrary vs. non-arbitrary). PREDICTIONS: If the active/central ingredient in the training paradigm is WM related, transfer is expected only to tasks involving high WM demands. RESULTS: Preliminary results are expected by the end of September when the study will be completed.

17. Neuropsychological Intervention in Parkinson's Disease: structured neuropsychological intervention vs. cognitive stimulation

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Background: In Parkinson's Disease (PD), cognitive dysfunctions, which can minor patients' quality of life, occur frequently. We conducted a randomized trial to examine, if nondemented PD patients improve in cognitive functions after six weeks of neuropsychological intervention and if these effects depend on the kind of treatment [structured neuropsychological intervention (NI) vs. cognitive stimulation (CS)]. Methods: All patients (Hoehn & Yahr I-III) - diagnosed with PD (UK Brain Bank) – were randomly allocated to one of two treatments [NI: n=22, 10♂; age=69.2 (4.9); education=13.1 (3.8); *DemTect*=13.7 (2.8), CS: n=22, 15♂; age=68.8 (6.7); education=13.6 (3.2); *DemTect*=13.9 (2.6)] or a control group [CG: n=22, 12♂; age=69.1 (11.3); education=12.7 (3.2); *DemTect*=14.8 (2.8)]. Neuropsychological tests were performed before and after the training, respiratory in a distance of 6-8 weeks. Results: NI improved in overall cognitive functioning (MMSE: *P* =.02), short-term memory (MEMO: *P* =.00) and working memory (DemTect: *P* =.02). CS improved in overall cognitive functioning (DemTect: *P* =.05) and depression (BDI-II: *P* =.02). CG did not improve in any test. Except working memory (DemTect: *P* =.01), there were no different effects between NI and CS (NI improved more). Discussion: Both interventions enhanced overall cognitive functions. Additionally, structured training leads to improved working memory.

18. Cognitive versus combined cognitive and physical training for healthy elderly

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Background: Some studies showed stronger cognitive effects of the combination of cognitive and physical training than single-factor-interventions for healthy elderly. Therefore, programs with both components should be studied to add to the growing database. Methods: 42 healthy elderly were trained with cognitive [CT; n=21; 6 men; age=67.43 (4.63); education=14.43 (3.93); *DemTect*=16.33 (1.83)] or combined cognitive-physical training [CPT; 6 men; age=66.95 (5.15); education=15.69 (4.14); *DemTect*=15.43 (2.09)] for six weeks. Neuropsychological tests were performed before and after the training. Results: Both groups showed significant improvements in average cognition [*MMST*: CT ($p \leq 0.001$); *DemTect*: CPT ($p \leq 0.01$)], short and intermediate memory [*DemTect: direct recall* (R1): CT ($p \leq 0.001$); CPT ($p \leq 0.001$); *delayed recall* (R2): CT ($p \leq 0.001$); CPT ($p \leq 0.001$); *Memo*, R1: CT ($p \leq 0.001$); R2: CPT ($p \leq 0.001$)] and executive functions [*COWA*: CT ($p \leq 0.01$); CTP ($p \leq 0.001$); *TMT-B*: CT ($p \leq 0.001$)]. Also, both groups reported less memory problems after the training [*MAC-Q* ($p \leq 0.01$)]. The CPT group achieved better scores in a figural memory task at posttest [*CFT*, VA ($p \leq 0.05$)] and showed stronger improvements in attention [*BTA* ($p \leq 0.01$)] and executive functions [*COWA* ($p \leq 0.01$)]. Discussion: Both trainings lead to significant cognitive effects. The results indicate the combination of physical and cognitive training to be superior in terms of improving cognitive functions in healthy elderly.

19. Investigating brain plasticity effects during word learning in 6-month-old infants: how a semantic training influences the processing of phonotactic regularities

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At 6 months of age infants can differentiate between native and non-native phonotactics. In our study we investigate how brain activity responses to native (i.e. legal) and non-native (i.e. illegal) phonotactic regularities are modulated through training in 6-month-old infants. We therefore acoustically presented phonotactically legal and illegal pseudowords embedded in a semantic training. During this kind of training the pseudowords were combined with pictures of real objects to create an associative learning setting. The same pseudoword was repeatedly presented in association with the same object and equally often with different objects. Each infant underwent a pretest, training, and posttest on three consecutive days. Pretest and posttest included trained and untrained pseudowords. Learning effects were monitored by event-related brain potentials. Preliminary results revealed a familiarization effect for phonotactically legal and illegal trained pseudowords. The familiarization was indexed by a decreasing frontally distributed negativity, a precursor of the N400, displayed from day 1 to day 3. This effect was not present for untrained words. These findings suggest that more acoustically oriented perceptual mechanisms guide word learning at this early age even within a semantic learning context rather than pure associative learning. More lexically oriented brain mechanisms might establish later during language acquisition.

