Cognition in interned adolescents
Aspects of executive functions and training

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Knut and Ture
Acknowledgements

To the best of my understanding, one of the main purposes of an acknowledgements section is to dispel the notion of the doctoral thesis as an individual achievement. This certainly holds true for the present thesis: this work is certainly the result of contributions from several people. And while each have contributed in their own way, there is one thing uniting them: patience. As with probably most theses, this one had its ups and downs. Yet throughout the process, I have been continuously awed by how the people around me would maintain level heads and soft voices at all times. Even when a breakdown would have been, well, justified.

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Abstract

This doctoral thesis examines adolescents with a history of antisocial behavior with a focus on investigating executive functioning, impulsivity and experiences of everyday executive problems. The thesis further investigates the associations between self-reported and performance-based measures. Finally, it investigates whether processed-based executive function training can influence trained and non-trained executive functions and related scholastic abilities.

Antisocial behavior is a complex concept, associated with high costs of personal, interpersonal and societal nature. In general, people implement the majority of their life’s share of delinquent and antisocial behaviors around the adolescent years, as described by the so-called age-crime curve. This period is associated with rapid cognitive development and deficits in this area of time have been associated with an increased propensity for antisocial behavior. Also, larger impairments are associated with more severe behaviors. In many western countries, there exist a duality of both welfare and judicial considerations in the case of antisocial individuals who are minors. As compared to adults, persons under the age of criminal responsibility typically face a different combination of rehabilitative and penal consequences from maladaptive, delinquent or antisocial behaviors. In this context, increased understanding of the cognitive underpinnings of antisocial behavior, and how best to support sound cognitive development are therefore relevant to the furthering of rehabilitative practice. This thesis expands on existing knowledge by examining interned adolescents from an executive functions framework and also investigates how it relate to other constructs of clinical relevance.

This is done in three empirical studies. The first two are cross-sectional and aimed at assessing a number of cognitive constructs and associated behaviors. The third study is aimed at examining the effects of a training intervention on said constructs. The studies indicated poorer pre-test performance by the interned adolescents as compared to their non-interned counterparts. However, no deficits specific to any one executive function was discernable. The results also showed that the internees self-reports expressed more perceived problems with inhibiting behaviors and managing unplanned prompts to shift from a planned activity. They also indicated it harder to resist impulsive behaviors related to negative affect, lower premeditative ability, and had more issues with persevering in prolonged tasks. In addition, there were a few connections between the performance-based and the self-reported accounts of executive functioning. Of particular interest was that the majority of group effects in self-reported constructs was related to the specific executive function updating, a finding not previously reported. This function has previously been suggested to be antecedent of antisocial behavior. As for the training gains, the
only substantial cognitive improvement was to perceptual speed, which occurred irrespective of training progression or experimental condition. This was mirrored by the posttest self-reports whose rather modest gains were also unrelated to both experimental condition and training gains.

In conclusion, executive functioning and trait-based cognition are related to some degree, and both associate to antisocial behavior as operationalized by internment status. Process-based cognitive training can however not be determined to affect or alter these relations feasibly.
## List of abbreviations

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>ASB</td>
<td>Antisocial behavior</td>
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<tr>
<td>BRIEF</td>
<td>Behavior Rating Inventory of Executive Function</td>
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<tr>
<td>CWI</td>
<td>Color-Word Interference</td>
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<tr>
<td>DoH</td>
<td>Declaration of Helsinki</td>
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<td>EF</td>
<td>Executive function</td>
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<td>SiS</td>
<td>Statens Institutionsstyrelse (Swedish National Board of Institutional Care)</td>
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<tr>
<td>WISC</td>
<td>Wechsler Intelligence Scale for Children</td>
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<td>WAIS</td>
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List of papers


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1. Introduction

At the onset of George R.R Martin’s *Game of Thrones* book series, one of the main characters ventures out on a perilous climb up a castle tower, despite having been explicitly told *not* to do so by his mother. An act of youthful mischief no doubt, but crucially the character was also lacking in forethought. The consequences would prove unimaginably severe, something fans of the saga undeniably appreciate, to no end. Indeed, young people getting themselves into trouble have a peculiar way of capturing both our imagination and our curiosity. This holds true for both fiction and real life. In the latter case, this curiosity will eventually lead one into the notion of *antisocial behavior*.

