Hovedoppgave

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Fakultet for samfunns- og utdanningsvitenskap
Institutt for psykologi

Marie Therese Aspevik

Executive functions in patients with substance use disorder; from the beginning of treatment to three months recovery

A prospective pilot study on the role of executive dysfunction in addiction

Hovedoppgave i Profesjonsstudiet i psykologi
Veileder: Siri Weider
Medveileder: Mats Peder Mosti
August 2022

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Preface

I would like to sincerely thank my supervisors Mats Peder Mosti and Siri Weider for much needed guidance in the process of writing this thesis. The work on this project has been educational and inspiring, and at times challenging. Since the beginning of working on this thesis, I have gained a new appreciation for the difficulties individuals with addiction face when trying to reach their goals.

Last, but not least I would like to thank the participants who, with their participation, made this project possible.

Abstract

Background: Behavioral change is effortful and requires the ability to follow long-term goals, to inhibit impulses and to adapt to changes in the environment. These are high-level executive processes that are often impaired in individuals with substance use disorder. Prior research shows that patients often have impaired executive functions upon treatment initiation, but results are less conclusive regarding the potential for recovery (Schulte et al., 2014). The main purpose of the present thesis was to investigate whether patients who completed a three-month inpatient treatment program experienced changes in executive functions. Patient characteristics such as age and type of substance use were examined as these are factors that may further inform how treatment can be adjusted to fit the individual needs of patients. **Method**: Self-reported executive functions were assessed using the Behavior Rating Inventory of Executive Function-Adult Version (BRIEF-A). The questionnaire was administered at treatment initiation and at treatment completion to assess changes in all BRIEF-A subscales in the patient sample (N=22). **Results**: Patients manifested heightened levels of executive dysfunction upon initiation of SUD treatment. This was especially true for the polydrug group, which experienced significantly higher scores of dysfunctions compared to the monodrug group. However, only five of the subscales showed statistically significant changes in scores from treatment initiation to treatment conclusion. This includes the Global Executive Composite Index, the Metacognition Index, and the subscales of Inhibition, Self-Monitoring and Plan/Organization. Some dysfunction appears to persist in the polydrug group despite in-patient treatment at three months, however all scale scores for this group were reduced to non-clinical levels of dysfunction. **Conclusion**: The findings indicate that executive functions are improved following treatment completion. However, despite showing overall reductions in executive dysfunction, many respondents continued to manifest somewhat elevated scores on the BRIEF-A compared to norm levels. This points to the importance of considering cognitive function when adjusting treatment to the specific needs of the patient.

Sammendrag

Bakgrunn: Atferdsendringer er krevende og forutsetter at man er i stand til å følge mål, inhibere impulser samt tilpasse seg til endringer i omgivelsene. Dette er høyere nivå eksekutive prosesser som ofte er svekket hos pasienter med ruslidelser. Tidligere forskning viser at pasienter ofte har reduserte eksekutive funksjoner ved oppstart av behandling, men det er større usikkerhet knyttet til mulighetene for bedring etter behandling (Schulte et al., 2014). Målet med denne studien var å undersøke om pasienter som fullfører en tremåneders døgnbehandling for ruslidelse opplever bedring i eksekutive funksjoner. Betydningen av alder og type rusbruk ble også undersøkt da dette er egenskaper som kan belyse hvordan behandling kan tilpasses pasienters individuelle behov. **Metode**: Selv-rapporterte eksekutive funksjoner ble undersøkt ved hjelp av spørreskjemaet Behavior Rating Inventory of Executive Function-Adult Version (BRIEF-A). Skjemaet ble administrert ved behandlingsstart- og slutt for å undersøke endringer i samtlige tolv BRIEF-A delskalaer i pasientutvalget (N=22). **Resultater**: Pasientene utviste forhøyete skårer for eksekutiv dysfunksjon ved behandlingsstart. Dette gjaldt særlig for deltakerne med blandingsmisbruk, som hadde signifikant høyere dysfunksjon sammenliknet med deltakerne med monobruk. Det var derimot bare fem av tolv delskalaer på BRIEF-A som viste statistisk signifikante endringer fra behandlingsstart til behandlingsslutt. Dette gjaldt indeksene for Generell Eksekutiv Funksjon og Metakognisjon, samt subskalaene Inhibisjon, Selvmonitorering og Planlegging/Organisering. Gruppen med blandingsmisbruk hadde fortsatt noe forhøyede skårer for dysfunksjon etter behandlingsslutt, men under grensen for klinisk dysfunksjon. **Konklusjon**: Resultatene viste bedringer i eksekutiv dysfunksjon etter tre måneders døgnbehandling for ruslidelse. Til tross for at samtlige delskalaer viste forbedringer i dysfunksjon, fortsatte mange deltakere å utvise forhøyede nivåer dysfunksjon sammenliknet med normnivå. Dette understreker viktigheten av vurderinger av kognitiv funksjon i behandling, da dette vil kunne bidra til å tilpasse behandlingen til pasienters individuelle behov.

Contents

Introduction

Substance use is common and is often driven by positive motives such as curiosity and exploration, excitement seeking, and social community. Most people who regularly use substances do not develop substance use problems. For some individuals however, the continued use of substances increases the risk of developing a disorder. Substance use disorder (SUD) is widespread in the population today and the number of individuals afflicted is predicted to increase worldwide (Whiteford et al., 2013). It is one of the most important risk factors associated with premature death in Norway (Kassebaum et al., 2016), with a higher mortality rate compared to the rest of the population (Degenhardt et al., 2013; Heiberg et al., 2018; Lindblad et al., 2016). Many individuals in need of treatment are also unemployed, and struggle to make a reliable income (Christiansen & Moan, 2022). The development of addiction therefore comes at a great personal cost to those afflicted.

The disorder is characterized by increased motivations to seek drugs and loss of control over drug use (George & Koob, 2010). Reducing substance use is therefore difficult for many individuals since they typically experience intense urges to use. Treatment itself is also highly effortful, demanding that the patient is capable of planning ahead, displaying self-control and following the steps of long-term treatment plans. As a result, substance use treatment is associated with frequent relapses to substance use and it is not uncommon for patients to drop out of treatment (Andersson et al., 2019; Lappan et al., 2020). For this reason, it is important to identify factors that can improve the chances of successful recovery.

Deficits in cognitive function is today viewed as a hallmark feature of SUD, affecting many patients with the disorder (Ramey & Regier, 2019). In recent years there has been an increased interest in studying the role of the executive functions (EFs) in particular, since deficits in these functions have been associated with poor clinical outcomes (Bates et al., 2006; Czapla et al., 2016; Domínguez-Salas et al., 2016; Goncalves et al., 2017). EFs are higher order cognitive processes involved in the control of behavior, including the ability to work toward goals, to inhibit impulses and to adapt to changes in the environment (Diamond, 2013). Impaired EFs may affect the individuals' ability to recover since treatment requires significant cognitive resources. However, since cognitive assessments in treatment are rare in Norway today (Vaskinn & Egeland, 2012), there is a possibility that impairments in cognition largely go unnoticed in this population. An examination of individual differences in EFs may thus be important since a mismatch between the patients' EFs and the demands in treatment can increase the risk of ineffective treatment. A better understanding of which cognitive deficits are found in SUD and which may recover, is therefore of clinical importance.

A neuroscientific framework

There exists today a multitude of different perspectives on the concept of SUD. Different models and theories focus on various aspects of the disorder, such as self-regulation, self-medication, neurobiology, socioenvironmental factors, and more (Miller, 2013; Ross et al., 2010; West & Brown, 2013). According to a prominent perspective today, SUD is regarded as a chronic, relapsing brain disease (Koob & Volkow, 2010), which has been the dominant neuroscientific paradigm for addiction research in recent years. This perspective maintains that the most central characteristics of SUD are disruptions in specific brain regions as a function of long-term substance use. While the initial choice of taking drugs is voluntary for most people, repeated drug use cause changes in brain function that decrease the individuals' capacity for self-control. Once present, these changes cause disruptions in cognition that may be persistent and long-term. According to another perspective, individuals are rational actors capable of self-control (Henden et al., 2013), and as a result are able to make decisions regardless of changes in brain function. Some have therefore proposed that addiction does not stop the individual from making decisions, however weakens their ability to make good and stabile decisions over time (Heyman, 2013). Disruptions in brain regions may as such affect the individuals' ability to make choices, however not to the extent that the individual is determined by these neurobiological changes.

The differences in perspectives on SUD have implications for the view on recovery. According to the brain disease model, it takes time for the brain to return to a normal state and complete recovery of these functions may not be possible for all individuals (Volkow et al., 2016). This is described as an important explanation for the difficulties individuals experience in reducing substance use in the long-term, despite motivations to stop. Changes in brain physiology may therefore be persistent, implying the need for long-term treatment and close follow-up. A criticism of the brain disease model is that it does not account for the great heterogeneity in outcomes for individuals with SUD, since many recover and remain abstinent through a variety of different ways, and after years of persistent use (Cunningham & McCambridge, 2012).

Even though there are differences in perspectives on the differential outcomes in individuals with SUD, this does not exclude the possibility that for some substances and for some individuals, the persistent use of substances is accompanied by persistent changes in cognition (Cunningham & McCambridge, 2012). There is general consensus today that altered brain structure and function underpins addictive disorders, and that these changes have neuropsychological consequences for the individual (Goldstein & Volkow, 2002; Yücel et al.,

2019). Examinations of the neuropsychological changes that accompanies the development and treatment of SUD is thus a valuable framework for understanding how to improve the chances of successful recovery for patients receiving treatment. Prior research shows that patients who drop out of treatment have higher levels of cognitive impairments compared to those who complete treatment (Sømhovd et al., 2019), and cognitive deficits have been listed as one of the most important risk factors for drop out (Brorson et al., 2013). For those who remain in treatment however, results show that improvements in cognition are possible and associated with positive treatment response and long-term abstinence (Bates et al., 2013). Examinations of the course of cognitive functions throughout treatment may therefore contribute to increased knowledge on the factors important for recovery.

The clinical diagnosis of SUD

Individuals with SUD exhibit a great variety of symptoms, which is reflected in the many criteria for the disorder in the current diagnostic manuals. SUD is defined in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as the continued use of one or several substances over time despite negative effects for the individual (American Psychiatric Association, 2013). The symptoms are categorized according to four main categories, including social impairment, hazardous use, impaired control, and increased physical dependence. The International Classification of Diseases (ICD-10) (World Health Organization, 1992) follow a similar set of criteria where at least three symptoms must be present simultaneously during a one-year period. The symptoms include a) the development of tolerance symptoms; b) abstinence symptoms upon substance reduction; c) a strong desire to consume substances; d) uncontrolled substance use; e) the neglect of activities in favor of substance use, and finally; f) continued use despite negative consequences. Since patients only need to fulfil some, and not all, of the listed symptoms to qualify for a diagnosis, there are great individual differences in symptoms in the SUD population.

