3. General discussion and conclusion
Neuropsychological Assessment of Cognitive Functions: An Objective Approach

Most theories on neuropsychological functions of adults with ADHD proposed a primary deficit of inhibitory executive functions (Barkley, 1997; Castellanos, Sonuga-Barke, Milham, & Tannock, 2006; Tannock, 1998) which resulted in a large body of research examining various functions associated with executive control, including focused attention, divided attention, vigilance, working memory, inhibition, set-shifting, verbal fluency and problem solving (Boonstra, Oosterlaan, Sergeant, & Buitelaar, 2005; Dinn, Robbins, & Harris, 2011; Hervey, Epstein, & Curry, 2004; Schoechlin & Engel, 2005; L. Tucha et al., 2008; L. Tucha et al., 2009; L. Tucha et al., 2011; O. Tucha et al., 2006; O. Tucha et al., 2005). However, theoretical considerations imply that executive dysfunction may also adversely affect memory functions of adults with ADHD. Therefore, Study 1 and Study 2 of the present thesis examined widely neglected memory functions in the field of ADHD, showing that adults with ADHD inefficiently encoded new information but had intact abilities in retention of information in memory once this information has been successfully encoded and stored. These results were in accordance with our expectations as executive operations are particular required in processes of encoding and retrieval (such as semantic clustering, effortful rehearsal, and strategic use of mnemonics) (Pollak, Kahana-Vax, & Hoofien, 2008). Retention of learned information, however, does not primarily depend on executive cognitive processes and appears not to be affected in adults with ADHD.

Furthermore, two studies of the present thesis examined functions of prospective memory and source memory, two memory components which have both been associated with executive operations (Glisky, Polster, & Routhieaux, 1995; Kliegel, McDaniel, & Einstein, 2000) and which are assumed to be important for daily life functioning. Impaired abilities in source discrimination (process to retrieve source information) of adults with ADHD, as it was shown in Study 2, can have negative consequences for the individual as detailed contextual information (source information) cause biographic events to become vivid and rich. Losing context information, therefore, may cause the recollection of such events meaningless and has also been shown to be associated with general cognitive impairments (such as increased interference in working memory or false recognition) (Drag, Bieliauskas, Kaszniak, Bohnen, & Glisky, 2009). Prospective memory was examined in a paradigm of complex prospective memory, a type of paradigm which required the execution of multiple delayed intentions, thereby trying to realistically represent prospective memory tasks of everyday life (the execution of several tasks in the future, e.g. making a phone call, giving a message to a friend, taking prescribed medication). On the basis of this study, it can be concluded that complex prospective memory consists of four largely independent cognitive components, i.e. task planning, plan retention, self-initiation and task execution. Adults with ADHD
have been shown to suffer from a specific impairment in task planning, suggesting that impaired prospective memory functioning of adults with ADHD does not result from a global cognitive deficit but may rather reflect a differential effect of impaired executive functioning. The importance of executive processes for source memory and prospective memory was emphasized by results of multiple regression analyses in both studies. Source discrimination was primarily explained by verbal fluency, a common measure for divergent thinking associated with executive functions (O. Tucha et al., 2005). A measure of retrospective memory, in contrast, did not predict performance in source discrimination. With regard to prospective memory functions in patients with ADHD, regression analyses identified inhibition to contribute significantly to task planning. Since patients with ADHD were largely impaired in task planning as an component of prospective memory, it can be concluded that inhibition may serve as a predictor for impaired functioning in prospective memory of adults with ADHD. This is consistent with evidence from previous research on prospective memory identifying inhibition as an important mediator of planning deficits in patients with Parkinson’s disease (Kliegel, Phillips, Lemke, & Kopp, 2005).

With respect to the memory impairments of adults with ADHD as presented in Study 1 and Study 2, the exploration of the effectiveness of established treatments (i.e. pharmacological intervention with stimulants) on these functions appear to be of clinical relevance. Considering the beneficial effects of stimulants on various aspects of cognition of adults with ADHD as it has been shown in previous studies (L. Tucha et al., 2011; O. Tucha et al., 2006; Verster et al., 2010) and considering the high demands of prospective memory and source memory on executive processes, stimulant drug treatment is hypothesized to also beneficially affect functions of prospective and source memory. Moreover, implications can be drawn from the present results for daily practice as well as for behavioral based intervention strategies (e.g. cognitive-behavioral therapy). For instance, behavioral based interventions should focus on structuring and organizing information, as well as on careful planning and preparing of intentions. With respect to prospective memory, for example, external help (e.g. by a therapist, coach or family member) might be necessary for patients to carefully plan and prepare intentions (e.g. structuring daily routines, keeping appropriate interactions with colleagues, controlling of impulsive behaviors, taking medication). Once intentions are formed, patients with ADHD (I) are able to store them in memory and, (II) at the appropriate time or event, are able to self-initiate and execute them to the same accuracy as healthy individuals. It would be desirable if treatment studies would be combined with the application of neuroimaging techniques (e.g. fMRI or NIRS) in order to explore the association between behavioral changes (i.e. improved executive control in tasks of prospective memory and source memory) and changes of brain activation, particularly in regions
in which abnormal activation patterns have been found in patients with ADHD (i.e. fronto-striatal and fronto-cerebellar brain activation) (Cubillo & Rubia, 2010).