Antisocial behavior is a complex concept, associated with high costs of personal, interpersonal and financial nature. It is context dependent and can be defined in several ways (Binder, 1988; E. W. Burgess, 1923). Criminologists use definitions such as delinquency, violent behavior or property damage, or rule breaking behavior in general, whereas psychologists and psychiatrists look at psychosocial symptoms such as conduct disorder (Piotrowska, Stride, Croft, & Rowe, 2015). However, all the above definitions do acknowledge cognitive processes as being crucial for controlling behavior. These control processes are called *executive functions* and involve the setting of goals, planning for them, and implementing the plans, while monitoring both progress and any new developments which might have an impact on the original plans.

Conversely, impaired executive functions can contribute to the adaptation of antisocial behavior. Consider a mundane everyday challenge of perhaps a financial, or intrapersonal nature. The number and quality of possible solutions perceived by an individual will be severely impaired if their *problem-solving* and/or *planning* abilities are deficient. Likewise, the failure to *shift* between different strategies and possible goal states will further complicate their choice of action. This is particularly troublesome if the ability to *monitor* and *update* oneself on the progress relating to the current choice of action is diminished, as will the selection of future solutions. If one lacks the *working memory* capacity to compare a current choice of action with the outcomes of previous similar situations, this becomes even more so. Also, the inability to *inhibit* inappropriate or unpremeditated behaviors will impede the implementation of the chosen course of action. When these functions are impaired, the risk of reinforcing a recurring trend of maladaptive behaviors is amplified.

Indeed, deficient executive control have been associated with a number of maladaptive behaviors, such as substance abuse (Nigg et al., 2006), excessive risk-propensity (Pharo, Sim, Graham, Gross, & Hayne, 2011; Syngelaki, Moore,
Savage, Fairchild, & Van Goozen, 2009), and aggression (Hoaken, Shaughnessy, & Pihl, 2003; Seruc & Silva, 2016). Certainly, this drive to examine the neuropsychological underpinnings of antisocial behavior have further nuanced our understanding of this phenomenon, particularly in clinical populations (E. Ross, 2012). This is further emphasized by its developmental relevance, as demonstrated in longitudinal observations on executive functioning and antisocial behavior from childhood onto adolescence (Raine et al., 2005).

This doctoral thesis examines adolescents with a history of antisocial behavior and focuses on investigating general and specific executive functioning, fluid intelligence, impulsivity and experiences of everyday executive problems. The thesis further investigates the associations between self-reported and performance-based measures. Finally, it investigates whether processed-based executive function training can influence trained and non-trained executive functions and, by extension, if the experience of executive problems, impulsivity, and performance on school related tasks are thusly facilitated.

Before reviewing the studies encompassed within this thesis, an introduction to the central constructs will be provided. The next chapter will discuss adolescence and antisocial behavior in relation to developmental trajectories. Thereafter, we will zoom in on executive control and discuss specific executive functions. This will be complemented with neuroscientific findings from clinical samples and a discussion on the merits of both performance-based and self-reported measures of executive functions. The following section will discuss the notion of impulsivity and how it relates to antisocial behavior and to executive function. This is followed by a look at how youth care practices are organized in Sweden. Finally, we will deliberate on cognitive training and review a number of recent findings of relevance.

Before venturing further, an important disclaimer needs to be made. Antisocial behavior is a very complex topic. It is influenced by a host of individual and structural factors, and has been studied from a wide range of perspectives. To mention but a few is the social worker perspective (S. A. Kirk, Wakefield, Hsieh, & Pottick, 1999), the relation to substance abuse (Durbeej et al., 2015), as well as neighborhood (Odgers, Donley, Caspi, Bates, & Moffitt, 2015) and family (Murray, Farrington, & Sekol, 2012) influences. As such, the present thesis examines but one facet of antisocial behavior, nevertheless I still hope this humble contribution will prove of some merit.
2. Adolescence and antisocial behavior

Adolescence, defined here as the teenage years plus minus a few years, is a period of rapid neural growth and increase in cognitive capacity. It is also the period in which most people are offending and the period when people commit their largest number of offences. This observation is stable at the population-level, and is followed by a gradual decline through adulthood (Sampson & Laub, 2003). This peculiar age-crime distribution in antisocial behavior has attracted the attention of researchers from a wide range of academic fields, including the perspective of developmental psychology (Bartol & Bartol, 2009; Ginner Hau, 2010). One of the most influential theories in this vein is Moffitt’s dual taxonomy. It describes two distinct developmental trajectories of antisocial behavior: adolescence-limited and life-course persistent. One consistent empirical finding within this theory is that two factors, age-at-onset and duration, divide young offenders into two relatively distinct groups (Moffitt, 1993).