Individuals also vary according to which substance they are addicted to. The most common SUD in Norway is related to alcohol use, with approximately 8% of men and 3% of women being diagnosed with this disorder in a given year (Kringlen et al., 2001, 2006). Other SUDs are less common and prevalence estimates are uncertain. According to the Norwegian Institute for Alcohol and Drug Research it is estimated that between 8600 and 12 600 people in the population injected heroin or amphetamine in 2009 (Amundsen, 2009). In 2006, about 10% of Norwegians between 21 and 30 years of age reported having used amphetamine in their lifetime, 8% had used cocaine and crack, and 6% had used ecstasy (Vedøy & Skretting,

2009). The proportion with an actual addiction in this population is however not known. Even though the use of illicit drugs is less prevalent than alcohol use, these substances are often more potent and have more addictive effects with repeated use (Bonnet et al., 2020). While some individuals with SUD only use one preferred substance, individuals are often considered polydrug users, in which several substances are used interchangeably. The use of multiple drugs concurrently have been associated with more severe social and health consequences compared to monodrug use, in which there is only one preferred substance (McCabe et al., 2006).

The development of SUD

The development of SUD is defined by a multitude of factors that influence each other. In terms of the biopsychosocial model the disorder is characterized by biological, psychological and socio-environmental factors that affect each other in multifaceted ways (Engel, 1977; Marlatt et al., 1988). Some factors are prerequisites to developing a disorder, such as access to drugs and long-term use. Individuals with SUD often have been using substances over many years before addiction onset (Kraft, 2016). An important factor in development of the disorder are subsequently the physiological changes that occur after having used drugs over extended periods. The classes of drugs usually share the same underlying activation of the reward system. The levels of dopamine are increased in the brain, which heightens the rewarding aspects of drugs over other stimuli (Wise & Robble, 2020). Persistent use over time, however, causes a dysregulation of the brain's reward system. This leads to being less able to reduce or stop substance use due to the conditioned response to drugs and wanting to avoid the negative emotions associated with abstinence (George & Koob, 2010). The use of substances over time therefore affects physiology to the extent that it is increasingly difficult for the individual to resist using.

However, not all who use drugs develop a disorder, indicating that the development of SUD is also determined by individual risk factors. Meta-analyses of twin and adoption studies find that approximately half of all risk factors may be genetic in origin (Verhulst et al., 2015; Ystrom et al., 2014), suggesting that genes play a large role in the development of SUD. Some individuals are also vulnerable for addiction through a heightened sensitivity to the physiological effects of drugs (Kraft, 2016). Several epidemiological studies have also found that social stressors and lack of social support is associated with a risk of addiction (Barton et al., 2018; Calcaterra et al., 2014; Campbell-Sills et al., 2018; Valentine & Shipherd, 2018), including environmental influences such as having a history of being bullied,

and sexual and physical assault (Lauritzen et al., 2013; Lauritzen et al., 1997). Others may have underlying disorders which can dispose for addiction development. A Norwegian study found that 91 % of the patients with SUD included in the study had been diagnosed with more than one psychiatric disorder during their lifetime (Landheim et al., 2006). Subsequently, the development of SUD is complex, characterized by many different motivations and mechanisms for use.

Substance use treatment

SUDs are generally regarded as treatable. In Norway, treatment usually consist of multidisciplinary specialized services that include several different approaches to treatment. Treatment often involves interventions aimed at improving the ability to cope in everyday life. The focus is on changing behavior and developing skills to prevent relapse and promote psychosocial functioning (Malhotra et al., 2005). Even though SUD is regarded as a treatable condition, treatment of the disorder faces several challenges. A Norwegian study showed that 37 % of patients had relapsed within three months after in-patient treatment (Andersson et al., 2019). Relapse is often associated with dropout from treatment, which in a review was found to be approximately 30 % in psychosocial treatment studies (Lappan et al., 2020). Since relapse is so common, some researchers have conceptualized relapse as part of the recovery cycle rather than a failure of treatment (Prochaska et al., 1997). However, the difficulties in reducing substance use in the long term indicate that treatment is not as effective for all patients.

Treatment can be defined as a planned, goal-directed change process in which the goal is to reduce substance use (Diamond, 2013). These are skills that demand executive cognitive resources on behalf of the individual. There is therefore reason to believe that SUD patients may have difficulties with particular aspects of treatment, since the cognitive impairments that define the disorder are to the very functions that need to be engaged in treatment. A review found some evidence that limited executive resources may be associated with a reduced capacity to benefit from talk therapies through lowered treatment adherence (Domínguez-Salas et al., 2016). This is consistent with evidence showing the effectiveness of some treatment interventions that have a lower cognitive load (Carroll et al., 2008). The importance of avoiding a mismatch between the patients' cognitive function and the demands in treatment is therefore that the individual may not be able to benefit from therapy that is too cognitively demanding. Studies have documented that some restoration of functioning after abstinence and treatment is possible, both in the EFs and in general cognitive functioning (Dutra et al.,

2008; Korponay et al., 2017; Parvaz et al., 2017). This is important as improvements in cognition have been associated with treatment response and long-term abstinence (Bates et al., 2013). Improvements in cognitive function may therefore increase the chances of successful recovery in the long-term.

Executive functions

The concept of executive functions

There is today no universally agreed upon definition of EFs. It is considered a multidimensional concept, consisting of several basic components that make up many of the cognitive, emotional, and social skills important for managing everyday life (Lezak et al., 2012). Subsequently, the EFs do not have a unitary function, but are rather a constellation of different components that work together to guide goal-directed behavior (Botvinick et al., 2001; Miller & Cohen, 2001). An important function of the EFs is thus a top-down control and regulation of the individuals' behavior and emotions as they are expressed in everyday life.

According to an influential empirical model, there are three main EF components, including inhibitory control, working memory, and cognitive flexibility (Miyake et al., 2000). Inhibitory control involves the ability to control impulses, behavior, and attention rather than to rely on habit and environmental influences. This enables us to focus on plans and goals and to resist temptations. Working memory makes us capable of holding information in mind relevant for making decisions and evaluations, and cognitive flexibility involves the ability to adjust behavior according to changing environments and to shift mental mindsets (Diamond, 2013). Results from confirmatory factor analysis indicate that these functions are moderately correlated with each other (Miyake et al., 2000), confirming that while considered separate functions, they also share some underlying commonality. This supports the idea of EF components as sharing related functions in their expression in everyday life.

The neurobiological basis of EF

The EFs have originally been associated with the prefrontal cortex (PFC) of the brain. Lesion studies showed that patients with damage to the prefrontal areas were no longer able to organize their behavior in everyday life in meaningful ways (Luria, 2012). The PFC has a larger connectivity to various brain regions than any other cortical region, with connections to the occipital, parietal, and temporal lobes (Bonelli & Cummings, 2022; Royall et al., 2002).

The PFC is therefore regarded as an especially important region for top-down control of other brain regions.

Since the functioning of the EFs involve connections to multiple brain regions, the EFs are among the last functions to fully develop in the individual. The EFs evolve throughout childhood and adolescence, continuing into young adulthood (Hsu et al., 2014; Kolb et al., 2012). Since the EFs have a protracted development involving multiple areas of the brain, the EFs may be especially sensitive upon disruptions to the PFC (Lezak et al., 2012; Stuss, 2011; Stuss & Levine, 2002). Conditions or damages affecting the PFC during development may subsequently have harmful effects on the functioning of the EFs. While remaining relatively stable during later adulthood, the functions show age-related declines associated with anatomical changes in the frontal lobe structures upon aging (Jurado & Rosselli, 2007), often after the age of 60 (Treitz et al., 2007). In summary, levels of EFs vary throughout life, with a particularly sensitive period in adolescence and young adulthood in terms of dysfunctional development.

Measuring executive dysfunctions

Identifying and measuring executive dysfunction has been a challenge in clinical neuropsychology, since such impairments are multifaceted and often expressed in unstructured environments (Royall et al., 2002). EFs are measured using either performance based or inventory-based methods. Performance based methods involve administering cognitive tasks while increasing demands on the different EF subprocesses. The inventory-based assessments are based on self-report, measuring the subjective experience of EF. These approaches are meant to measure the same underlying construct, yet studies often find low correlations between the two measures (Toplak et al., 2013). It has therefore been proposed that they may tap different components of EF. While performance based tasks tap EF capacity, the subjective measures assess EF performance in real-life (Gioia et al., 2010). Hence, both assessments may be considered valid approaches to measuring EF, however varying in strengths and limitations.

Performance-based measures are typically completed in highly structured settings which may reduce demands on EF and subsequently affect the ecological validity of the measure (Isquith et al., 2013). Indeed, performance-based tests have been suggested to account for less than half of the variance in everyday executive functioning (Chaytor & Schmitter-Edgecombe, 2003). Inventory-based assessments are believed to be more sensitive

to EF as expressed in daily life (Gioia et al., 2000). They may also be less susceptible to day to day changes factors such as quality of sleep, stress, and apprehensiveness during testing (Holanda Júnior & Almondes, 2016; Liston et al., 2009), which to a greater extent may affect performance-based measures.

It is found that individuals with executive dysfunctions often perform normally on performance based tests (Isquith et al., 2013), and for this reason a combination of both performance based- and inventory based measures is recommended. A commonly used inventory is the self-report measure the Behavior Rating Inventory of Executive Functions – Adult version (BRIEF-A; Roth et al., 2005). It is considered an ecologically valid inventory assessing meaningful outcomes in daily life. The BRIEF-A is commonly used in studies of EF in the substance use population. A Norwegian study found that the BRIEF-A, compared to a performance based measure, is the more sensitive measure of EF specifically in patients with SUD (Hagen et al., 2016). They found that the BRIEF-A was a significant predictor of substance use status, separating individuals with SUD from controls. For that reason, the BRIEF-A may be particularly relevant in clinical settings. Some caution must be used however, since the scores on self-report inventories are known to be negatively influenced by psychological distress (Hagen et al., 2019a). This may artificially inflate the scores of dysfunctions in some self-report measures.

Conceptualizing EF in addiction

Theories and models on the role of EFs in addiction vary in terms of the definitions of EF used and the subfunctions included. There is subsequently no single account of addiction that encompasses all EFs. An overall, simplified framework for understanding the role of EF in SUD has however been proposed, based on the interactions between the limbic areas and the cortical areas of the brain. According to this perspective there are two types of changes in brain function that typically develop in addiction; changes in the reward network, i.e. the mesolimbic system, and changes in the PFC (Kraft, 2016). The role of EF in addiction can be described as the change that occurs in the balance between these two functional systems in the brain.

The mesolimbic system has the function of motivating us to have our basic needs met, and therefore influences the choices we make in the short term. It is in this system that impulses occur. If a situation occurs where we have the possibility of fulfilling a physical need, there will be an immediate impulse to act as to have this need met. In individuals with

addiction, this system has developed into categorizing substances as such a need (Robinson & Berridge, 1993). This creates a strong impulse to use the substance.

In the prefrontal and orbitofrontal cortex, the signals of reward from the reward system are assigned meaning (Volkow & Fowler, 2000). The use of the EFs centered in these areas makes the individual capable of discovering and inhibiting these impulses signaling immediate fulfilment of needs. Research shows that in individuals with addiction, this area of the brain is associated with decreased activity (Jentsch & Taylor, 1999). The consequence may be that the ability to exert self-control and make beneficial decisions are increasingly lowered with the continued use of substances. The result is an impaired prefrontal top-down control of substance use.