**Self-evaluation of Cognitive Functioning: A Subjective Approach**

As a substantial limitation of psychometric tests, the ecological validity of objective neuropsychological assessments has been considered questionable as the predictive validity of objective measures of executive functions have been shown to be low to insufficient when judged against direct observations of executive functioning in natural settings (Acker, 1990; Barkley & Murphy, 2010; Barkley, 1991; Sbordone & Long, 1996). For this reason, self-ratings of cognitive functioning, as they were applied in Study 3 and Study 4, receive particular significance in predicting impairments in real life settings. These studies revealed large self-experienced impairments of patients with ADHD in all cognitive domains, including attention, retrospective memory, prospective memory and executive functioning. The substantial self-rated memory impairments of adults with ADHD, including self-rated impairments of prospective memory, underline the relevance of neuropsychological studies on memory functions as presented in Study 1 and Study 2. Further analysis on self-rated cognitive functioning (Study 3) showed that the majority of adults with ADHD experience impairments in more than one cognitive domain (e.g. about 70% of patients with ADHD reported multiple impairments in attention, memory and executive functioning) which might indicate that patients with ADHD suffer from a general cognitive inefficiency rather than complaints in specific cognitive functions.

Even though both subjective and objective assessment tools of cognitive functioning revealed significant group differences and considerable impairments in the majority of patients in all cognitive domains assessed, a comparison of effect sizes revealed larger dysfunctions in the subjective assessment than in the objective assessment (Study 4). Furthermore, logistic regression models demonstrated that impairments as determined in the objective assessment could not be predicted by subjective self-reports of cognitive functioning. Accordingly, impairments as determined in the subjective self-report could not be predicted by objectively defined cognitive impairments. Several explanations have been accounted for the poor associations between subjective and objective cognitive measures, such as limitations in the ecological validity of objective neuropsychological assessment tools (weak association between objective test performance and real life functioning) or impaired metacognitive abilities of patients with ADHD (lack of self-knowledge about their own functioning and abilities). As another explanation for the discordance between self-evaluations of cognitive functioning and neuropsychological test performance, it was suggested that subjective and objective measurement tools have a distinct function for the clinical assessment of cognition, both providing important...
but non-redundant information (Toplak, West, & Stanovich, 2013). In this respect, psychometric tests assess the efficiency of cognitive processes in highly structured and externally defined environments in which participants are requested to perform as best as possible (optimal performance). In contrast, self-ratings assess typical performance by requesting participants to rate how well they perform in situations of daily life that are likely to involve cognitive resources. In self-ratings, task instructions and settings are not externally constrained. Self-ratings assess the extent to which individuals achieve their goals in typical day-to-day situations and thereby provide an indication of individual goal pursuit.

Thus, results of subjective self-reports and objective assessments of cognitive functioning as reported in Study 3 and Study 4 emphasize the need for treatment interventions in adults with ADHD as impairments of considerable size were revealed in a variety of functions by both approaches. Furthermore, considering the discordance between current subjective and objective measures of cognition, the development of new, disease specific assessment tools become necessary in order to specifically measure cognitive impairments that are assumed to cause major problems for patients with ADHD in daily life, e.g. problems of distractibility, impulsivity, as well as in self-organization and time-management (Barkley & Murphy, 2010; Biederman, 2005).

Treatment of Cognitive Dysfunctions: Whole Body Vibration

In order to address limitations of current treatment strategies for patients with ADHD (i.e. clinical side effects and high financial costs), the potential of Whole Body Vibration (WBV) for improving cognition was examined in Study 5 and Study 6. Acute beneficial effects of WBV treatment (amplitude = 4 mm, frequency = 30 Hz) on attention were found in a large sample of healthy individuals as well as in a smaller sample of adults diagnosed with ADHD (Study 5). The effect of WBV treatment on attention was measured directly after a short WBV interval of two minutes within subjects. In addition, a case study (Study 6) demonstrated prolonged beneficial effects of WBV treatment (amplitude = 4 mm, frequency = 30 Hz) on various measures of cognition in an adult man diagnosed with ADHD. WBV treatment was applied on 10 consecutive days and resulted in an improved neuropsychological test performance on the day following completion of the treatment (compared to the baseline performance measured on the day prior to the start of the 10-day WBV treatment interval). Improvements of various measures were observed, including vigilance, divided attention, flexibility, inhibition, divergent thinking (verbal fluency) as well as in self-rated impairments of attention. However, the improvements were observed only temporarily as a follow-up neuropsychological assessment (14 days following completion of WBV treatment) revealed that cognitive performance mostly fell back to its baseline level.
Taken together, the group study on acute effects of WBV treatment on attention in healthy individuals and individuals with ADHD (Study 5) as well as the case study of prolonged effects of WBV treatment on various neuropsychological functions (Study 6) emphasize the clinical value of WBV as a novel strategy in the treatment of neuropsychological functions of patients with ADHD. WBV is easy to apply, cost effective, does not interfere with other interventions (such as pharmacological treatment) and can be set up in private or institutional settings (e.g. at home, in school or at work). Only short periods of WBV treatment per day might be sufficient to cause clinically relevant effects which can be assumed to result in a high compliance rate as this approach requires only little individual effort (e.g. in form of active exercise). Furthermore, no detrimental side effects are currently known by the application of passive WBV as it was also shown by own pilot work on a large number of participants (n > 200).