Of these groups, the majority fall within the group adolescence-limited offenders. These start offending relatively late and have their delinquent behaviors confined to the adolescent years. Thereafter, a sharp and permanent drop in offending occur in early adulthood which has been suggested to be related to differential trajectories of neuronal development. More specifically, the earlier development of structures related to sensation- and reward-seeking behaviors compared to structures related to cognitive control are thought to generate a temporary “maturity gap” (Romer, 2010; Steinberg, 2010). This gap is characterized by a more pronounced preference for novelty at the expense of cognitively guided premeditative ability. The second group described in the dual taxonomy is the life-course persistent offenders. These individuals start offending in late childhood, and persist in their maladaptive behavior patterns into midlife or even longer. Life-course persistent antisocial behavior has been suggested to originate earlier in life as a continuously accumulating process of difficult early temperament interacting with an adverse social environment, thus impeding the development of prosocial skills. This is further aggravated by an increased prevalence of psychosocial comorbidities, and by cognitive deficits either inherited or acquired (Lynam, Moffitt, & Stouthamer-Loeber, 1993; Moffitt et al., 2007).

Regarding cognition however, more recent research has indicated instead that both groups show deficient functioning, albeit the life-course persistent group more severely so (Johnson, Kemp, Heard, Lennings, & Hickie, 2015). Several meta-analyses support this notion by showing a stable and substantial relationship between antisocial behavior and diminished cognition, and particularly so for the executive functions (Morgan & Lilienfeld, 2000; Ogilvie,
Stewart, Chan, & Shum, 2011; Pennington & Ozonoff, 1996). However, the specifics of these deficits are still unclear, as is to what extent they relate to adolescent antisocial behavior. This is both owing to a lack of studies and a methodological disparity, issues this thesis will endeavor to answer. Therefore, the next chapter will proceed with a more detailed look at the notion of executive functions.
3. Executive Functions

Executive functions are a set of limited-capacity higher-order processes allowing us to conduct goal-directed behavior. As mentioned in the first chapter, this involves the setting of goals, planning for implementation of these, and actually implementing the plans. The plans need to be kept in mind whilst monitoring the implementation, and new developments which might affect the original plans need to be incorporated and remembered as well. The majority of psychological models describe these as top-down processes, and particularly important in resolving non-routine situations. The adaptive flexibility exhibited by humans is greatly amplified by effective executive functions and is accordingly curtailed when their efficiency is compromised.

Being of acknowledged importance for human agency, this class of processes has seen a substantial amount of research with several models proposed (Banich, 2009). Executive functions have been viewed as emergent from fundamental psychological constructs (Salthouse, 2005), as a framework of executive attention (Kane & Engle, 2002), an executive control component in a working memory model (Baddeley, 2003), and as a number of related cognitive subcomponents (Friedman et al., 2006). In this thesis, I will adopt the latter view. This approach is supported by patterns in both behavioral and neural development, by the effects of acquired brain damage, and in experimental studies. These will be discussed in the next following sections.

3.1 Development of the executive functions

Throughout childhood, executive functions improve rapidly. This can be observed across a host of abilities, such as attention, numerical and spatial memory and reasoning ability (S. E. Gathercole, Pickering, Ambridge, & Wearing, 2004). The improvements are more rapid in earlier years, slower during adolescence and level off during early adulthood. For instance, the development of continuous attention occurs in early childhood, whereas selective attention is developed only towards middle childhood. Delays in this development is associated with specific real-life challenges, including scholastic attainment (S. Gathercole & Pickering, 2003) and antisocial behavior (Raine et al., 2005).

3.2 Executive functions and the brain

Throughout childhood and adolescence, multiple developmental processes contribute to a brain in continuous structural reorganization (Casey, Tottenham, Liston, & Durston, 2005). Myelination of neurons make for faster signals and pruning of non-contributing connections facilitate the specialization of
development of ever more specialized neural networks over time (Bathelt, Gathercole, Johnson, & Astle, 2016). Higher cognition, including the executive functions, are associated with frontal and prefrontal areas of the brain: These include structures such as lateral prefrontal and parietal cortices, and dorsal striatal areas (Diamond, 2012; Romer et al., 2011). Development of cognition are strongly associated to neural developments in these areas. Motivation and reward-seeking behaviors though, are associated with limbic and paralimbic areas. These including orbitofrontal and medial prefrontal cortices, and ventral striatal areas (Steinberg, 2008). Importantly, while these two neural networks are thoroughly interconnected, they nonetheless have differing developmental trajectories during adolescence. Areas associated to motivation and reward-seeking behaviors develop at a faster pace in early adolescence, in advance of the areas associated to cognitive control. This creates a temporary imbalance in the gross neural network. It has been suggested that this imbalance generates a “maturity gap,” forming the biological basis of the age-crime distribution mentioned above in chapter one (Romer et al., 2011; Steinberg, 2010).