20. Learning native and non-native phonotactic regularities by different semantic training settings: Evidence from an EEG study in adults

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Phonotactics describes the possible combination of phonemes in a specific language (e.g., `br` is a legal onset in English whereas `bz` is not) and is thus relevant for word learning. We investigate the neuronal changes during exposure to pseudowords of native and non-native phonotactic rules embedded in two semantic contexts. The

first training consisted in the acoustic presentation of these pseudowords together with pictures of real objects reflecting a classical L2 acquisition scenario where a new name has to be assigned to a known object. The second training combined the pseudowords with pseudoobjects, thus simulating in adults an L1 acquisition scenario as it occurs in early infancy. For both trainings a pretest, training, and posttest were administered on three consecutive days. ERP results for the Real Objects Training show a fast increase of the N400 to non-native pseudowords after the first training session suggesting that illegal nonwords approximate a lexical status. Native pseudowords show a decrease with increasing exposure to the stimuli indicating familiarization effects. The Pseudoobject Training showed only a decrease in N400 amplitude for non-native pseudowords suggesting an improved ability to sort them out as nonwords with increasing exposure. These findings indicate very fast neuronal changes through learning.

21. Compensation of age-related cognitive decline by working memory training

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Age-related cognitive decline is reflected as impairments in various functions, such as working memory (WM), attention, and executive control. Recent studies have yielded promising results in improving cognitive functions by training in younger adults; however, effects of cognitive training in compensating cognitive impairments in the elderly have been mixed. Therefore, we systematically studied the effects of WM training on various measures of executive functions and attentional processes in older adults. Participants practiced on a WM task for a period of 14 days, before and after which they completed tests on the untrained functions. The trained group showed improvements in the WM task after training, which confirmed that it is possible to train cognitive functions even at an older age. Additionally, transfer effects from training to untrained measures tapping WM updating, task switching, and attentional control paralleled our previous findings with younger adults, although with a smaller effect size. Results are discussed in reference to the plasticity of cognitive functioning in older adults.

22. Memory enhancement in seniors using a combined intervention program of cognitive and physical training

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Background. Cognitive abilities increase during adulthood, reach a maximum and slowly decline thereafter. In pathological aging, the loss in cognitive functioning may even include severe dementia and loss of executive functions. However, this age-dependent decline in cognitive functions is not inevitable: exercise interventions as well as cognitive training have been shown to promote cognition even in old age. Combining physical exercise with computer-based cognitive trainging might be especially effective in enhancing or at least preserving cognition due to reciprocal and complementary stimulation of neuroplastic processes in the brain. This study investigates short-term cognitive benefits of such a combined training within the Long Lasting Memories (LLM) project. Methods. A total of over 120 seniors above the age of 60 years completed an 8-week-combined training program of physical fitness and cognitive training. The cognitive training consisted of a language-adapted version of the Brain Fitness Programm. The physical training component included aerobic, resistance, balance and flexibility exercise training. Episodic memory, working memory and executive functions were assessed within two weeks before and within two weeks after the training. The cognitive tests, which were not part of the cognitive training, included the Digit Span Test, the Trail Making Test, and a language-adapted version of the California Verbal Learning Test as well as the Mini Mental State Examination (MMSE). Results. Results revealed a significant improvement of episodic and working memory for the training group relative to the control group. The improvement of cognitive functions was independent of the cognitive status prior to the intervention assessed by the MMSE. **Conclusion.** A combined training protocol of physical exercise and cognitive training can help to improve episodic memory and working memory capacities in older people. Even seniors with low cognitive functions and early symptoms of dementia can benefit from the combined training intervention. This study allows no statements as to the relative contribution of cognitive compared to physical exercise to the observed training success. Future studies should investigate the individual contribution and the added value of combined physical and cognitive training.

23. Use cases for a mobile EEG headset

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We report our experience with a consumer headset to record electrophysiological signals, the Emotiv EPOC neuroheadset. It is easier to attach than common eeg caps and allows wireless transmission of the recorded data. Thus it appears suitable for mobile settings. We describe potential usage scenarios as well as challenges using such a low-cost device. The contribution may be of interest for researchers who intend to take their setups out of the laboratory into the field.

24. Physical Education enhances your concentration!

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There is growing evidence that physical education has not only positive effects on the physical health of children and adolescents, but also contributes positively to personality development and to performance in cognitive tasks. Existing studies indicate chronic as well as acute effects of physical education on cognitive performance. However, underlying mechanisms, required content of the physical intervention and duration of the effects are still unclear. In order to shed light on some of these open questions, the present study investigated the acute effects of a special form of physical education, integrating cardiac-stimulating tasks with executive demands, on the concentration of 11-year olds. Concentration was assessed three times using the d2-R Test. Intervention (n=38) and control group (n=35) did not differ in their d2-R performance in pre- nor in post-test, which took place after either a physical intervention or a normal core subject lesson respectively. In the follow-up test however, which was completed after two more core subject lessons for both groups, the intervention group improved more in their d2-R performance than the control group $F(1, 71)=4.95$, $p=.03$, indicating that physical education can positively influence children's concentration, not immediately after the activity, but later on during the following school lessons.