In order to establish WBV treatment as an intervention strategy for patients with ADHD, further group studies are needed providing prove of prolonged, long lasting effects of WBV treatment on cognitive functions. These studies should examine which functions are most sensitive to WBV treatment, i.e. by considering several aspects of attention and executive control which are crucial for daily functioning and which have been found to be impaired in adults with ADHD (Boonstra et al., 2005; Schoechlin & Engel, 2005; L. Tucha et al., 2008; L. Tucha et al., 2011). The validity and the clinical significance of effects of WBV treatment on cognition would be supported by showing associations with external criteria such as changes in social, educational or occupational functioning following WBV treatment. In addition, the underlying mechanism of WBV induced cognitive enhancement should be subject of future research. Several hypothesis have been proposed, including an enhanced muscle activity resulting in increased oxygen uptake and heart rate (Cardinale & Bosco, 2003), sensory stimulation in cortical brain areas and increased activity of the cholinergic as well as dopaminergic neurotransmitter system as found in studies of WBV treatment in mice (Keijser et al., 2011; Lahr et al., 2009; Timmer, Van der Zee, & Riedel, 2006; Van der Zee et al., 2010). However, most of the proposed mechanisms remain speculative as empirical prove in humans is still missing.

Public Perceptions and Beliefs about Adult ADHD: Stigmatization

The level of functioning of a person with ADHD is not only determined by the individual’s abilities and impairments which were in the focus of Study 1 to Study 6, but it is also affected by the attitudes of the general public about the disorder and associated impairments. Discrediting stereotypes (stigmatization) of the public towards individuals with ADHD were shown to be more pronounced than stigma towards physical impairments, which was explained by the stronger association between mental
illness and uncontrollability and norm-violating behavior in the general public (Weiner, Perry, & Magnusson, 1988). As presented in the review of the literature of stigma in ADHD (Study 7), it has been revealed that in particular externalizing and norm-violating behaviors of persons with ADHD can lead to discrimination, isolation and social rejection. Stigmatization can have adverse consequences for the individual, leading to diminished self-esteem, self-efficacious beliefs and ultimately a reduced quality of life (Canu, Newman, Morrow, & Pope, 2008; Kellison, Bussing, Bell, & Garvan, 2010; Martin, Pescosolido, Olafsdottir, & McLeod, 2007; Pescosolido et al., 2008). Furthermore, it has been shown that stigmatization of pharmacological treatment (e.g. being blamed for loss of control and dependence after adhering to medication) can lead to noncompliance as individuals with ADHD try to avoid the labeling by rejecting treatment and ignoring their symptoms (Burch, 2004; Stine, 1994).

Considering the risk of individuals with ADHD to be stigmatized, the lack of knowledge about stigmatizing beliefs and the lack of disease specific assessment tools for the measurement of stigmatization towards adults with ADHD is surprising. The available measures which have been applied in previous research primarily focus on children or do not distinguish between children, adolescents and adults with ADHD. Moreover, most of the measures have not been specifically developed to measure stigmatization in ADHD but represent general assessment tools to measure stigmatization towards mental disorders (Berger, Ferrans, & Lashley, 2001; Kellison et al., 2010). Therefore, a questionnaire specifically measuring stigmatizing beliefs towards adults with ADHD was developed (Study 8). A large number of participants (n > 1000) indicated their affirmation to a set of stigmatizing statements (64 items) on which psychometric properties were investigated by means of exploratory and confirmatory factor analyses, resulting in a 6-factor structure containing 37 items in total. New dimensions of stigmatization were proposed, including Reliability and Social Functioning, Malingering and Misuse of Medication, Ability to Take Responsibility, Norm-violating and Externalizing Behavior, Consequences of Diagnostic Disclosure and Etiology. In a subsequent study (Study 9), this newly developed questionnaire was applied on teachers and comparison participants, as teachers’ attitudes on adults with ADHD represent a meaningful source to evaluate current beliefs and behavioral tendencies towards adults with ADHD in the educational setting. Overall level of stigmatization was found to be low to moderate in both teachers and comparison participants. Comparing teachers with comparison participants, teachers showed significantly less stigmatizing attitudes in various dimensions, including Reliability and Social Functioning and Malingering and Misuse of Medication, demonstrating a more sensitized attitude of teachers towards ADHD in adulthood. Furthermore, with regard to teachers, frequency of contact with adults with ADHD was not related to stigma, however, knowledge about the disorder was negatively correlated with stigma,
indicating lower expressed stigma with increasing knowledge about adult ADHD. Therefore, special education programs may have the potential to reduce stigmatization towards adults with ADHD. Teachers could be specifically informed by offering additional training courses, providing special education programs, seminars, and workshops or by providing relevant information via flyers, brochures or special online platforms which are certified for their contents. Particular emphasis should be given on information about the etiology of ADHD, since it has been repeatedly pointed out that knowledge about the etiology of the disorder might reduce stigmatization (Burch, 2004; Kendall, 1998). However, surveys in general are often questioned with regard to their ecological validity since the impact of attitudes on actual behavior is not fully explained. Therefore, the external validity of the questionnaire on stigmatization of adults with ADHD would benefit from showing associations between questionnaire responses and data of actual behavior towards adults with ADHD as measured with more realistic approaches (such as videos or observations). The consequences of stigmatizing attitudes of the general public (public stigma) on actual behavior towards individuals with ADHD, and the consequences of stigmatizing attitudes held by individuals with ADHD themselves (self-stigma) represent a crucial challenge to be explored in future research.