### 3.2.1 Brain injuries
Cognitive abilities are unfortunately rarely as readily noticed and defined as when they are suddenly absent. This can be attested to by anyone recovering from a stroke. In the same way, a substantial part of what is known about the neural substrates of executive functioning comes from the study of injuries and abnormalities in the brain (Koski & Petrides, 2001; Luria, 1966). This relates to executive functioning as individuals with a history of head trauma often exhibits increased impulsivity and diminished ability to plan, make decisions and regulate emotions as well maintaining functional social behaviors (Novakovic-Agopian et al., 2011). Indeed, particularly the prefrontal regions of the brain (Fellows & Farah, 2005; Rolls, Hornak, Wade, & McGrath, 1994; Shallice & Burgess, 1991) as well as a number of sub-cortical structures (Monchi, Petrides, Strafella, Worsley, & Doyon, 2006), has been found to be of susceptible to damage in this regard. Furthermore, imaging studies indicate that impairments to decision making are differently related to damage in the separate neural structures associates with the aforementioned maturity gap (Fellows & Farah, 2005). This is also evident in the diminished performance on neuropsychological tests, both with regard to cognition (ibid.) and to socio-emotional behaviors (Rolls et al., 1994).

The observation on neural damage and cognitive dysfunction also have a relationship to antisocial behavior (Yang, Glenn, & Raine, 2008). As a general tendency, interned populations are highly overrepresented on account of having a history of traumatic head injury (Kavanagh, Rowe, Hersch, Barnett, & Reznik, 2010; Mullin & Simpson, 2007). Furthermore, frontal lobe damages have been
explicitly been associated to a number of dyscontrolled behaviors, including aggression (Brower & Price, 2001) and domestic violence (Marsh & Martinovich, 2006). However, these observations are by themselves not sufficient to fully accommodate the relationship between executive dysfunction and antisocial behavior (E. Ross, 2012).

3.3 Performance-based assessments of executive functioning
Another vein of inquiry concerning the separation of executive functions comes from experimental studies using neuropsychological tests on non-clinical populations. Even in the absence of injury, individual differences have been found to be highly correlated, albeit separate, from other central cognitive constructs, such as fluid intelligence or working memory. The main point here is that these individual differences have a strong tendency to fit into robust multi-component structures at the latent level. A core three-factor structure is consistently observed across studies (Diamond, 2013). This structure is described in the Unity/Diversity framework (Friedman & Miyake, 2017; Miyake et al., 2000) which will be used to conceptualize executive function throughout this thesis. The name of the framework stems from the dual properties of having its components being both related yet separable: the component executive functions all contribute, albeit differently, and to various extents, in the resolution of various types of tasks and operations. To note, the Unity/Diversity framework does not encompass all processes of executive character but rather the three most robustly expressed in experimental contexts (Friedman & Miyake, 2017). The three component executive functions in the model are labeled: inhibition, shifting and updating.

Inhibition is a component corresponding to the ability to inhibit instinctual, proponent and reflexive behaviors and retain attention. This supports the ability to exhibit goal-directed behavior by facilitating non-instinctual courses of action. It is also crucial for persevering in more arduous tasks and maintaining cognitive resources in resolving non-routine tasks.

Shifting is a component related to reassignment of cognitive resources. The use for such a component is permitting a controlled shifting of attention. This has several advantages, such as maintaining or monitoring parallel tasks (“multitasking”), and the changing of mental sets, or goal states. This also facilitate goal-directed behavior by allowing for greater behavioral flexibility.

Updating is a component related to in/out processing of information in working memory. This component involves the discarding of obsolete information and the incorporation of new information in working memory. It enables up-to-date
awareness of ongoing events, allowing for response and adjustment in the light of changing contingencies.