25. Using a Triple Blind Design in Cognitive Training Studies; Can We Do More With Less?

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Abstract: Cognitive training studies commonly explore improvements in non-trained tasks after a training period and are mostly done using a pre-posttest design. In recent years, it is not uncommon for training studies to be conducted using a silent control group, in part to save resources and increase the number of participants. This is done despite the many validity threats that accompany this type of experimental control, among them the subject's knowledge that performance should be improved after training. Here we present a novel design that uses a triple-blind principle and aims to deal with these validity threats while still keeping a cost-effective procedure. This is done by dividing the classic double blind design in to two standalone experiments (i.e. training, measurements) that includes separate experimental teams, recruitment ads and facilities. After presenting the triple blind protocol in detail we discuss the relevance, pros and cons of this design to future training studies.

26. Transfer of executive control training revised – why do some individuals benefit more than others?

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Training-related improvements in executive control tasks can be transferred to new, untrained tasks in young and old adults. However, less is known regarding the interindividual differences that contribute to the success of a training intervention. Why do some individuals benefit more than others? In the present study, we investigated transfer of task-switching training in younger (N=42, 18-26 years of age) and older adults (N=42, 62-76 years of age) in a pretest-training-posttest design. The pretest and posttest assessment included a battery of cognitive tasks and the training included four sessions of intensive training on an internally cued switching task. Both age groups showed a reduction of switching costs. In addition, we found transfer of training to a structurally similar switching task that was administered at pre- and at posttest. The analysis of between-group differences showed that transfer

was larger in older adults than in younger adults. Across both age groups, individuals with lower task-switching abilities at pretest showed larger training and transfer benefits after the training. Moreover, intelligence and working memory contributed to the training success in younger adults but not in older adults. Implications for further research will be discussed.

27. Neural Correlates of Transfer Effects between Working Memory Tasks in Aging

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Age-related working memory (WM) decline has been associated with alterations in the lateral prefrontal cortex (lPFC). In this fMRI study, we examined the role of the lPFC for the transfer of WM training effects between WM tasks. 15 old subjects (age 60-75) performed a numerical n-back task and a verbal Sternberg task during fMRI before and after a 4-week adaptive n-back WM training (12 sessions). N-back training effects were compared with an age-matched untrained group. In the Sternberg task, letters had to be maintained or updated with letters based on a task cue. This allowed disentangling transfer effects for maintenance vs. updating, respectively. Performance in the trained n-back task and the untrained Sternberg task improved after training. fMRI analyses revealed reduced activity during n-back performance and the delay phase of the Sternberg task after training. Specifically for the updating condition, activity decreases were present in bilateral lPFC, right inferior parietal cortex and left Putamen. Importantly, right lPFC decrease overlapped with the corresponding activity decrease in the n-back task in the trained compared to the untrained group. These findings support the view of an increase in processing efficiency in lPFC through cognitive training, specifically related to the process of WM updating.

28. Improving Cognitive and Motor-Cognition Performance of Older Adults with Simultaneous Motor-Cognitive Training

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Old age leads to a decrease in cognitive and physical resources such as motor performance. In particular, the ability to simultaneously perform motor and cognitive tasks is impaired. While many studies confirm the positive effect of both cognitive and physical training on cognitive performance of older adults, only little is known about the combination of cognitive and physical or motor training on cognitive performance and none about the simultaneous performance of them. The current study provides a new training approach by simultaneously conducting verbal working memory and cardiovascular training with the objective to improve cognitive and motor-cognition performance of healthy older adults. Both the combined as well as a single cognitive training group demonstrated similar training progress and larger improvements in the executive control task when compared to a passive control group. In addition, the combined training resulted in larger improvements than the single training in the paired association task and was able to reduce the step-to-step variability during dual task in the motor-cognition task when compared to the single training and the passive control group. In conclusion, the simultaneous training of cognitive and physical abilities is a successful future- oriented training concept improving cognitive as well as motor-cognition performance.

29. Basal ganglia volume in older adults differ with regard to the type of physical activity

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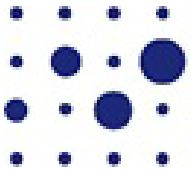
Aging is related to cognitive performance loss and brain volume shrinkage. For older adults, cardiovascular fitness and training have been positively related to brain volume in several brain regions and to higher cognitive functioning. So far, motor fitness and coordination training have also been associated with better cognitive performance and different brain activation patterns; structural brain data are missing, however. We analyzed data from healthy older adults (n= 72; M= 68.51 years; SD= 3.53) from the *Old Age on the Move* project (Voelcker-Rehage et al., 2010,

2011) and found diverging associations for physical and motor fitness (cross-sectional study) and differing effects of cardiovascular and coordination training (12 month intervention study), respectively, on the volume of the basal ganglia demonstrating positive associations only for motor fitness and coordination training. In the next step, we will investigate whether in this sample volume of the basal ganglia is related to cognitive and/ or motor performance.

Voelcker-Rehage et al. (2010). Physical and motor fitness are both related to cognition in old age. *The European Journal of Neuroscience, 31*(1), 167-176.

Voelcker-Rehage et al. (2011). Cardiovascular and coordination training differentially improve cognitive performance and neural processing in older adults. *Frontiers in Human Neuroscience, 5*, 26.



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