Conclusion
Neuropsychological research has revealed impairments of adults with ADHD in various cognitive domains. Two studies of the present thesis (Study 1 and Study 2) clearly demonstrated that executive dysfunctions of adults with ADHD also adversely affect memory processes resulting in impairments of encoding, source discrimination as well as prospective memory. In order to address underlying mechanisms and determining factors of cognitive dysfunctions in ADHD, we performed further research beyond the scope of the present thesis in spontaneously hypertensive rats (SHR), an established animal model of ADHD (Sontag et al., 2013). In this study, we found motor activity of the SHR to substantially predict performance in working memory and spatial reference memory. Therefore, with regard to humans, motor symptoms can be hypothesized to be linked to cognitive symptoms in individuals with ADHD. Support for this hypothesis was provided by studies showing differences in cognitive performance between individuals of different subtypes of ADHD, i.e. depending on whether criteria for only inattention were fulfilled (inattentive subtype) or whether criteria for both inattention and hyperactivity/impulsivity were fulfilled (combined subtype) (Dinn, Robbins, & Harris, 2001; L. Tucha et al., 2008). With regard to a profile of cognitive functioning in adults with ADHD, a large body of research has failed to show a characteristic pattern of cognitive impairments in individuals with ADHD (Lange, Beck, Tucha, & Tucha, 2010). Instead, individuals with ADHD have unique profiles of neuropsychological functioning, with
some patients showing impairments in one function while other patients displaying impairments in another function (Thome et al., 2012). On a group level, however, individuals with ADHD may reliably differ from typically developed individuals as it was revealed in a large number of studies measuring a range of cognitive functions of individuals with ADHD (Hervey et al., 2004; Schoechlin & Engel, 2005). For this reason, a neuropsychological evaluation of individuals with ADHD should involve a comprehensive assessment consisting of multiple tests measuring various aspects of cognition. In order to provide such as an assessment tool, we compiled a test battery for clinical application (Cognitive Functions ADHD – CFADHD) (L. Tucha, Fuermaier, Aschenbrenner, & Tucha, 2013) which consists of tests which have been shown to be sensitive in determining cognitive impairments often observed in adults with ADHD (L. Tucha et al., 2013). This test battery CFADHD does not only refer to objective neuropsychological test procedures but also takes subjective self-reports of cognitive functioning into consideration, since the present thesis clearly highlights that the information gained from the two approaches are not interchangeable but provide both important and non-redundant implications for clinical practice (Study 3 and Study 4).

Furthermore, considerable cognitive impairments of adults with ADHD as assessed in this thesis with subjective and objective measures emphasize the need for treatment interventions. In this respect, the present thesis presented promising beneficial effects of WBV treatment on cognitive functions of adults with ADHD (Study 5 and Study 6). The need and the high relevance of novel treatment strategies are underlined by the limitations which are associated with current treatments. WBV treatment might represent such a novel approach as it is associated with several advantages, e.g. it can be applied in combination with conventional effective treatments, is relatively cheap, is easily applicable, and appears to have an effect on those functions which were found to be reduced in individuals with ADHD.

Finally, by shifting the focus from the individual to the general public, the present thesis (Study 7) points out that the public’s stigmatizing attitudes towards ADHD can have substantial adverse consequences for the individual person with ADHD. With the development of the disease specific questionnaire which measures stigmatization towards adults with ADHD (Study 8), we proposed new dimensions of stigmatization which were shown to be sensitive in measuring differences between groups of different educational and occupational background (i.e. teachers and physicians) (Study 9). This disease specific measurement tool can be helpful in determining the level of stigmatization of various groups of people but also in evaluating the effectiveness of prevention and intervention methods of stigmatization towards adults with ADHD.
4. References


References


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5. Summary
The present thesis examined cognitive functioning of adults with ADHD from different angles by applying different methodologies. Four parts can be distinguished by their respective methodology and content, including (1) objective neuropsychological tests to study memory functions of adults with ADHD, (2) self-reports of patients with ADHD to study cognitive complaints and their relationship with objectively defined impairments, (3) Whole Body Vibration (WBV) to treat cognitive dysfunctions of adults with ADHD and (4) a survey approach to study public's attitudes and beliefs about ADHD.