One implication of this is that the component functions can be differentially assessed by using batteries of performance-based neuropsychological instruments. This is assumption of particular relevance to the present thesis; the inquiry at hand concerns interned adolescents, which for practical reasons, limits the opportunity to assess executive functioning at the latent level. Furthermore, the Unity/Diversity framework has been found to be appropriate from a developmental perspective as it emerges from two-factor structure in early-to-mid childhood to the typical three-factor structure by late childhood (Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003). It has also been used successfully to assess and categorize clinical groups, including antisocial groups (Herrero, Escorial, & Colom, 2010). As such, it is a relevant model to use when examining adolescent groups with a history of maladaptive behavior.

3.4 Report-based assessments of executive functioning

As has already been pointed out, executive functioning is crucial in handling new situations. This is relevant in activities such as structuring or performing tasks and chores, and in solving logistical challenges. Such situations require a host of cognitive capacities, but are nonetheless difficult to capture using instruments adapted for the experimental context. Indeed, performance-based tasks have well-defined goal states and are typically taken in a controlled environment. These tasks are generally neuropsychological instruments aimed at assessing the efficiency of the information processing at optimal conditions. Often the context is either provided by the researcher and/or kept artificially barren. This reduction of situational richness and contextual factors, can act as a supporting scaffolding, allowing cognitively impaired participants to perform at unimpaired levels (Lezak, 1993). This is a contributing reason why ecological validity, i.e. the correspondence between experimental task performance and analogous everyday activities, is relatively low in performance-based cognitive tasks (P. Burgess, Alderman, Evans, Emslie, & Wilson, 1998; Nęcka, Lech, Sobczyk, & Śmieja, 2012). By contrast, the predictive power of experimental cognitive tasks to individual scholastic attainment is substantially greater (Alloway, Gathercole, Adams, & Willis, 2005; Bull & Scerif, 2001; Loosli, Buschkuehl, Perrig, & Jaeggi, 2012).

Cognitive demands in everyday life are rarely straightforwardly process pure, nor are they without involvement of idiosyncratic factors such as internal goals or affect. This can be described as cognitive functioning with the inclusion of modulating effects from emotions. These effects, including the experience of reward and punishment, everyday wants, needs, and desires, are all ultimately
related to personality. Certainly, the link between emotion and decision making has been demonstrated in a range of clinical (Malloy-Diniz, Fuentes, Leite, Correa, & Bechara, 2007; S. R. Ross, Benning, & Adams, 2007; Stout, Rock, Campbell, Busemeyer, & Finn, 2005) and experimental (Franken & Muris, 2005; Suhr & Tsanadis, 2007) settings. Neuronally, this link has been related to the orbitofrontal cortex and a number of subcortical structures, exhibiting a multi-level modulating effect on cognitive processing (Bechara, Damasio, & Damasio, 2000).

Provided the important distinction between cognition with and without emotional modulation then, it makes sense to incorporate both in a study of aberrant conduct. As we shall see, both types are related to executive functioning, and both have been associated with antisocial conduct. These maladaptive behaviors can by definition can be argued to include a deficient cognitive component in the form of aberrant planning, problem-solving and decision making. Nonetheless, the relationship between executive functioning and self-regulatory aspects of personality has until recently been an understudied topic (Hofmann, Schmeichel, & Baddeley, 2012). Crucial interactions may be missed by persistence to examine either variety by itself, differing cognitive process levels none withstanding. While the present thesis is but scratching the surface, this combined approach had been noted to be both promising and urgent (L. J. M. Cornet, van der Laan, Nijman, Tollenaar, & de Kogel, 2015).

I chose to ameliorate the issue by supplementing performance-based instruments with report-based ones, allowing for the assessment of how executive functioning is perceived. Report-based instruments have the advantage of permitting reports by both the individual and by others in the immediate environment, also making comparisons possible. This type of instrument tends to have high correlations with everyday functioning and low correlation with performance-based instruments (Duckworth & Kern, 2011). On the subject of executive functioning, report-based instruments are typically developed and structured to be used in research, but have also found their way into clinical practice. There, they are used to assess individual perceptions on their cognitive environment, and in screening procedures prior to more comprehensive investigations. Report-based instruments are typically in questionnaire format which simplify administration and provide a standardized way to evaluate both strengths and weaknesses as perceived in everyday functioning (Nęcka et al., 2012).
3.5 A combined approach in the study of antisocial behavior