In summary, this perspective on addiction emphasizes the imbalance between the impulsive relative to self-controlled behaviors that have been traced to these brain areas in patients with SUD. Since both systems are affected in addiction, this explains the difficulties in abstaining from using despite motivations to stop. Other conceptualizations of EF in addiction claim that substance addiction in general is characterized by both top-down and bottom-up processes that compete for control of behavior (Sofuoglu et al., 2016). Since the executive top-down processes are impaired in individuals with SUD, the strong pull of drugs and drug cues through the bottom-up processes make individuals susceptible to drug use and relapse. A common conceptualization of EF in addiction, is subsequently the reduced top-down cognitive control of behavior through impaired EFs, which has an impact on the ability to control substance use.

On the level of individual subfunctions of EF, some functions have been proposed as particularly relevant in addiction. Response inhibition includes the ability to resist temptations and to resist acting impulsively. Dysfunctions in response inhibition have therefore been regarded as particularly relevant for addiction by several authors, since impairments in this function may directly result in a loss of control over substances, leading to cravings, relapsing and binging (Goldstein & Volkow, 2002). Inhibitory control is indeed central in several models of addiction. According to one such model, substance use causes dysfunctions in the PFC, which results in disrupted cortical top-down processes that leads to impaired response inhibition and salience attribution (Goldstein & Volkow, 2011). In other words, when individuals with addictions are exposed to drugs, they experience a decreased ability to correct their behavior (response inhibition impairment), as well as experiencing an abnormally high salience of drugs and drug cues in their environment (salience attribution

change). The increased salience of drugs in combination with decreased response inhibition, eventually make it difficult to resist using. Inhibition as a central executive dysfunction is supported empirically by a review which finds dysfunctions in inhibition across several types of substances (Smith et al., 2014).

Prior literature on EF and SUD

There are great discrepancies in findings in the literature on the relationship between EF and SUD. The lack of agreement on a clear definition of EF, the subfunctions it contains, and the effect it has on the individual may contribute to the observed differences in findings. There are also great variations in methodology, with the use of different EF inventories, assessment methods and length of abstinence before measurement, making it difficult to compare studies directly. Methodological challenges inherent in the SUD population, such as high dropout rates and interruptions in abstinence are also challenging when interpreting results. Few respondents use only one type of substance, and so information on the effects of individual substances on EFs are scarce. As a result, it is difficult to summarize the relationship between EF and SUD in treatment. For this reason, the following sections will first relate the relationship between EF and SUD with a focus on executive dysfunction as a risk factor and consequence of substance use problems, before specifically reviewing the literature on EF during treatment.

Executive dysfunction as a risk factor

Low EFs are possibly a risk factor for the initial development of SUD. Some research indicates that low EFs are present before the onset of addiction. Evidence from animal and human studies have found that specific subfunctions, such as impaired decision-making and heightened impulsivity, may predate initiation of drug use and mediate the transition from substance use to substance dependence (Belin et al., 2008; Dalley et al., 2007; Tarter et al., 2003). Others have found that impairments in EFs may be a cognitive endophenotype associated with a vulnerability to develop drug addiction (Ersche et al., 2012; Gierski et al., 2013). This is supported by a prospective study showing that low EFs are associated with later alcohol use disorder and number of substances used (Nigg et al., 2006). This points to the possibility of low EFs being a genetic risk factor for later substance use problems. A prospective study of 850 twins found however that while EFs were negatively related to the number of substances ever used in adolescence, such a relationship was no longer found in adulthood (Gustavson et al., 2017). The genetic correlations were however stable over time, indicating that low EFs may be a genetic risk factor for increased substance use problems in

late adolescence, while factors other than EFs may be associated with substance use problems in adulthood. Executive dysfunction as a genetic risk factor may thus play a larger role in the younger compared to the older substance use population.

Adolescence and young adulthood represent periods in development in which it is normative to experiment with drugs. Increased risk-taking and novelty seeking are common and many experiment using multiple drugs (Spear, 2000). This is however also a developmental period in which the prefrontal cortices and associated EFs are not yet fully developed, with studies reporting lowered performance on EF measures at this age (Gogtay et al., 2004). The combination of EFs still in development and increased drug experimentation may make adolescents and young adults particularly vulnerable for developing substance use problems. Studies report higher levels of executive dysfunction in young adults with substance use problems, as indicated by heightened BRIEF scores (Hadjiefthyvoulou et al., 2012). The EF summary scale in BRIEF has been found to be significantly different among adolescents with SUD and controls, with 29 % of the SUD group showing difficulties on a clinical level (Clark et al., 2012).

Young age may therefore represent a developmental risk factor for substance use problems since this is a particularly vulnerable period in development. This may also affect their ability to remain abstinent. An investigation of baseline characteristics of individuals undergoing inpatient treatment for SUD found that emerging adults are at an increased risk of relapse, particularly young polydrug users with comorbid ADHD (Andersson et al., 2021). For older adults, only baseline mental distress was predictive of relapse. Young adults may therefore be particularly sensitive to development of substance use problems while also experiencing executive difficulties.

Executive dysfunction as a consequence

The use of substances may cause changes in EFs. Persistent use of substances affect the brain in ways that result in long term cognitive changes (Volkow et al., 2019). There is thus a possibility that individuals who use similar types of drugs also share similar changes in EFs, since psychoactive drugs have different effects on brain physiology. A review has found that the use of different substances has such specific effects (Fernández-Serrano et al., 2011). They found relatively more robust effects of alcohol use on cognitive flexibility and impulsivity, of alcohol and MDMA use on selective attention, and cannabis and MDMA use on processing speed and planning. This is an indication that substance use does influence various EF components. However, the results from this study also showed generalized

neuropsychological effects from the drugs used, pertaining to impulsive behavior, updating and emotional processing, among others (Fernández-Serrano et al., 2011). There are subsequently indications that using different substances are tied to both specific and generalized effects on EFs.

Some studies indicate that the degree of cognitive impairments is dependent on whether substance use has been persistent over time. A study found that cocaine use first had specific effects on cognition, while use in the long term was tied to general cognitive impairments (Spronk et al., 2013). It is therefore possible that the use of substances has some specific effects, but that long term use eventually leads to global, non-specific cognitive effects regardless of the substance used. There are however few studies that have been able to track such changes in the long term.

Persistent substance use may be particularly harmful for adolescents and young adults, as they appear particularly sensitive to the neurotoxic effects of substances in this age (Conrod & Nikolaou, 2016; Lubman et al., 2008). The use of substances in young age may therefore be harmful as this is a sensitive period in development. Exposure to substances in early age may decrease EFs through disruptions to the development of the PFC (Nestler, 2014). This may increase the long-term risk for addiction since the prolonged development of the EFs makes these functions susceptible to such environmental factors. There is some evidence that adolescents who use substances experience lasting cognitive deficits in EFs, as seen in a study of cannabis use (Lubman et al., 2015). The authors maintained it was plausible that prolonged use in adolescence results in disruptions of neuromaturation processes occurring in this period. In summary, different drugs may have different neuropsychological consequences; however, the degree and scope of cognitive dysfunction may also depend on factors such as age of initiation and long-term use.

Prior literature on EF and treatment

Prior studies on the relationship between EFs and substance use treatment have used a variety of different performance- and inventory-based measures. Various definitions of EFs are used, either focusing on specific subfunctions or assessing changes in general EF. Often studies have focused on different substance use populations undergoing various types of treatment programs. To limit the scope of the following literature presentation, the subsequent section will primarily draw knowledge from studies that have used the BRIEF-A, or comparable EF measures.

As reviewed in the previous section, studies have shown that individuals with SUD have heightened executive dysfunctions that can both be an antecedent to substance use problems, and also a consequence of substance use problems. Studies using the BRIEF-A have confirmed that executive dysfunctions are indeed heightened in SUD patients where this measure is used. Current polydrug users have reported significantly more executive dysfunction on the BRIEF-A compared to non-users and previous substance users (Hadjiefthyvoulou et al., 2012). When it comes to other substance groups, there is limited information using the BRIEF-A. Studies using other measurements have however confirmed that individuals who habitually use only one drug also show evidence of impairments in executive components (Fernández-Serrano et al., 2011).

However, much less is known about the persistence of such dysfunctions. Recovery over the longer term have been difficult to ascertain as some functions shows improvements and others not (Fabian & Parsons, 1983; Fein et al., 1990; Oscar-Berman & Marinković, 2007; Rourke & Grant, 1999; Yohman et al., 1985). A review of prospective studies found that sustained abstinence from drug use may restore some EFs, such as improved inhibition, working memory and decision making (Schulte et al., 2014). One study with a limited sample size found that completion of a one month intensive out-patient treatment program was associated with improved EFs as measured by the BRIEF-A (McKowen et al., 2018). However, the respondents still had somewhat elevated scores on the various subscales, with all measures falling just below the threshold for impairment and therefore heightened compared to norm levels. Only the Plan/Organization subscale was associated with a statistically significant change.

Studies have shown that among patients with polysubstance use there are greater improvements on the BRIEF-A after one year of abstinence from drugs compared to those who relapsed (Hagen et al., 2017). Despite this improvement they however still experienced some impairments in EF, and other studies have confirmed that even abstinence over longer time periods may not be associated with a significant increase in executive functioning among polysubstance users (Fernández-Serrano et al., 2011). There is a limited number of BRIEF-A studies investigating other substance groups, since most people with SUD use more than one type of substance. One study has however found that patients with cocaine use disorder experienced mild cognitive recovery specifically in the functions of cognitive flexibility and planning/organization, as shown by scores on the BRIEF-A after three months of treatment (Inozemtseva et al., 2016). While experiencing improvements, a complete recovery was however not achieved. A meta-analysis on the effects of alcohol use and the time necessary

for observing cognitive improvements found that several cognitive impairments, including EF dysfunctions, remained stable for some time before abating after one year of abstinence (Stavro et al., 2013).

In summary, there are indications that improvements in EFs are possible, however the studies reviewed vary as to the time required for such changes to happen, and to which executive subfunctions are affected. Generalizations of the results presented here are limited due to methodological differences across studies, however some conclusions can be drawn. The studies reviewed demonstrate that levels of EFs are likely to improve upon treatment and abstinence, indicating that executive dysfunction is malleable for patients with SUD, however improvements to norm levels should perhaps not be expected.

Research aims and hypotheses

The prevalence of SUD is generally high in the population, with great personal costs for those afflicted. It is for this reason important to find factors that will improve the chances of successful recovery. Since cognitive assessments during treatment are rare in Norway today (Vaskinn & Egeland, 2012), there is a possibility that cognitive deficits go unnoticed in this population. Therefore, little is known regarding the cognitive functions of patients, as well as possible changes in function after treatment. There has been a particular scarcity in studies concerning the role of EFs in in-patient samples. According to the national guideline recommendation, a mismatch between the patients' cognitive functions and the demands in treatment can increase the risk of dropout and ineffective treatment (Helsedirektoratet, 2017). The present thesis therefore aims to increase the knowledge base concerning EFs in this patient group, as well as the changes of EFs throughout treatment.