In Study 1 and Study 2, it was argued that the widely accepted assumption of primary executive dysfunctions in adults with ADHD may also result in impaired memory functions of adults with ADHD. For this reason, two studies were performed demonstrating impairments of adults with ADHD in several components of memory, including encoding of information, source discrimination and prospective memory. The hypothesis of executive dysfunctions to cause memory impairments in adults with ADHD was supported by further analysis showing that impairments of prospective memory and source memory were primarily predicted by measures of executive functions but failed to be predicted by measures of retrospective memory. Furthermore, the high relevance of prospective memory and source memory as well as implications for clinical practice was emphasized in Study 1 and Study 2. For example, it was shown that prospective memory consists of four largely independent cognitive components. Adults with ADHD, however, display a considerable impairment in only one of those components, i.e. task planning of delayed intentions. Behavioral-based interventions should therefore focus on increasing organizational and planning skills of patients with ADHD in order to improve memory functioning in daily life.

Moreover, cognitive complaints of adults with ADHD were assessed by collecting comprehensive self-reports (Study 3 and Study 4). A subjective assessment (self-report) of cognitive functioning and its relationship with results obtained from an objective neuropsychological assessment receive particular significance considering the limitations which have been raised in previous research regarding the ecological validity of neuropsychological tests. The subjective assessment of cognitive functioning presented in Study 3 revealed large self-reported impairments of adults with ADHD in all cognitive domains, including attention, retrospective memory, prospective memory and executive functioning. The majority of adults with ADHD reported impairments in more than one cognitive domain, indicating that patients with ADHD experience a general cognitive inefficiency rather than complaints in specific cognitive functioning. In Study 4, the concordance between subjective and objective measures of cognition was explored, showing that impairments in the objective assessment could not be predicted by subjective self-reports and, likewise, impairments as determined in the subjective self-report could not be predicted by objectively defined cognitive impairments. It was concluded that both subjective and objective measures of cognition provide important
information for the clinical assessment of adults with ADHD. However, results obtained by both approaches are not interchangeable but may provide non-redundant information with distinct implications for clinical practice.

Subjective and objective measures of cognitive functions were also applied to explore the effects of WBV (a training method which exposes the whole body of an individual to vibration) on cognition (*Study 5* and *Study 6*). In previous research, WBV has been found to beneficially affect various physiological processes in humans and has also been shown to improve cognitive performance as well as neural activity in mice. The present thesis was the first to study effects of passive WBV (in which no physical exercise was required) on subsequent cognitive performance, showing acute beneficial effects of WBV treatment on attention (as measured directly after treatment intervention) in both healthy individuals and adults with ADHD (*Study 5*). In addition, a case study of an adult with ADHD revealed prolonged beneficial effects of WBV treatment on various measures of cognition on the day after completion of a longitudinal treatment period (*Study 6*). The clinical significance of the findings of WBV treatment on cognition was discussed, such as the potential relevance of WBV as a supplementary meaning in the treatment of ADHD.

In the fourth part of the thesis, the focus was shifted from the individual level to the general public in order to study public’s attitudes and beliefs about ADHD and associated consequences. In a review of the literature (*Study 7*) it was concluded that the impact of public’s discrediting stereotypes (stigmatization) on the individual person with ADHD is an underestimated factor which has been widely neglected in research for a long period of time. Compared to physical illness, mental disorders such as ADHD were assumed to be at higher risk of being stigmatized, which was explained by a stronger association between mental disorders and uncontrollability in the public. More specifically, it was shown that high associations between ADHD on the one side and both externalizing and norm-violating behaviors on the other side can lead to discrimination, isolation and social rejection. However, since there has been a lack of knowledge about the content of stigmatizing beliefs, a questionnaire specifically measuring stigmatization towards adults with ADHD was developed (*Study 8*). Six dimensions of stigmatization towards adults with ADHD were proposed according to psychometric analysis. Furthermore, the sensitivity of these dimensions was explored in a subsequent study on a sample of teachers and comparison participants (*Study 9*). In addition, based on previous findings as well as on additional analyses of the present data, it was suggested that special education programs informing the general public about ADHD may have the potential to reduce stigmatization towards adults with ADHD.

Finally, a concluding discussion of the studies presented in this thesis was provided by highlighting major implications for clinical practice as well as clinical research and by pointing to future directions.
6. Dutch summary
De huidige thesis richt zich op het cognitieve functioneren van volwassenen met ADHD en onderzoekt deze vanuit verschillende perspectieven door verschillende methoden toe te passen. Vier delen kunnen worden onderscheiden op basis van hun respectievelijke methode en inhoud, namelijk (1) objectief neuropsychologisch onderzoek naar geheugenfuncties van volwassenen met ADHD, (2) zelfrapportages van patiënten met ADHD die zijn gebruikt om cognitieve klachten te inventariseren en de relatie met objectief bepaalde beperkingen vast te stellen, (3) Whole Body Vibration (WBV) die is gebruikt om cognitieve dysfuncties van volwassenen met ADHD te behandelen en (4) een vragenlijst benadering die is gebruikt om overtuigingen en attitudes van de bevolking ten opzichte van ADHD te bepalen.