The research on the cognitive underpinnings of antisocial behavior is an expanding field of research, with executive functioning deficits having been demonstrated in a range of antisocial groups, and across a variety of methodical approaches (Morgan & Lilienfeld, 2000; Ogilvie et al., 2011; Pennington & Ozonoff, 1996). Aspects of lacking executive functioning have been related to a variety of maladaptive behaviors, such as substance abuse (Nigg et al., 2006), excessive risk-propensity (Pharo et al., 2011; Syngelaki et al., 2009), aggression (Hoaken et al., 2003; Seruca & Silva, 2016) and varying severities of criminality (Burton, Demuyneck, & Yoder, 2014; Pihet, Combremont, Suter, & Stephan, 2012). Both performance-based and report-bases means of investigation are convergent on the relationship between deficits related to executive functioning and antisocial behavior.

However, the much of the previous research on this topic has been conducted on adult populations, and often using singular measures for complex and multi-faceted constructs and regularly in the absence of a comprehensive theoretical framework for executive functioning. This makes it difficult to ascertain both extent and quality of executive function impairment in younger antisocial groups. What is known is that prevalence rates of impairment in young offenders show considerable variation, with some estimates being well over half the group in question (Muscatello et al., 2014).

As such, the present thesis attempts to incorporate both types of assessments, to assess their relations, and this within a theoretical framework with both experimental and neurological foundations.

Having concluded with the discussion of the relevance of considering executive functions in the study of antisocial behavior, we now turn to the notion of impulsivity. This multi-faceted aspect of personality has long been considered of relevance in the study of antisocial behavior in and of itself. When incorporated into the study of executive function, it enables investigation of the modulating effects of motivation and emotion as well. In the upcoming chapter, we will take a closer look at why this is relevant in the study of adolescent antisocial behavior.
4. Impulsivity

Moving from executive functions to impulsivity, I should first note that this concept is by no means new to the study of antisocial behavior. In adolescents, one of the more consistent empirical findings is the propensity for rash, injudicious and otherwise unplanned actions (White et al., 1994) which have been suggested to relate to antisocial behavior (Gordon & Egan, 2010; Lynam et al., 1993). This elevated impulsivity is considered a contributing factor to the characteristics of the previously mentioned age-crime curve. Sure enough, the notion of impulsivity has been found to associate with various forms of antisocial behavior in both community samples (d’Acremont & Linden, 2005; Pharo et al., 2011), clinical samples (Swann, Bjork, Moeller, & Dougherty, 2002) and young offenders (Carroll et al., 2006).

Historically, impulsivity has been studied from differing venues of approach. This thesis will consider two: trait-based and cognitive conceptualizations. In the former, impulsivity is viewed as a personality trait whereas in the latter, it is viewed as a cognitive control characteristic. However, both strands of research share the proposition that the concept of impulsivity subdivides into multiple components, rendering a singular definition insufficient. Both of these conceptualizations have also been found to be associated with maladaptive behaviors (Lane, Cherek, Rhoades, Pietras, & Tcheremissine, 2003; Smith et al., 2007), though scarcely with one another (Cyders & Coskunpinar, 2012; Duckworth & Kern, 2011; Reynolds, Ortengren, Richards, & de Wit, 2006; Sharma, Kohl, Morgan, & Clark, 2013). A proposed explanation for this lack of shared variance is the different levels of cognitive processing required by the instruments used within the two conceptualizations. Instruments within the cognitive methodological tradition tend to assess the efficiency of the information processing with the goal states provided by the task structure. On the other hand, instruments assessing trait-based impulsivity allow greater freedom in interpreting the task which may result in goal states differing between participants (Toplak, West, & Stanovich, 2013).

Nonetheless, as both conceptualizations have proven sensitive to various clinical conditions, a combined study design would enable the study of impulsivity from a larger perspective (Sharma, Markon, & Clark, 2014). Furthermore, even if the overarching conceptualizations are largely uncorrelated, the occurrence of specific relations within the context of adolescent antisocial behavior can still prove informative.
4.1 Cognitive impulsivity

For the purposes of this thesis, the concept of cognitive impulsivity will be assessed within the Unity/Diversity framework of executive functions (Miyake et al., 2000; Miyake & Friedman, 2012). The reasoning behind this choice is relatively straightforward. The majority of studies on cognitive impulsivity employ neuropsychological tasks that are either similar to, or the same as, those used in studies of executive functioning. Moreover, it is a recurring feature of cognitive impulsivity that it subdivides into separate, though associated, components. The relationship to executive functioning becomes even more evident when considering what components are typically derived: Inattention, Disinhibition and Impulsive Decision Making (Reynolds, Penfold, & Patak, 2008; Sharma et al., 2014). Less frequently occurring, but nonetheless suggested as additional cognitive impulsivity components, are Response Delay difficulty, Time Distortion (Cyders & Coskunpinar, 2011, 2012) and difficulty in Shifting (Sharma et al., 2014). These components also relate to central constructs as is studied in cognitive psychology, including self-regulation, attention, planning (Steinberg, 2008) reward processing, working memory (Romer et al., 2009), self-control, and monitoring (White et al., 1994).