As detailed above, impairments in EFs may be an antecedent to substance use problems, and also the result of persistent substance use. Since the executive subfunctions both theoretically and empirically are related to each other, lowered scores on all EF subscales are expected at treatment initiation. The degree of executive dysfunction appears in the literature strongest related to the use of multiple drugs (i.e., polydrug use) rather than the use of specific drugs per se (i.e., monodrug use), even though there is some evidence that different substance types are associated with specific executive impairments. The literature reviewed also indicate that young individuals with SUD are particularly vulnerable for executive dysfunction. The following hypothesis is therefore proposed:

1. Higher self-reported scores of executive dysfunctions at baseline, particularly in the polydrug group and the youngest age group

Empirical studies using the BRIEF-A find that results differ as to which specific EF subscales are impaired. There are some indications in the literature reviewed that dysfunction in response inhibition specifically has a central role in addiction, with empirical evidence of impairments in inhibition regardless of substance type. The following hypothesis is therefore proposed:

2. Elevated dysfunctions particularly in the inhibition subscale of the BRIEF-A

Earlier studies of EFs indicate that there is a possibility for improvements in function upon treatment. It is however unclear to what extent SUD patients experience meaningful improvements and which of the subscales of the BRIEF-A are affected. At the level of individual subscales, the study is therefore exploratory. The second hypothesis is as follows:

3. Decreased scores of executive dysfunctions in all twelve BRIEF-A scales at treatment completion

Method

Sampling and procedure

This is a longitudinal pilot study assessing the EFs of patients undergoing in-patient treatment for SUD. It is part of a research project conducted at the Clinic of Substance Use and Addiction Medicine at Trondheim University, St. Olavs Hospital. Participants were recruited at admission to the inpatient treatment facility between February 2021 and August 2021. Due to the pandemic, the data collection was somewhat delayed since covid restrictions limited access to the treatment facility. Instead of the author gathering the data, this was delegated to research assistants. Upon recruitment, participants were categorized according to their primary intoxicant, either alcohol, opiate/opioid or a combination of different substances (polydrug). The study includes measurements at two time-points as part of the intake procedure before treatment (T1) and immediately after 3 months of treatment was concluded (T2). The final sample included 22 respondents at baseline and 17 respondents at treatment completion. Statistical analyses were performed on the total data and change was assessed pre- and post-treatment on all BRIEF-A subscales. The project was approved by the Regional Ethical Committee (REK 2020/10256). Respondents gave written informed consent to participate and were informed of their right to withdraw their participation at any time.

Measurement instruments

BRIEF-A

The Behavior Rating Inventory of Executive Function, Adult version (BRIEF-A; Roth et al., 2005) is a self-report form addressing respondents' own view of their executive functioning in everyday life. It is an ecologically sensitive measure of EFs as expressed in daily life (Gioia et al., 2000) and is a frequently used inventory among Norwegian neuropsychologists (Ryder, 2021). The questionnaire is reported as having moderate to high alpha coefficients in normative and mixed clinical samples, indicating strong internal consistency (Roth et al., 2014). The test-retest reliability is r = 0.82 - 0.94 (Roth et al., 2005), which supports using the BRIEF-A when interpreting changes over time. Raw scores were converted to *T* scores (M = 50, SD = 10), and corrected according to age.

The BRIEF-A is composed of 75 items asking whether a given behavior has been a problem the past 4 weeks, e.g., «has trouble staying on the same topic when talking». Each item is rated along a 3-point Likert scale, indicating whether the behavior has "never", "sometimes" or "often" been an issue. Higher scores on the BRIEF-A indicate a higher degree of impairment, with *T*-scores ≥ 65 considered clinically significant and an indication of executive dysfunction (Isquith et al., 2005). Each item is organized within nine mutually exclusive scales measuring different aspects of executive functions, as well as two index scales and one total summary scale measuring overall functioning.

The inhibition scale is a measure of impulsivity and inhibitory control. It is related to being able to stop one's behavior when appropriate, to resist urges and to consider consequences before acting. *The Shift scale* is a measure of the ability to shift attention between different situations, activities, or aspects of a problem when necessary. The *Emotional Control* scale assesses the ability to adjust emotional responses to situations appropriately, and the *Self-Monitor Scale* measures awareness of the effect of one's behavior on others in social situations. The *Initiate scale* measures the ability to start doing tasks and activities, in addition to generating new ideas and ways to solve problems. The *Working Memory scale* assesses the extent to which you're able to hold information in mind for the duration of a task or activity. The *Plan/Organize scale* assesses the ability to manage tasks to reach goals; the Plan component of the scale entails anticipating future events and goals and the steps involved to reach them, and the Organize component measures the ability to bring order to information. The *Task Monitor Scale* measures the ability to evaluate and keep track of problem solving, and to do necessary adjustments. Finally, the *Organization of Materials*

scale measures the ability to keep things and materials in order in a variety of different locations, such as the workplace and at home.

The clinical scales are subsumed under the two more broadly defined indexes of *Behavioral Regulation (BRI)* and *Metacognition (MI)*. The BRI measures the individuals' overall ability to regulate behavior and emotional responses while keeping track of self-behavior, and includes the subscales of Inhibition, Shift, Emotional Control, and Self-Monitoring. The MI describes the individuals' ability to solve problems efficiently by planning and organizing, and is composed of the remaining scales of Initiation, Working Memory, Plan/Organize, Task Monitoring and Organization of Materials. The overall score from every scale combined is summarized in the Global Executive Composite (GEC), which yields the individuals' total summary score on executive functioning.

Three validity scales were examined to assess the validity of the results from each respondent, where elevated scores on one or more of the three scales invalidated the test protocol. The negativity scale measures the extent to which the respondent has answered selected items in an unusually negative way. The inconsistency scale measures the degree to which items that are similar in nature are answered accordingly. The infrequency scale measures the extent to which answers are highly atypical or unusual. A Norwegian study found that the BRIEF-A was associated with emotional distress in both a healthy and a neurological group, while no or weak associations were seen in regards to performance based tests of EFs (Løvstad et al., 2016). For this reason, the SCL-10 was included in the present study since the BRIEF-A might be more influenced by emotional distress compared to other measures. This inclusion is particularly important in the initial phases of treatment, seeing as psychological distress typically is elevated at this point.

SCL-10

The SCL-10 is a self-report inventory measuring psychological distress the past 7 days. The inventory consists of 10 items, e.g., "feeling everything is an effort". The measure was administered at T1 and T2. Each item is rated on a 4-point Likert scale, from «not at all» (1) to «extremely» (4). A mean score above the cut off value of 1,85 is an indication that the respondent is experiencing psychological distress. The SCL-10 has shown good sensitivity and specificity in discovering psychological symptoms of distress compared to other more extensive measures (Strand et al., 2003). Studies on Norwegian SUD patients have shown increased SCL-10 scores indicating a considerable burden of mental health symptoms in this population (Aas et al., 2021).

Statistical Procedures

Data were analyzed using IBM SPSS Statistics version 27 and the BRIEF-A SP program was used for EF scoring. Prior to analyses, the data were examined for normality and potential outliers. A visual examination of histograms, Q-Q plots and non-significant Kolmogorov-Smirnov test indicate a normal distribution. An inspection of boxplots identified one outlier at T2, however considering the limited sample size and an approximately equal mean and 5% trimmed mean, the outlier was not excluded from further analyses. Independent samples *t*-tests were performed to examine group differences in baseline characteristics on the BRIEF-A. The Pearson correlation coefficient was used to examine the relationship between the scores on the SCL-10 and the BRIEF-A subscales, both in total and according to drug- and age group. Changes in all the 12 subscales of the BRIEF-A from T1 to T2 were assessed using paired samples mean *t*-tests, and Hedges Correction was used as a measure of effect, considering the limited sample size of less than 20 at T2. Based on the statistically significant dependent *t*-tests, these were further examined using two-way ANOVA comparisons to assess whether the changes in the BRIEF-A subscales differed according to type of substance and age group. Statistical significance was determined at $p < .05$.

Results

Sample characteristics

Included in the study were 22 participants ranging from 19 to 60 years of age (*M* = 34,09, *SD* =10,98), consisting of six women (27%) and 16 men (73%). Length of education varies, with eight respondents (36%) having finished primary and lower secondary school, 10 respondents (46%) having completed upper secondary school and four respondents (18%) having completed higher education. A variable consisting of two age groups was created, consisting of nine respondents younger than 30 (41%) and the remaining 13 respondents older than 30 (59%).

The polydrug group was the largest group consisting of 13 respondents (59%), whereas the alcohol group contained seven respondents (32%) and the opioid group only two respondents (9%). Since the opioid group was so small, the opioid and alcohol groups were combined to form a merged alcohol/opioid group consisting of nine respondents in total (41%). The two opioid users were 34 and 45 years old (*M* = 40, *SD* = 7,78), while the alcohol users ranged from 28 to 60 years of age (*M* = 41, *SD* = 12,1). The length of education was approximately equal between the alcohol users (*M* = 13, *SD* = 2,94) and the opioid users (*M* = 11, *SD* = 2,12). However, the two opioid respondents scored higher on the SCL-10 scale (*M* =

2,1, *SD* = 0,85) compared to the alcohol users (*M* = 1,61, *SD* = 0,55) and higher on the summary GEC scale (*M* = 62, *SD* = 14,14) compared to the alcohol users (*M* = 53,43, *SD* = 10,7). Despite these differences in baseline characteristics, the alcohol and opioid groups were combined since both groups shared the same substance pattern in using only one drug. This separates them from the remaining respondents who used several substances interchangeably. The distinction between substance groups in the present study was thus between respondents who were polydrug users (the polydrug group), and respondents who were monodrug users (the combined alcohol/opioid group).

Of the total sample there were five missing respondent measures on the BRIEF-A at T2, equaling 23% of the original sample. One of these respondents also had two missing items in the BRIEF-A Shift scale at T1. Due to an excessive number of missing item responses for this particular respondent, the Shift, BRI and GEC scales were invalid. No other protocols had missing items in the pre- or post-test administrations. All respondent scores were considered acceptable on the validity scales included, and did not exceed the recommended cutoff values as proposed by the original authors (Roth et al., 2005). None of the respondents were thus excluded from the study due to invalid response styles.

BRIEF-A

Descriptive statistics of baseline characteristics can be seen in Table 1. As seen in the column for Total scores, the three BRIEF-A summary scores of the BRI, MI and GEC scales were elevated compared to norm levels (*M*=50, *SD*=10). None were above the cut off value of $T \geq 65$ for clinically significant executive dysfunction, however several were close to the cut off value.

When examining individual test scores, 11 respondents (50 %) had scores above the cut off value on the summary GEC scale. This is an indication that a large proportion of the respondents did experience executive dysfunctions to the level of clinical significance, even though the average scores for all respondents on the summary scales were just below cut off. As seen in Table 1, when the respondents were grouped according to type of substance, the polydrug users in particular had higher scores of dysfunctions compared to the monodrug users. While the polydrug group scores were above clinical cut off on all three scales, none of the monodrug group scores exceeded clinically significant levels of dysfunction.

Table 1

Baseline characteristics and EF scale variables according to substance group (N=22)

	Polydrug (*n*=13) *M* ± *SD*	Monodrug (*n*=9) *M* ± *SD*	Total (*N*=22) *M* ± *SD*
Age	29,62 ± 8,90	40,56 ± 10,85	34,09 ± 10,98
Education	11,54 ± 1,61	12,44 ± 2,88	11,95 ± 2,21
SCL-10	2,02 ± 0,64	1,72 ± 0,60	1,90 ± 0,63
Behavior Regulation Index	66,42 ± 10,63	54,22 ± 10,72	61,19 ± 12,10
Metacognition Index	68,92 ± 8,80	55,22 ± 10,38	63,32 ± 11,52
Global Executive Composite	68,58 ± 9,41*	55,33 ± 11,19*	62,90 ± 12,00

Note. *M*=mean; *SD*=standard deviation; *$p \leq .05$=significant difference between the monodrug and polydrug groups.