In *Studie 1* en *Studie 2* werd beargumenteerd dat de primaire executieve dysfuncties van volwassenen met ADHD ook zouden kunnen resulteren in geheugenbeperkingen. Om dit te onderzoeken werden twee studies uitgevoerd die aantoonden dat volwassenen met ADHD beperkingen laten zien in verschillende componenten van het geheugen, zoals het inprenten van informatie, het discrimineren van bronnen van informatie en het prospectief geheugen. De hypothese dat executieve dysfuncties ten grondslag liggen aan de geheugenbeperkingen van volwassenen met ADHD werd ondersteund door verdere analyses die aantoonden dat beperkingen in het prospectief geheugen en het geheugen voor bronnen primair werden voorspeld door prestaties op executieve functietests en niet door prestaties op retrospectieve geheugentests. De relevantie van het prospectieve geheugen en het geheugen voor bronnen voor de klinische praktijk werd benadrukt in *Studie 1* en *Studie 2*. Zo werd bijvoorbeeld aangetoond dat het prospectieve geheugen bestaat uit vier grotendeels onafhankelijke cognitieve componenten. Volwassenen met ADHD lieten echter slechts een beperking zien in één van deze componenten, namelijk bij het plannen van taken die in de toekomst moeten worden uitgevoerd. Gedragsinterventies zouden zich daarom moeten richten op het verbeteren van organisatorische en planningsvaardigheden van patiënten met ADHD zodat hun geheugenfuncties in het dagelijks leven kunnen worden verbeterd.

De cognitieve klachten van volwassenen met ADHD werden in kaart gebracht door uitgebreide zelfrapportages te verzamelen (*Studie 3* en *Studie 4*). Gezien de in eerdere studies gerapporteerde gebrekkige ecologische validiteit van neuropsychologische tests is het erg van belang om een subjectieve assessment (zelfrapportage) van het cognitieve functioneren uit te voeren en de relatie tussen de subjectieve assessment en de prestaties die zijn behaald tijdens een objectieve neuropsychologische assessment te bepalen. De subjectieve assessment van het cognitieve functioneren, die wordt gepresenteerd in *Studie 3*, liet zien dat volwassenen met ADHD beperkingen rapporteren in alle cognitieve domeinen, zoals aandacht, retrospectief geheugen, prospectief geheugen en executief functioneren. De meerderheid van de volwassenen met ADHD rapporteert...
beperkingen in meer dan één cognitief domein. Dit suggereert dat patiënten met ADHD een algemene cognitieve inefficiëntie ervaren in plaats van beperkingen in één specifiek cognitief domein. In Studie 4 werd de overeenstemming tussen subjectieve en objectieve assessments van het cognitieve functioneren bepaald. De resultaten toonden aan dat de beperkingen die werden aangetoond met objectieve assessments niet konden worden voorspeld door subjectieve zelfrapportages en dat subjectieve zelfrapportages niet konden worden voorspeld door objectief bepaalde cognitieve beperkingen. Op basis hiervan werd geconcludeerd dat zowel subjectieve als objectieve assessments van het cognitieve functioneren belangrijke informatie oplevert voor de klinische assessment van volwassenen met ADHD. De resultaten die werden verzameld met beide benaderingen kunnen echter niet worden uitgewisseld. In plaats daarvan leveren beide benaderingen niet-redundante informatie op en hebben ze beide hun eigen implicaties voor de klinische praktijk.

Subjectieve en objectieve assessments van het cognitieve functioneren werden ook gebruikt om de effecten van WBV (een trainingssmethode die het volledige lichaam van een individu bloosttelt aan vibratie) op het cognitieve functioneren te exploreren (Studie 5 en Studie 6). In eerder onderzoek werd aangetoond dat WBV een positieve invloed heeft op uiteenlopende fysiologische processen bij mensen en op het cognitieve functioneren en de neurale activiteit bij muizen. In de huidige thesis worden voor het eerst de effecten van passieve WBV (waarbij geen fysieke activiteit noodzakelijk is) op het cognitieve functioneren beschreven en werden acute positieve effecten van de behandeling met WBV op aandacht (zoals gemeten direct na de behandeling) aangetoond bij zowel gezonde individuen als bij volwassenen met ADHD (Studie 5). Daarnaast liet een case studie bij een volwassene met ADHD langdurige positieve effecten van behandeling met WBV zien op verschillende cognitieve maten op de dag na de voltooiing van een langdurige behandelperiode (Studie 6). De klinische significante van de behandeling met WBV op het cognitieve functioneren werd besproken. Zo werd bijvoorbeeld aangegeven dat WBV een potentiële relevante aanvulling is op de reguliere behandeling van ADHD.