4.1.1 Cognitive impulsivity and antisocial behavior

While the relationship between cognitive functioning and impulsivity is understudied from the perspective of antisocial behavior (Meijers, Harte, Jonker, & Meynen, 2015), what studies there are points to specific, rather than general deficits. These include deficits in working memory and reward processing (Romer et al., 2009), elevated rapid-response impulsivity (Swann, Lijffijt, Lane, Steinberg, & Moeller, 2009) and low inhibitory control (Carroll et al., 2006). However, the lack of a comprehensive theoretical framework and a proliferation of methodological variations (Reynolds et al., 2006) precludes the emergence of a consistent picture. That being said, several authors have suggested cognitive functioning (Arce & Santisteban, 2006; Raine et al., 2005; Romer et al., 2011; White et al., 1994) to drive the relationship between impulsivity and antisocial behavior. Reports of real-life risky adolescent behavior (Pharo et al., 2011) as well as on psychopathy (Vitacco, Neumann, & Wodushek, 2008), are in line with these suggestions.

4.2 Trait based impulsivity

The concept of trait based impulsivity is related to the notion of personality and to socio-emotional behaviors. As such, it is related to subjective perception and goal-directed behaviors rather than information processing. It is usually studied using standardized instruments of self-report and other-report type. Contemporary research has taken a step away from the notion of trait based
impulsivity as a unified construct, instead conceptualizing trait based impulsivity as a number of separate, yet interrelated facets. Indeed, a number of factor-analytically derived models have been proposed (Duckworth & Kern, 2011; Reynolds et al., 2008; Whiteside & Lynam, 2001). The notion of impulsivity as a construct with multiple stable facets, or impulsigenic traits, is reinforced by the highly comparable features across models. This include features such as the propensity for affective action, the notion of attentional self-control and behaviors concerning novelty seeking are all recurring and are typically regarded as established impulsigenic traits (Sharma et al., 2013). These traits are present in the model, UPPS (Whiteside & Lynam, 2001), used in the present thesis. UPPS is an acronym for the four constituent impulsigenic traits Urgency, (lack of) Premeditation, (lack of) Perseverance and Sensation Seeking. Here, the propensity for action under negative affect is represented by Urgency, while attentional self-control is represented by the two facets Premeditation and Perseverance, respectively. These first three tend to intercorrelate whereas the novelty seeking behaviors, represented by Sensation Seeking, tend to show separate and uncorrelated variance (Duckworth & Kern, 2011).

The subdivision into impulsigenic traits, and the separateness of novelty seeking behaviors, also fit with the notion of functionally and neuronally separate systems. Both the Dual Systems Model (Steinberg, 2010), and the Striatal Imbalance Model (Romer et al., 2011) deal with adolescent impulsivity and risk-taking behaviors. Their models propose separate systems for socio-emotional behaviors, including novelty seeking, and for cognitive control, guiding action and inhibition.