When comparing the polydrug group and the monodrug group on the total summary GEC scale, differences emerged. There was a statistically significant difference between the polydrug group (*M* = 68.58, *SD* = 9.41) and the monodrug group (*M* = 55.33, *SD* = 11.19) on the GEC scale, *t*(19) = -2,946, *p* = .008. The polydrug group therefore experienced a significantly higher overall degree of executive dysfunction compared to the monodrug group. In terms of age differences, the results showed that there was a difference in scores between the youngest and the oldest age group. However, even though the younger age group (*M* =64.75, *SD* = 8.08) exhibited higher rates of executive dysfunction in the GEC scale compared to the older age group (*M* = 61.77, *SD* = 14.08), this difference in scores was not statistically significant, *t*(19) = 0.62, *p* = .55.

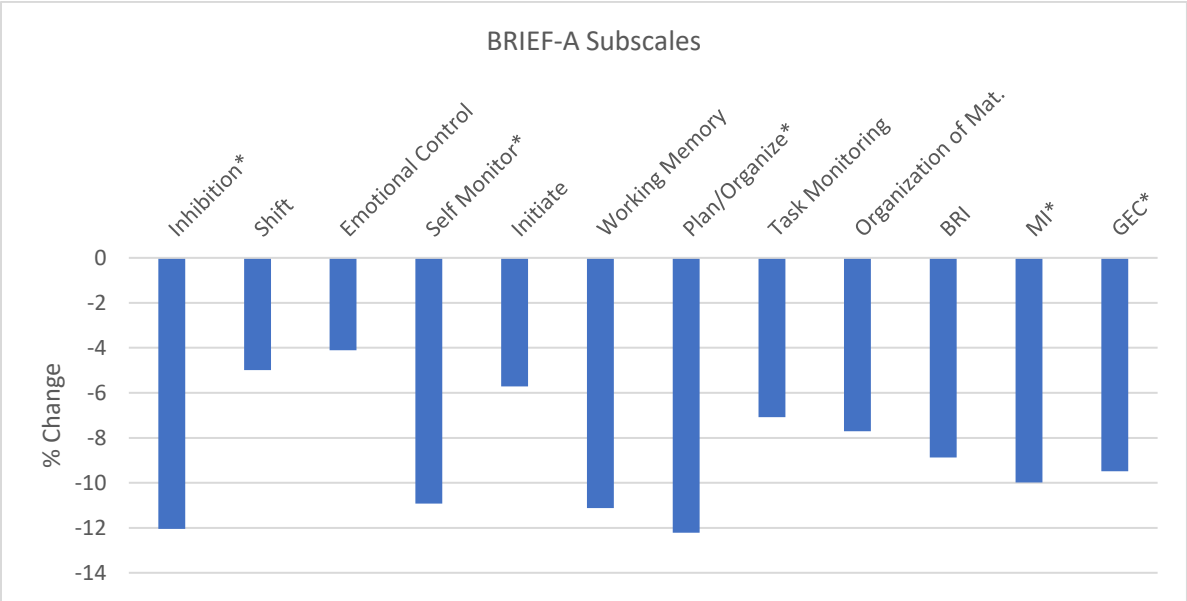
In summary, the baseline results indicate that all total scale scores were elevated compared to norm levels at treatment initiation. However, only the polydrug group had scores above cut off for clinically significant levels of executive dysfunction. This is an indication that the polydrug users experienced executive dysfunctions to a larger degree than the monodrug users at baseline. While the youngest age group scored in the direction of higher levels of executive dysfunction compared to the older age group, this difference was not statistically significant.

The baseline results were subsequently compared to the scores at follow-up. When comparing the baseline scores with the follow-up scores, there was a marked decrease in scores of executive dysfunctions. All subscales of the BRIEF-A showed a negative change

from baseline to follow-up. Figure 1 shows the results presented as the percent change in scores on all 12 subscales from treatment initiation to treatment completion.

Figure 1

Total % change in mean T-scores on the BRIEF-A subscales from T1 to T2



Note. Percent change in mean T-scores from T1 to T2; *$p \leq .05$.

As seen in Figure 1, all subscales showed a decrease from baseline to follow-up, indicating a global reduction in executive dysfunction following treatment completion. However, of the 12 scales there were only five that showed a statistically significant decrease in *T*-scores from T1 to T2. There was a statistically significant decrease in scores in the Inhibition subscale, the Self Monitor subscale, the Plan/Organize subscale, the Metacognition Index, and finally the Global Executive Composite.

The BRIEF-A results for the total sample at T1 and T2 are shown below in Table 2. The decrease in GEC scores had a 95% confidence interval of the difference ranging from .38 to 7.39, and the decrease in MI scores had a 95% confidence interval of the difference ranging from .004 to 7.06. The Inhibition subscale had a confidence interval ranging from .47 to 8.27, the Self-Monitoring scale had a confidence interval ranging from .10 to 7.31, and finally the Plan/Organize subscale had a confidence interval ranging from .45 to 8.96. None of the remaining decreases in scale scores showed a statistically significant change.

Table 2

BRIEF-A results for the total sample at baseline (T1) and follow-up (T2)

	Baseline (N=22) *M* ± *SD*	Follow-up (N=17) *M* ± *SD*	*p*-value	Effect Size
Inhibit	64,41 ± 12,83	56,65 ± 9,98	.031*	.56
Shift	57,14 ± 11,06	54,29 ± 10,60	.660	.11
Emotional Control	57,23 ± 11,28	54,88 ± 11,82	.286	.26
Self-Monitoring	59,23 ± 12,32	52,76 ± 11,42	.045*	.52
Initiate	63,45 ± 12,12	59,82 ± 7,39	.369	.22
Working Memory	62,68 ± 12,32	55,71 ± 11,61	.088	.43
Plan/Organize	62,86 ± 11,84	55,18 ± 10,36	.032*	.56
Task Monitoring	59,00 ± 11,11	54,82 ± 12,40	.666	.10
Organization of Materials	58,77 ± 9,63	54,24 ± 10,60	.113	.40
Behavioral Regulation	61,19 ± 12,10	55,76 ± 10,83	.052	.50
Metacognition Index	63,32 ± 11,52	57,00 ± 10,83	.050*	.50
Global Executive Comp.	62,90 ± 12,00	56,94 ± 11,27	.032*	.56

Note. M=mean; *$p \leq .05$. Scores are reported as T-scores, with higher scores reflecting increased symptoms of dysfunction.

While all total scale scores showed reductions from T1 to T2 as seen in Table 2, none of the scores fell below or at norm levels (*M*=50, *SD*=10) at follow-up. Examinations of results according to substance groups, did however reveal that while the polydrug group had scores that were still somewhat elevated at follow-up (though under cutoff for clinically relevant levels), the monodrug group showed scores approximating norm levels on nearly all subscales. The monodrug group, largely consisting of respondents with alcohol use problems, therefore seemed to experience reductions in executive difficulties nearing norm levels.

Based on the five significant dependent *t*-tests, these were further submitted to a two-way repeated measures ANOVA to examine differences in EF scores from T1 to T2, according to type of substance and age group. It was of interest to explore the impact of substance group and time (T1-T2) on levels of executive dysfunction, as well as the impact of age group and time (T1-T2) on levels of executive dysfunction. The results showed that none of the five BRIEF-A scales had a significant interaction effect between substance group and time, and

between age group and time on the BRIEF-A scores. This implies that the age groups and drug groups did not have significantly different patterns of change from T1 to T2.

Five respondents did not complete the BRIEF-A at T2. They were characterized by having high baseline scores on the SCL-10 and GEC scale compared to the rest of the respondents. All had scores above cutoff for psychological distress, and all had scores above cutoff on the GEC scale, except for one respondent. Overall, this is an indication that these respondents were experiencing somewhat larger difficulties compared to the remaining respondents in the study.

SCL-10

The BRIEF-A has been shown to be negatively influenced by psychological distress when compared to performance-based measures (Hagen et al., 2019b). This may artificially inflate the scores on executive dysfunction, and the SCL-10 was therefore included in present study. The Pearson correlation coefficient was used to examine a possible relationship between the SCL-10 and the BRIEF-A. The results showed that there was not a statistically significant correlation between the scores on the SCL-10 and the BRIEF-A subscales at T1, as exemplified by the non-significant relationship between the SCL-10 and the Global Executive Composite, $r = .221$, $p = .336$. The degree of psychological distress as measured by the SCL-10 therefore did not appear to relate to executive dysfunction in this sample. Results also showed that there was not a statistically significant correlation between the scores on the SCL-10 and the BRIEF-A subscales at T2, as shown in the non-significant relationship between the SCL-10 and the Global Executive Composite, $r = .162$, $p = .534$. The degree of psychological distress therefore did not significantly relate to the results on executive dysfunction, which was similar to the baseline results.

The results on the SCL-10 for the total sample at T1 (see Table 1) showed a mean of 1,90 (*SD* = 0,63) and was therefore above the cut off value of 1,85. This is an indication that the respondents on average were experiencing some degree of mental distress. This pertains particularly to the polydrug group, which had the highest mean scores of 2,02 (*SD* = 0,64), compared to the monodrug group with a mean score of 1,72 (*SD* = 0,60). The difference in mean SCL-10 scores between the two groups was however not statistically significant, $t(20) = -1,08$, $p = .293$.

The SCL-10 scores at T2 for all respondents have a mean of 1,76 (*SD* = 0,60), which is somewhat below the cut off value for clinical significance. This represents a small decrease in scores as compared to the T1 results (M = 1.90, *SD* = 0,63). A paired samples t-test showed

that this change in scores from baseline to follow-up was not statistically significant, $t(19) = .89$, $p = .39$.

Discussion

Neurocognitive research has shown the central role of neuropsychological impairments, and especially executive dysfunctions, in SUD. The role of these functions during recovery are however still under investigation. The main aim of the present thesis was to examine the role of EFs from admission to discharge of a three-month in-patient treatment program for patients with SUD. The BRIEF-A was used as outcome variable on EFs, and the SCL-10 was included as an estimation of psychological distress. A particular focus was on the age of respondents and type of substance used since these characteristics are known to affect cognition.

Baseline

The hypothesis at baseline was that respondents would score lower than normal on executive functioning at baseline, as indicated by elevated scores on the BRIEF-A scales. The results supported this hypothesis, showing elevated scores on all twelve subscales compared to norm levels. However, even though results showed overall elevated scores, none of the subscales reached the level of clinically significant dysfunction. This is comparable to some other studies who have used the BRIEF-A in the SUD population, finding that respondents on average had clearly elevated scores on all scales at baseline, however just below cut off for clinically relevant levels (Hagen et al., 2017; McKowen et al., 2018). These studies are however based on outpatient and mixed clinical patient samples, and not in-patient respondents. Since patients qualifying for in-patient treatment represent a more selected group, often displaying more severe symptoms of addiction compared to patients in outpatient programs, one would have expected higher levels of dysfunction in the present sample.

A possible explanation for the lower-than-expected scores of dysfunctions may be that the BRIEF-A uses US norms. Some prior studies have found that Norwegian control groups tend to score 0.5-0.75 *SD* below the U.S. normative mean of *T* score = 50 (Løvstad et al., 2016). Patient scores between 56–64 might therefore be within clinical range in Norwegian samples (Løvstad et al., 2016). If this is the case, then it is highly likely that the scores obtained in the present study would approximate clinical levels of dysfunction to a larger degree.