In het vierde deel van deze thesis verschuift de focus van het individuele niveau naar de algemene bevolking om de overtuigingen en attitudes van de bevolking ten opzichte van ADHD en de hieraan gerelateerde consequenties te bepalen. Op basis van een review van de literatuur (Studie 7) werd geconcludeerd dat de impact van discrediterende stereotypen (stigmatisering) op een individu met ADHD een factor is die wordt onderschat en die lange tijd over het hoofd is gezien. In vergelijking met fysieke aandoeningen lijken mentale aandoeningen zoals ADHD een hoger risico op stigmatisering te hebben. Dit wordt verklaard door een sterke associatie tussen mentale aandoeningen en een zekere mate van oncontroleerbaarheid wanneer deze individuen zich in het openbaar bewegen. In dit kader werd specifiek aangetoond dat sterke associaties tussen ADHD enerzijds

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en zowel externaliseren als normschendend gedrag anderzijds kunnen leiden tot discriminatie, isolatie en sociale afwijzing. Echter, aangezien er een gebrek aan kennis is over de inhoud van stigmatiserende overtuigingen werd een vragenlijst gericht op het meten van stigmatisering van volwassenen met ADHD ontwikkeld (Studie 8). Zes dimensies van stigmatisering van volwassenen met ADHD werden voorgesteld op basis van een psychometrische analyse. De sensitiviteit van deze dimensies werd vastgesteld in een vervolgstudie in een groep onderwijzers en controleproefpersonen (Studie 9). Op basis van zowel eerdere bevindingen als op de basis van aanvullende analyses van de huidige data werd gesuggereerd dat speciale onderwijsprogramma’s die de algemene bevolking informeren over ADHD de potentie kunnen hebben om stigmatisering van volwassenen met ADHD te reduceren.

Tot slot werden in een concluserende discussie de studies die zijn beschreven in deze thesis besproken door de belangrijkste implicaties voor zowel de klinische praktijk als voor klinisch onderzoek te benadrukken. Ook werden suggesties voor de toekomst gegeven.
7. Publications
PUBLICATIONS

2012


2013


2014


Under review

**Fuermaier, A.B.M., Tucha, L., Koerts, J., Hauser, J., Kaunzinger, I., Aschenbrenner, S., Weisbrod, M., Lange, K.W. & Tucha, O.** *(resubmitted).* Cognitive impairment in adult ADHD - Perspective matters!


Tucha, L., **Fuermaier, A.B.M., Koerts, J., Groen, Y. & Thome, J.* *(under review).* Detection of feigned attention deficit hyperactivity disorder.


258 | Publications

**Published abstracts**


8. Curriculum vitae
Name: Anselm Bernhard Maria Fuermaier

Date of birth: 25th April 1985

Place of birth: Munich, Germany

Education

1991 - 2004 School Education in Prien am Chiemsee, Germany
2004 - 2010 University of Regensburg, Germany
Department of Experimental Psychology
2006 - 2007 Keele University, Staffordshire, UK
ERASMUS exchange
2010 - 2014 University of Groningen, the Netherlands
Department of Clinical and Developmental Neuropsychology

Academic degrees

2006 B.Sc. in Psychology (with distinction)
University of Regensburg, Germany
2010 M.Sc. in Psychology (with distinction)
University of Regensburg, Germany
2010 - 2014 Ph.D. candidate
Department of Clinical and Developmental Neuropsychology
University of Groningen, the Netherlands

Research interest

Cognitive functioning of adults with ADHD, neuropsychological assessment and treatment, stigmatization of mental disorders

Memberships in professional associations

World Federation of ADHD

Advanced Neuropsychological Diagnostics Infrastructure (ANDI)
Presentations on conferences, symposia and research meetings

2013
4th World Congress on ADHD, Milan, Italy.
15th International Congress of the Society for European Child and Adolescent Psychiatry (ESCAP), Dublin, Ireland.
Presentations in the research meeting of the Department of Clinical and Developmental Neuropsychology, University of Groningen, the Netherlands.

2012
2nd International ADHD Conference (Eunethydis), Barcelona, Spain.
Research meeting of the psychiatry Karlsbad-Langensteinbach, University of Heidelberg, Germany.
27. Jahrestagung der Gesellschaft für Neuropsychologie (GNP), Marburg, Germany.
Research meeting of the Department of Clinical and Developmental Neuropsychology, University of Groningen, the Netherlands.
Research meeting of the School of Behavioral and Cognitive Neuroscience (BCN), University Hospital Groningen, the Netherlands.

2011
The 3rd International Congress on ADHD, Berlin, Germany.
Research meeting of the Department of Childhood and Adolescent Psychiatry, University Medical Hospital Groningen, the Netherlands.
Research meeting of the Department of Clinical and Developmental Neuropsychology, University of Groningen, the Netherlands.

2010
1st International ADHD Conference (Eunethydis), Amsterdam, the Netherlands.
9. Acknowledgments
In February 2010, I completed my studies and received my master's diploma in Regensburg. Even though living in Germany was great, and a fantastic place to grow up, I had been thinking for a while about applying for a position at a university abroad so I could spend some time outside my own country. I was therefore very happy, honored, and curious to be offered the opportunity to do my PhD at the RUG in the Netherlands, a country I had almost exclusively only ever known from television broadcasts of football world championships (at least the first part of those). I, obviously, accepted and the past four years have been a very eventful, intense and happy time in Groningen. Even though there were certainly events and circumstances which were hard to cope with, the experience overall was more than worth it. Looking back at the past four years, there are many people I would like to thank for their support.