While the total results on average did not show executive dysfunction to the level of clinical significance, there were statistically significant differences between monodrug users and polydrug users in degree of executive dysfunction. The polydrug group scored above clinical cutoff on all scales, indicating clinically relevant executive difficulties, whereas the monodrug group scored below clinical cutoff on all scales. The results therefore support the hypothesis that the respondents who use multiple drugs would experience higher degrees of dysfunction compared to monodrug users, who habitually use only one type of drug. Potential differences within the monodrug group, i.e., between the opioid and alcohol users, have not been open to examination due to only two respondents being opioid users. The opioid users did however differ from the alcohol respondents by showing higher scores on the summary GEC scale and the SCL-10 at baseline. It is therefore possible that they experienced larger executive dysfunctions than alcohol users. However, since the opioid group was so small it was not possible to examine the degree of EF dysfunction according to specific types of drugs.

The present results found that the polydrug group experienced higher levels of psychological distress compared to the monodrug group, as measured by the SCL-10. This is in line with previous research documenting that polydrug users often experienced psychological distress to a higher degree than other substance use groups (Andreas et al., 2015; Quek et al., 2013; White et al., 2013). Since psychological distress has been associated with increased scores on the BRIEF-A to a larger degree than performance based tests (Hagen et al., 2019a), there is a possibility that this has contributed to inflated scores of dysfunction in the polydrug group. Since the difference in SCL-10 scores was not significant between the polydrug and monodrug groups, and also the scores on the SCL-10 and the BRIEF-A subscales were not correlated, it was concluded that psychological distress did not appear to be related to executive dysfunction in the present sample. There is however also the possibility that a correlation was not found due to a lack of statistical power as a result of a relatively small sample size.

It was further hypothesized that the youngest age group, aged 30 or younger, would show heightened levels of dysfunction compared to the older age group. Early adulthood was presented in the present thesis as a period of high risk for developing substance problems, seeing as they are more likely to seek out drugs in this age, while also being more sensitive to the effects of the drugs they consume. Continued substance use may be harmful in this age since young adults appear particularly sensitive to the neurotoxic effects of substances

(Conrod & Nikolaou, 2016; Lubman et al., 2008). Previous studies have reported lowered performance on EF measures in this age group (Gogtay et al., 2004), as well as higher levels of executive dysfunction in BRIEF scores (Hadjiefthyvoulou et al., 2012). Data on year of initiation of substance use, including length of use, would have contributed to clarify this in the present study, relative to the BRIEF-A results. The results in the present study showed however only a non-significant higher rate in the younger age group compared to the older age group. The direction of the effects therefore supported the hypothesis; however, this difference was not statistically significant. There is a possibility that this non-significant finding is also due to low power in the present study, as relatively few respondents are included. This typically affects the ability to detect differences in the data.

A possible explanation for the non-significant finding is that the age cut off separating the two age groups was set too high. The effect might have been more pronounced with a lower cut off than 30 years, which was chosen in the present study based on obtaining a close to equal number of respondents in each group. Prior studies of young individuals in inpatient treatment for SUD have used a cut off value of 25 years old (Andersson et al., 2021), and therefore more closely targeted the emergent adult population. This would also be prudent considering the protracted development of EF most likely would signify lower functions in younger individuals on a group level.

In summary, the results indicated that SUD patients attending inpatient treatment indeed experienced heightened scores of dysfunctions at treatment initiation, relative to norm levels. This was most pronounced for the polydrug group, which scored significantly higher on degree of dysfunction compared to the monodrug group. Even though the youngest age group scored higher on executive dysfunction compared to the older age group, this difference was not significant. Thus, the use of multiple drugs appeared more clearly related to executive dysfunction compared to age.

Follow-up

Prior research has confirmed the existence of executive dysfunctions in many SUD patients at treatment initiation, however it remains to be determined whether improvements are possible following treatment. The hypothesis at follow-up was that respondents would experience overall reductions in executive dysfunctions after three months of substance use treatment. Results showed that all twelve scale scores were reduced post-treatment, in support of the hypothesis. Since influential theories and models of EFs claim that different types of executive functions are correlated and sharing similar functions (Miyake et al., 2000), it was

expected that all BRIEF-A subscales would be affected . While all scale scores indeed were reduced post-treatment, only five of the 12 scales had a statistically significant reduction in scores. This includes the scales of Inhibition, Self-Monitoring, Plan/Organize, Metacognition Index and the Global Executive Composite.

When examining changes compared to norm levels, it was evident that the monodrug group experienced improvements in EFs that approximated norm levels on all scales but the Initiation scale (i.e., levels based on the normative sample including adults in which a wide range of ethnic and educational backgrounds). While the monodrug group experienced a partly normalization of executive dysfunctions, the polydrug group still experienced heightened levels of dysfunction at follow-up. As the polydrug group also had the highest scores of dysfunctions at baseline, this is not unexpected.

Hence, there is a possibility that three months of treatment may not be enough for executive functions to completely recover for all respondents. There is some evidence that longer periods of abstinence and treatment showed larger improvements in cognition (Stavro et al., 2013). A recent replication study found however that individuals who were abstinent beyond 1 year still experienced negative impacts from cognitive functions (Crowe et al., 2020). This may be an indication that once changes in brain functions are present, they cause disruptions in cognition that may be persistent and long-term. In terms of cognitive training, improvements are often not expected immediately after treatment, but rather at later follow-ups. The results of a Goal Management Training intervention found that the strongest improvements were seen 6 months post-treatment, as evidenced by results on the BRIEF-A (Tornås et al., 2016). While improvements in executive functions as seen in the present study may be evident shortly after treatment, larger improvements may not be observed until later. Thus, there is a possibility that the five subscales that showed a significant improvement during treatment are only the first of several subscales that has a potential for improvements at later measurement times.

It is however also possible that complete recovery should not be expected. As this study only has measured EFs at two time points, one cannot exclude the possibility that respondents may have had executive dysfunctions that are present before development of SUD. Low EFs are possibly a risk factor for the initial development of SUD. Evidence from animal and human studies have indicated that specific subfunctions of executive functions may mediate the transition between drug use and drug dependence (Belin et al., 2008; Dalley et al., 2007; Tarter et al., 2003), and others have found that impairments in EFs may be a cognitive endophenotype associated with a vulnerability to develop drug addiction (Ersche et al., 2012;

Gierski et al., 2013). Executive dysfunctions may therefore partly precede, however also be a cause of substance use problems, since prior research has indicated the possibility of bidirectional influences between SUD and EF dysfunction. As such, a complete recovery to norm levels should perhaps not be expected. The reason for the heightened scores of dysfunctions at follow-up may therefore reflect not necessarily just that the impairments in cognition are persistent and long-term, but that the individual has some pre-existing dysfunctions that may have contributed to the development of SUD in the first place.

At the level of individual BRIEF-A subfunctions, the study was exploratory. However, it was hypothesized that the scale of Inhibition would be most affected at baseline. This is due to inhibition being defined as the ability to resist temptations and to resist acting impulsively, and therefore has been regarded as particularly relevant for addiction by many authors (Goldstein & Volkow, 2002). The results supported this hypothesis finding that inhibition was indeed the subscale that showed the highest scores of dysfunctions across drug groups. Impairments in response inhibition may directly result in a loss of control over substances, leading to relapsing and binging. Empirically, a review found inhibition dysfunctions across different types of substances, which supports dysfunctions in inhibition as central in addiction (Smith et al., 2014).When comparing drug groups, it was the polydrug group which evidenced the highest levels of dysfunction on inhibition. Interestingly, a significant finding is that inhibition was also associated with the largest improvements during treatment. While being the subscale with the highest scores of dysfunctions at baseline, it was also the subscale that showed the largest improvement. This is highly promising, considering inhibition is viewed as central in many theories on how addiction is developed and sustained (Kalivas & Volkow, 2005).

The BRIEF-A measure

Measuring executive dysfunctions has been a challenge in neuropsychology since such impairments are multifaceted and often expressed in unstructured environments (Royall et al., 2002). Measures can be either performance based or inventory based, yet studies often find low correlations between these approaches (Toplak et al., 2013). It has therefore been proposed that they may tap different components of EF. Consequently, it may be beneficial to use both measurement approaches when assessing executive dysfunctions in different populations. This would also have been an advantage in the present study, especially since the BRIEF-A has been found to be negatively influenced by psychological distress in comparison to the MoCA (Hagen et al., 2019a), which is a commonly used performance based measure.

However, there are several benefits to using the BRIEF-A when measuring EFs in the SUD population. The BRIEF-A has the advantage of capturing actual functioning in various settings, which can be regarded as a strength compared to objective measures based on performance on different tasks. In addition, it has also been found that individuals with executive dysfunctions often perform normally on performance based tests (Isquith et al., 2013). The present results have shown that the BRIEF-A is in fact a sufficiently sensitive measure, capable of capturing changes in impairments even in a small sample in a limited time span. In comparison, a Norwegian study of patients with SUD found that there were hardly any changes in impairments as shown in MoCA results, even after 9 months at a treatment facility (Fjærli et al., 2021).

Implications

The results have implications for treatment since a mismatch between the patients' EFs and the demands in treatment can increase the risk of ineffective treatment. A central finding in the current study was that polydrug users had significantly higher scores of executive dysfunctions compared to monodrug users, and that they experienced difficulties to the level of clinically significant dysfunction. This group did however also evidence improvements during treatment, in which the scale scores were reduced below clinical levels while still being somewhat elevated compared to norm levels. A large proportion of treatment seeking individuals are polydrug users, and therefore it is particularly important to investigate their needs in treatment. This is especially important since treatment often has been less effective for patients with polysubstance use compared to patients with monodrug use (Connor et al., 2014; Williamson et al., 2006). Implications of these findings are that polydrug users may benefit from treatment that is less cognitively demanding in the initial phases of treatment. Patients who are polydrug users may benefit from a gradual increase in the cognitive load in treatment, since present results have shown that improvements in EFs are possible for this group. Since the results have shown that elevated scores of dysfunctions may however still be somewhat present in this group after three months of in-patient treatment, it is important to acknowledge that SUD patients may struggle long-term, and that close follow-up also after in-patient treatment may be beneficial.

Future research should focus on designing longitudinal studies that will help delineate the role of individual characteristics versus drug characteristics on observed EF impairments. Prospective studies with measurements across multiple time points will help determine whether differences in neurocognitive functioning are a cause or consequence of SUD.

Furthermore, the EF impairments found in addiction may be potentially important targets for interventions as a way to promote recovery. There are studies showing that different components of EF may be trainable (Morrison & Chein, 2011; Shipstead et al., 2012; Verdejo-Garcia et al., 2019), and therefore might improve with targeted practice.

Limitations

The BRIEF-A is based on normative data from the United States and therefore the results need to be interpreted with caution. Some earlier studies have indicated that Norwegian control groups score somewhat lower than U.S. norms. A study found that healthy Norwegian participants tended to have BRIEF-A scores 0.5-0.75 *SD* below the U.S. normative mean of *T* score = 50 (Løvstad et al., 2016). The tendency toward lower scores in Norwegian samples has been replicated in several studies (Grane et al., 2015; Sølsnes et al., 2014). This may have implications for the clinical use of the questionnaire, as a T-score of 65 is not necessarily a suitable threshold for symptoms to be considered of clinical interest. Patient scores between 56–64 might therefore be within clinical range in Norwegian samples (Løvstad et al., 2016). It is therefore possible that the scores obtained in the present study are clinically relevant even if the T-scores are below the cut off value of 65. This would significantly increase the number of respondents defined as above cutoff in the present study.

The limited sample size of only 22 respondents at T1 and 17 respondents at T2 may affect the statistical power of the study, thus affecting the ability to detect changes between baseline and follow-up, as well as possible correlations between variables. Since patients with cognitive deficits are overrepresented among patients who drop out of treatment, this has the potential of introducing bias in the current findings. The five respondents who dropped out the study were in fact among the respondents with the highest scores of dysfunctions. This warrants caution when interpreting and generalizing the findings, which should be interpreted considering the present context and limitations of the study.

Since there was no control group included, we were unable to measure the direct effect of treatment on executive dysfunction and were subsequently only able to infer how levels of EF change throughout treatment. No causality can be inferred regarding the causes of the observed changes in EF and the capacity of treatment to affect cognition.

Some would argue that the use of dependent t-tests on all twelve scales at T1 and T2 equals multiple testing, and that the *p*-values should be adjusted according to this. However, in such a small study with limited amount of data it was deemed more important to retain as much power as possible. The fact that we did not have information on length of substance use

for individual respondents, made us unable to rule out the possibility that the observed levels of EF at T1 and T2 also may be subject to duration of use. Studies have shown increased impairments in neuropsychological task performances in people who have been dependent for longer periods of time (Pitel et al., 2009). Since we do not have information on the length of use from individual respondents it is not possible to conclude on this matter.

The present study used the BRIEF-A and SCL-10 inventories which both are self-report measures. While they both are considered ecologically valid, the inventories are not objective measures. They may therefore be subject to limitations typically inherent in self-report measures, such as lack of awareness from respondents and variations in interpretations of worded items, demand characteristics, over/underreporting of symptoms, and social desirability bias, among others.

Conclusion

The lack of effective treatment and prevention strategies today proves that more research is needed to strengthen the neuroscientific basis of our understanding of SUDs. Present results showed that patients manifested heightened levels of executive dysfunction upon initiation of SUD treatment. Patients who are polydrug users experienced significantly higher scores of dysfunctions compared to those who used only one preferred substance. Only five of the twelve subscales of the BRIEF-A showed statistically significant changes in scores from treatment initiation to treatment conclusion, including the Global Executive Composite Index, the Metacognition Index, and the subscales of Inhibition, Self-Monitoring and Plan/Organization. Some dysfunction appears to persist in the polydrug group despite in-patient treatment at three months, however all scale scores for this group were reduced to non-clinical levels of dysfunction. The results have implications for treatment since a mismatch between the patients' EFs and the demands in treatment can increase the risk of ineffective treatment. This shows that the treatment of SUD needs to assess cognitive function to adjust treatment to the specific needs of the patient.

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Appendix

Appendix A: Application to the Regional Ethical Committee

Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
Hilde Eikemo	73597508	11.11.2020	10256

Region:
REK midt

Grete Flemmen

10256 Hvordan går det med pasientene? Implementering av strukturert fysisk trening for ruspasienter: Implikasjoner for behandlingsutfall, livsmestring, psykisk og fysisk helse.

Forskningsansvarlig: St. Olavs Hospital HF

Søker: Grete Flemmen

REKs vurdering

Vi viser til søknad om prosjektendring mottatt 04.11.2020. Søknaden er vurdert på fullmakt av komiteens sekretariatsleder, med hjemmel i helseforskningsloven § 11 og forskrift om behandling av etikk og redelighet i forskning § 10 annet ledd.

Omsøkte endringer

Du har søkt om følgende endringer:

1) "Vi ønsker å inkludere to nevropsykologiske tester for å undersøke betydningen av kognitiv funksjon på behandlingsutfall hos ruspasienter. Det er da snakk om et selvrapporteringsskjema (BRIEF-A) og en oppgavebasert test (MoCA). Begge er relativt kortfattet og ansett som godt egnet for bruk på ruspasienter."

2) revidert forskningsprotokoll og informasjonsskriv til deltakerne (begge v. 4.11.20)

Vurdering

Vi vurderer at de nevropsykologiske testene vil kunne heve den vitenskapelige kvaliteten på prosjektet, med minimal ekstra belastning for deltakerne. Testene er beskrevet fint i revidert informasjons- og samtykkeskriv. REK kan derfor ikke se at endringen reiser nye forskningsetiske spørsmål. Vi tar revidert protokoll og skriv til orientering uten innvendinger.

Vi minner om at prosjektet må gjennomføres i henhold til tidligere vedtak i saken.

REK midt **Telefon**:73 59 75 11 | **E-post**:rek-midt@mh.ntnu.no

Besøksadresse: Øya Helsehus, 3. etasje, Mauritz Hansens gate 2, Trondheim **Web**:https://rekportalen.no

Vedtak

Godkjent

Med vennlig hilsen

Hilde Eikemo
Sekretariatsleder, ph.d.
REK midt

Klageadgang

Du kan klage på komiteens vedtak, jf. forvaltningsloven § 28 flg. Klagen sendes til REK midt. Klagefristen er tre uker fra du mottar dette brevet. Dersom vedtaket opprettholdes av REK midt, sendes klagen videre til Den nasjonale forskningsetiske komité for medisin og helsefag (NEM) for endelig vurdering.

Appendix B: Participant Consent Form

FORESPØRSEL OM DELTAKELSE I FORSKNINGSPROSJEKTET

Hvordan går det med pasientene?

En undersøkelse av behandlingsutfall for pasienter som mottar døgnbehandling for rusavhengighet

BAKGRUNN OG HENSIKT

Dette er et spørsmål til deg om å delta i en forskningsstudie der vi vil se hvordan det går med pasienter som mottar døgnbehandling for rusmiddelavhengighet. Målet er å undersøke om rusbehandlingen bidrar til redusert rusbruk og bedret livskvalitet. Det blir spesielt viktig for oss i denne studien å undersøke effekten av å ha innført strukturert trening som en del av rusbehandlingen ved klinikken. Vi ønsker å trekke lærdom av den behandlingen du og andre pasienter får. Resultatene fra studien vil kunne brukes til å forbedre behandlingstilbudet for rusavhengige i fremtiden.

HVA INNEBÆRER PROSJEKTET?

Undersøkelsen går ut på at du skal svare på et spørreskjema ved innleggelse i døgnavdelingen, og når du skrives ut. Det vil ta ca. 10-15 minutter å svare på disse spørsmålene. På en annen dag vil det bli gjort tester av kognitiv funksjon i form av to spørreskjemaer og noen praktiske oppgaver som til sammen vil ta omtrent 15-20 minutter å gjennomføre. I tillegg ber vi om lov til å bruke noen opplysninger fra journalen din, deriblant mål fra de fysiske testene du gjennomfører i treningspoliklinikken. Dette er målinger av den aerobe utholdenhetskapasitet (VO2max) og muskulær styrke. Etter VO2max testen vil det bli tatt en liten blodprøve (stikk i fingeren) for å måle laktatverdien etter fullført test. Vi ønsker også å kontakte deg pr. telefon ca. tre måneder og 12 måneder etter utskrivelse, for å undersøke hvordan det går med deg etter at du har avsluttet døgnbehandlingen.

MULIGE FORDELER OG ULEMPER

Resultater fra undersøkelsen vil kunne hjelpe andre med samme type problemer som deg selv. Deltakelse i studien vil ikke medføre spesielle ubehag. For noen kan det imidlertid oppleves som en belastning å svare på spørsmål om egen helse og livssituasjon. Dersom du har behov

for å komme i kontakt med en behandler etter at du er skrevet ut, kan du ringe vakttelefonen ved Klinikk for rus- og avhengighetsmedisin, St. Olavs Hospital. Tlf. 73 86 28 60.

FRIVILLIG DELTAKELSE OG MULIGHET FOR Å TREKKE SITT SAMTYKKE

Det er frivillig å delta i studien. Du kan når som helst, og uten å oppgi noen grunn, trekke ditt samtykke til å delta. Dette vil ikke få konsekvenser for din videre behandling. Dersom du ønsker å delta, undertegner du samtykkeerklæringen som er lagt ved. Om du nå sier ja til å delta, kan du senere trekke tilbake ditt samtykke uten at det påvirker din øvrige behandling. Dersom du senere ønsker å trekke deg, eller har spørsmål til studien, kan du kontakte prosjektleder Grete Flemmen ved forskningsavdelingen til Rusklinikken ved St. Olavs Hospital. Tlf. 908 77 876. E-post: grete.flemmen@stolav.no

HVA SKJER MED OPPLYSNINGENE OM DEG?

Svarene du gir gjennom spørreskjemaet, og informasjonen som registreres om deg, skal kun brukes slik som beskrevet i hensikten med studien. Alle opplysningene vil bli behandlet uten navn og fødselsnummer, eller andre direkte gjenkjennende opplysninger. En kode knytter deg til dine opplysninger, gjennom en navneliste.

Det er kun autorisert personell knyttet til prosjektet som har adgang til navnelisten, og som kan finne tilbake til deg. Det vil ikke være mulig å identifisere deg i resultatene av studien når disse publiseres. Alle opplysninger vil slettes senest i 2030.

FORSIKRING

Deltakerne er forsikret gjennom ordningen norsk pasientskadeerstatning (NPE).

ØKONOMI [GAVEKORT]

Ved deltakelse på alle målepunktet vil det bli gitt et gavekort som godtgjøring for tidsbruk. Dersom du svarer på spørsmålene stilt av vår forskningsmedarbeider ved alle måletidspunktene vil du få et gavekort på kr. 300,- Om du i tillegg gjennomfører de fysiske testene vil gavekortet ha en verdi på kr. 500,-.

GODKJENNING

Regional komité for medisinsk og helsefaglig forskningsetikk har vurdert prosjektet, og har gitt forhåndsgodkjenning (2019/501).

Etter ny personopplysningslov har behandlingsansvarlig Klinikk for Rus- og avhengighetsmedisin, St. Olav og prosjektleder Grete Flemmen et selvstendig ansvar for å sikre at behandlingen av dine opplysninger har et lovlig grunnlag. Dette prosjektet har rettslig grunnlag i EUs personvernforordning artikkel 6 nr. 1a og artikkel 9 nr. 2a og ditt samtykke. Du har rett til å klage på behandlingen av dine opplysninger til Datatilsynet.

KONTAKTOPPLYSNINGER

Dersom du har spørsmål til prosjektet kan du ta kontakt med prosjektleder Grete Flemmen ved forskningsavdelingen ved Klinikk for Rus- og avhengighetsmedisin ved St. Olavs Hospital. Tlf. 908 77 876. Epost: grete.flemmen@stolav.no

Personvernombudet ved St. Olavs kan kontaktes på E-post: personvernombudet@stolav.no

SAMTYKKE TIL DELTAKELSE I STUDIEN

Jeg er villig til å delta i studien

---------- ----------

(Navn med blokkbokstaver) Fødselsdato

(dag/mnd/år)

---------- ----------

(Signert av prosjektdeltaker) Dagens dato

Jeg bekrefter å ha gitt informasjon om studien

(Signert, rolle i prosjektet, dato)

Appendix C: The Symptom Check List (SCL-10) Self-Report Form

SCL-10

Symptom Check List

Strand etal. (2003). *Measuring the mental hea/th status ofthe Norwegian population: A comparison of/he instruments SCL-25, SCL-10, SCL-5 and MHl-5.*Nordic Journal of Psychiatry, 57, 113-118.