My first contact, and also one of the primary reasons that I joined the RUG, was Oliver Tucha and soon after Lara Tucha, and our friendship has only got stronger and closer during the last four years. There are many things I could mention and that I would like to thank both Oliver and Lara for, but it would double the size of this thesis. So, I would like to point out three characteristics that you both possess, Oliver and Lara, that I appreciate the most: First, I admire the enthusiasm with which you engage in projects. Your positive attitude and passion for work infected me immediately and is still largely responsible for the pleasure I experience when working together with you. Second, the way you both treat people and how caring and reliable you both are, is a positive characteristic that is rarely seen and deserves to be praised and lauded. I really appreciate how personally responsible you feel for your colleagues and friends no matter who it is that is requiring support. Third, your outlook on the workplace as a social environment is something that is not only great, but also an outlook that I want to emulate and take with me in the future wherever I go. At the end of the day, we work better if we enjoy what we do, with people we like, in a group we care about. Oli, Lara, I deeply appreciate the time we had together in Groningen, and I am absolutely convinced that there are still many chapters we will write together in the future!

I am also very happy and lucky that I got to collaborate together with many esteemed people within and outside our department at the RUG. Specifically, I would like to point out Janneke Koerts, my co-supervisor, who was always available for support and advice, and who was very helpful in working out the daily problems that one is faced with in the first months after moving to a foreign country. I would also like to thank Yvonne Groen and Jolanda Polling-Oosterloo, who were always a pleasure to work with and helped me in many ways. Thank you very much!
The success of my projects and the satisfaction I experienced working on them was also greatly determined by fruitful collaborations with working groups outside the department, with which I shared, and still share, many mutual interests and goals. As such, I would like to thank the group of Matthias Weisbrod in Karlsbad-Langensteinbach for the very fruitful and stimulating collaboration we have. Working together with you and your co-workers, in particular Steffen Aschenbrenner and Annett Bergt, was always a pleasure. I would also like to thank Klaus Lange and Ivo Kaunzinger from Regensburg for their effort and support over the last four years. They kept an eye on my PhD project right from the beginning, never lost contact with me, and I always felt welcome to return home to Regensburg to catch up with them and former colleagues. I would also like to thank Eddy van der Zee, who immediately showed interest and took the initiative to start a common research project when we first got in contact in the early phase of my PhD project. My thanks also to André Aleman and Johannes Thome, who were members of the reading committee and whose thoughts, comments and feedback I very much appreciated!

Furthermore, in addition to acknowledging the personal contact and support I received, I would like to share some of my thoughts of how I experienced the Dutch academic system at the RUG. I am truly impressed by how young people who are starting an academic career are stimulated and promoted by Dutch universities, in general, and the RUG in particular. I am sure the conditions of a PhD at the RUG are perfectly tailored to provide students great opportunities to acquire research skills that are essential and valuable for starting an academic career anywhere else in the world. Over the last four years I was presented with the opportunity to carry out interdisciplinary and international research projects and the freedom to follow my own interests and ideas. I also strongly appreciated the specified training that my graduate school Behavioral and Cognitive Neuroscience (BCN) provided to me during my PhD. Furthermore, I gained valuable experience in teaching students, I was supported to participate in teaching training for higher education, and I got the opportunity to regularly attend and contribute to international conferences led by esteemed and international recognized experts in the field. So, I have to thank the RUG for letting me be part of this exceptional program!

Of course I also like to thank my family and friends for their support, and for being there for me. Although I have spent the last years in a country about a thousand kilometers north of my home, my family was always enthusiastic about taking part in my life, visiting me, getting to know people I have met while in Groningen and to share experiences with me. So, thank you to my mother, my father, my sister Hannah, her partner Martin and their sweet little daughter, my godchild, Mathilda, my brother
Peter, his partner Paula, and my honored and caring grandparents, Oma and Opa, to whom I feel deeply attached. I am also happy to have managed to keep a close bond to my friends from home, Christoph Bauer and Benedikt Reiter, with whom I have had, and continue to have, a close friendship over the last decades, no matter where we were and what we were doing. Also, during the time when I was a student in Regensburg I met Sebastian Raba and Ina Dobler, with whom I am still very good friends. Over the last years in Groningen, new people entered my life, such as my fellow PhD students who played an important role for me over the last years, Felix Schirmann with whom I spent amazingly good times, and Stefanie de Vries, a person I care about and who brought Dutch culture closer to me. To all of my other friends and colleagues that I did not mention specifically here, please forgive me for not mentioning you by name and thank so much you for this special and pleasant time together!

Also, a special thank you to Herbert for your passionate support designing the cover and layout of this thesis! You have a talent that I greatly admire and it was a pleasure working together with you!

Finally, to my Paranymphs, Peter and Felix, thanks for doing this you are truly born for it!