Mann O **Kvinne** O **Alder:** LJ **Dato:**

Under finner du en liste over ulike plager. Har du opplevd noe av dette den siste uken (til og med i dag)?

		Ikke plaget	Litt plaget	Ganske mye	Veldig mye
1	Plutselig frykt uten grunn	O	O	O	O
2	Føler deg redd eller engstelig	O	O	O	O
3	Matthet eller svimmelhet	O	O	O	O
4	Føler deg anspent eller oppjaget	O	O	O	O
5	Lett for å klandre deg selv	O	O	O	O
6	Søvnproblemer	O	O	O	O
7	Følelse av å være unyttig, lite verdt	O	O	O	O
8	Nedtrykt, tungsindig (trist)	O	O	O	O
9	Følelse av at alt er et slit	O	O	O	O
10	Følelse av håpløshet mht. framtiden	O	O	O	O

Appendix D: The BRIEF-A Self-Report Form

(Behavior Rating Inventory of Executive Function-Voksen)

Kartleggingsskjema for Eksekutive Funksjoner

SELVRAPPORTERINGSSKJEMA

Robert M. Roth, Ph.d, Peter K. Isquith, Ph.d, og Gerard A. Giola, Ph.d
Til norsk ved Jude Nicholas og Anne-Kristin Solbakk (2006)

Instruksjoner

På de følgende sidene er det en liste over påstander. Vi vil gjerne vite om du har hatt problemer med disse typene atferd i løpet av den siste måned. Vennligst besvar alle påstandene så godt du kan. vær vennlig å IKKE UTELATE NOEN AV PÅSTANDENE. sett en ring rundt ditt svar:

A	hvis atferden	**Aldri** er et problem
I	hvis atferden	**Iblant** er et problem
O	hvis atferden	**Ofte** er et problem

Hvis, for eksempel, du **aldri** har vansker med å ta en avgjørelse, skal du sette en ring om A ved dette utsagnet: Har vansker med å ta en avgjørelse

Hvis du gjør en feil og ønsker å rette den, så sett et kryss over der du satte feil ring, og svar med ny ring rundt det du mener er riktig. Før du begynner å besvare påstandene, vennligst fyll ut rubrikkene øverst på spørsmålsarket som angår navn, kjønn, alder, fødselsdato, datoen i dag, antall år og type skolegang/utdanning.

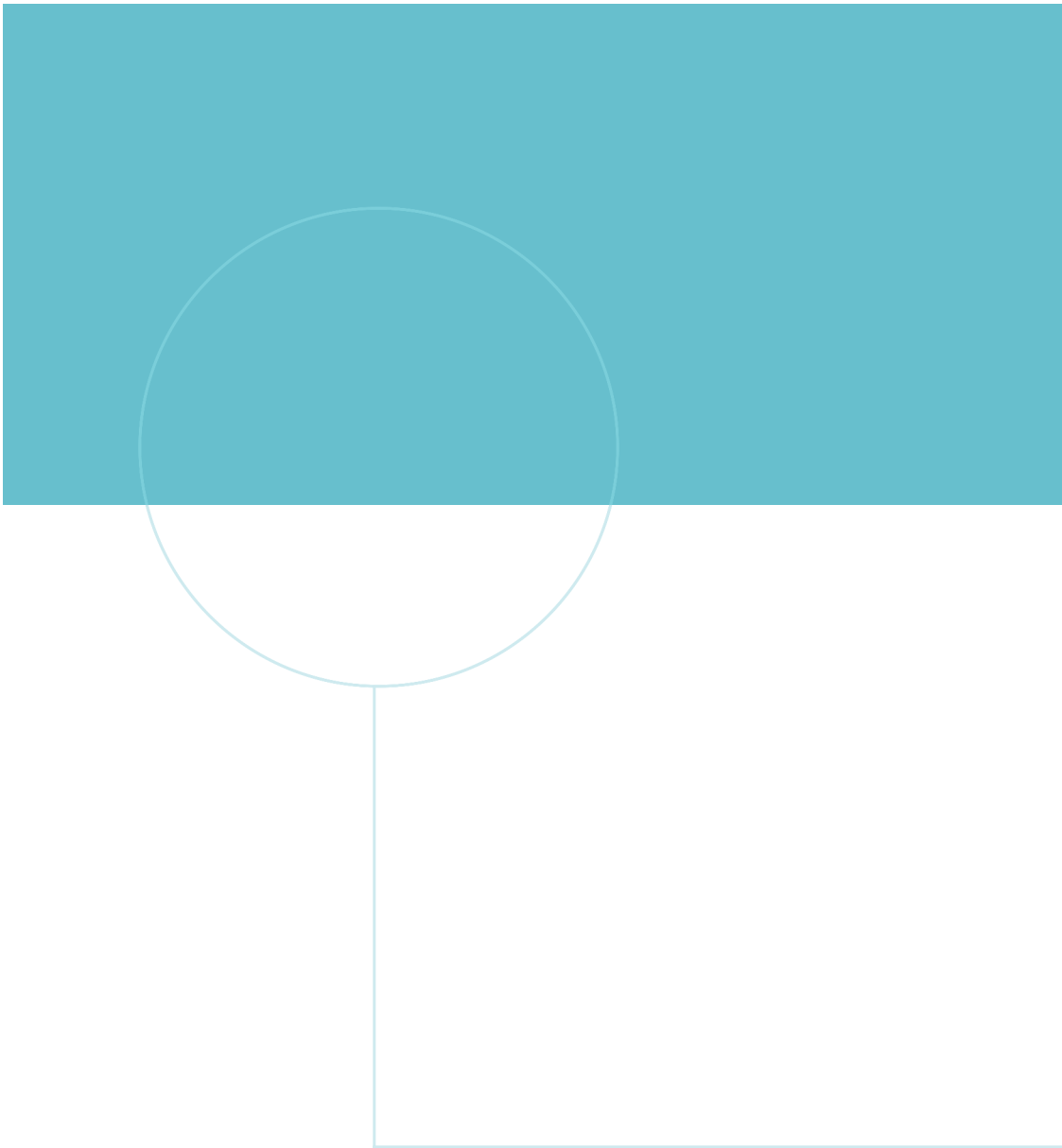
Svar på følgende påstander ved å markere den ruten du mener passer best (sett kun én ring for hvert spørsmål, og besvar vennligst alle spørsmål)

1. Jeg har sinneutbrudd
2. Jeg gjør slurvefeil når jeg arbeider med oppgaver
3. Jeg er uorganisert
4. Jeg har vanskelig for å konsentrere meg om oppgaver (f.eks. dagligdagse gjøremål, lesing eller jobb)
5. Jeg trommer med fingrene eller dirrer med beina
6. Jeg må bli påminnet om å komme i gang med en oppgave, selv om jeg har lyst
7. Klesskapet mitt er rotete
8. Jeg har vanskelig for å bytte fra en aktivitet eller oppgave til en annen
9. Jeg blir overveldet av større oppgaver
10. Jeg glemmer hva jeg heter
11. Jeg har problemer med jobber eller oppgaver som består av mer enn ett trinn
12. Jeg overreagerer følelsesmessig
13. Jeg merker ikke når jeg får andre til å bli lei seg eller sint, før det er for sent
14. Jeg har vansker med å komme i gang om morgenen
15. Jeg har vanskelig for å prioritere aktiviteter
16. Jeg har problemer med å sitte i ro
17. Jeg glemmer hva jeg holder på med selv om jeg er midt oppe i det
18. Jeg sjekker ikke arbeidet mitt for feil
19. Jeg reagerer følelsesmessig for den minste ting
20. Jeg oppholder meg mye hjemme
21. Jeg setter i gang med oppgaver (f.eks. matlaging, prosjekter) uten å undersøke om de riktige tingene er på plass
22. Jeg har vanskelig for å akseptere forskjellige måter å løse problemer på når det gjelder jobb, venner eller oppgaver
23. Jeg snakker på feil tidspunkt
24. Jeg feilvurderer hvor vanskelige eller lette oppgaver kan være
25. Jeg har vanskelig for å komme i gang på egen hånd
26. Jeg har vanskelig for å holde meg til saken når jeg snakker
27. Jeg blir trøtt
28. Jeg reagerer mer følelsesmessig i situasjoner enn mine venner
29. Jeg har vansker med å vente på tur
30. Folk sier at jeg er uorganisert
31. Jeg mister ting (f.eks. nøkler, penger, lommebok, hjemmelekser osv.)
32. Jeg har vansker for å finne en ny måte å løse et problem på når jeg ikke får ting til
33. Jeg overreagerer på små problemer

Hvor ofte har hver av de følgende former for atferd/reaksjon vært et problem for deg i løpet av den siste måned?

34. Jeg planlegger ikke for framtidige aktiviteter
35. Jeg har et kort oppmerksomhetsspenn
36. Jeg kommer med upassende seksuelle kommentarer
37. Når folk er sinte på meg, forstår jeg ikke hvorfor

38. Jeg har vanskelig for å telle til tre
39. Jeg har urealistiske mål
40. Jeg går fra et rotete bad
41. Jeg gjør slurvefeil
42. Jeg blir lett følelsesmessig opprørt
43. Jeg tar beslutninger som får meg i trøbbel (juridisk, økonomisk og sosialt)
44. Jeg plages av å måtte forholde meg til forandringer
45. Jeg har vanskelig for å bli begeistret
46. Jeg glemmer lett instruksjoner
47. Jeg har gode idéer men får dem ikke ned på papiret
48. Jeg gjør feil
49. Jeg har problemer med å komme i gang med oppgaver
50. Jeg sier ting uten å tenke
51. Temperamentet mitt er voldsomt, men det går fort over
52. Jeg sliter med å avslutte oppgaver (som f.eks. dagligdagse gjøremål, arbeid)
53. Jeg begynner med ting i siste liten (som f.eks. oppdrag, dagligdagse gjøremål, oppgaver)
54. Jeg har vanskelig for å fullføre en oppgave på egenhånd
55. Folk sier jeg blir lett distrahert
56. Jeg har vanskelig for å fullføre en oppgave på egenhånd
57. Folk sier at jeg er altfor følsom
58. Jeg haster igjennom ting
59. Jeg blir irritert
60. Jeg forlater rommet eller huset i et eneste rot
61. Jeg blir forstyrret av uventede forandringer i daglige rutiner
62. Jeg sliter med å komme på hva jeg kan gjøre i fritiden min
63. Jeg planlegger ikke oppgavene på forhånd
64. Folk sier at jeg ikke tenker før jeg handler
65. Jeg har problemer med å finne ting på rommet, i skapet eller på pulten min
66. Jeg har problemer med å organisere aktiviteter
67. Etter å ha støtt på et problem, kommer jeg ikke lett over det
68. Jeg har problemer med å gjøre mer enn en ting om gangen
69. Humøret mitt svinger ofte
70. Jeg tenker ikke på konsekvenser før jeg gjør noe
71. Jeg sliter med å organisere arbeidet
72. Jeg blir fort opprørt over småting
73. Jeg er impulsiv
74. Jeg rydder ikke etter meg
75. Jeg har problemer med å gjøre ferdig jobben min



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