The cognitive control system has been associated with the dorsal part of the frontostraial pathway (Romer et al., 2011), a region noted to develop steadily throughout adolescence (Van Leijenhorst et al., 2010). It is related to propensity to act non-premeditatedly and under the influence of negative emotionality (Magid, Maclean, & Colder, 2007; Smith-Spark & Fisk, 2007). The socio-emotional system is associated with the ventral part of the frontostraial pathway, a region undergoing rapid development during early puberty, a time which has been noted to feature an increase in novelty and reward-seeking behavior (Steinberg, 2008). The neural structures associated with these two types of behavior do thus differ in their developmental trajectories throughout adolescence. This is the proposed neural mechanism behind the aforementioned “maturity gap,” occurring in early to middle adolescence, thus coinciding with the adolescent age-crime curve peak. Here the cognitive control system as not yet caught up with the passions of the socio-emotional system (Moffitt, 1993; Romer, 2010).
4.2.1 Trait based impulsivity and antisocial behavior
Significant progress has been made in linking impulsigenic traits to various forms of maladaptive and antisocial behavior. With regard to the UPPS model, diminished Premeditation and increased Sensation Seeking have been associated with antisocial behaviors in non-delinquent adult populations (DeShong & Kurtz, 2013; Miller, Flory, Lynam, & Leukefeld, 2003). Concerning clinical groups, the UPPS also show discriminatory power: lower Perseverance in drug rehabilitants (Sargeant, Bornovalova, Trotman, Fishman, & Lejuez, 2012) and higher levels of Urgency in aggressive (Carlson, Pritchard, & Dominelli, 2013; Dereffinko, DeWall, Metze, Walsh, & Lynam, 2011) and borderline personality disordered groups (DeShong & Kurtz, 2013; Jacob et al., 2010). Higher levels of Urgency is also associated with the severity of maladaptive behaviors (Anestis, Selby, & Joiner, 2007; Smith et al., 2007). Higher levels of Sensation Seeking have also been associated with a higher frequency of maladaptive behaviors (Smith et al., 2007). It has been pointed out however, that a period of increased reward-seeking behaviors early in life is likely beneficial from an evolutionary perspective and, in the majority of people, from a personal perspective as well (Sercombe, 2014).

4.3 Combining the two approaches to impulsivity
Impulsivity is decidedly relevant to study in the context of adolescent antisocial behavior. While elevated sensation-seeking behaviors, diminished cognitive control, and poor cognitive functioning have all been observed in adult antisocial populations, adolescents are markedly understudied in this regard. The relative contributions of impulsivity and cognitive functioning on both sides of the aforementioned “maturity gap” is still largely unclear. There are substantial benefits to advancing the knowledge of which impulsigenic traits are elevated in adolescents with a history of maladaptive behavior, and how these are related to cognitive functioning. Additional depth in the investigative and screening settings can improve the basis for selecting rehabilitative actions (Gordon & Egan, 2010). This thesis attempts to advance this knowledge.

In the first four chapters, we have acquainted ourselves with the main theoretical concepts in question for this thesis. In the next chapter we will take a closer look at some societal perspectives on adolescent maladaptive behavior in Sweden and how these relate to the present research endeavor.
In the legal practices of many western countries, the societal response to maladaptive behaviors differs depending on if the person in engaging in them is an adult or a minor (under the age of criminal responsibility). In the case of individuals who are minors, there exist a duality of both welfare and judicial considerations. As compared to adults, persons under the age of criminal responsibility typically face a different combination of rehabilitative and penal consequences from maladaptive, delinquent or antisocial behaviors. Several reasons underlie this state of affairs. Industrialized societies do typically assume certain responsibilities regarding the welfare of their under-age citizens, including provisions for social services, health care and education for young individuals exhibiting maladaptive behaviors. Also, minors are not considered fully accountable for their actions, on account of not having fully developed cognitive abilities and impulse control.

In Sweden, these dual considerations of justice and welfare for maladaptive adolescents is manifest in both legal system and in the practices of the social service agencies. Approximately 30,000 under-age individuals are annually assigned to various types of out-of-home care. The assignment decisions are based on legal history and current psychosocial and socioeconomic conditions, and are intended to prevent, reverse or ameliorate adverse outcomes. Out of these instances, approximately 4%, or 1,100 out of 29,000 youth (Dahlström, 2013), are assigned to compulsory care in closed facilities.

5.1 Compulsory care

The governmental agency charged with providing this type of compulsory care is the Swedish National Board of Institutional Care (Statens Institutionsstyrelse, SiS). The individuals assigned to SiS are those with the most pronounced needs and/or more adverse home environments precluding other forms of treatment. The majority have backgrounds involving social deviance, psychosocial issues, involvement with the juvenile justice system or problems with substance misuse. Roughly 5% of the internees have a history of more severe criminality and instead serve their sentences in the care of SiS.

5.1.1 Structure of the National Board of Institutional Care

SiS provides care by operating specialized facilities, dispersed throughout Sweden. These facilities have a functional organization featuring three main
types of wards: emergency, evaluation, and treatment. The majority of the SiS facilities operate all three types of wards to some extent.

Emergency wards are intended to help individuals break an ongoing destructive behavior or substance misuse pattern in order to allow for other types of treatment. Internees typically spend but a few weeks at such a ward before being either discharged or transferred.

Evaluation wards assess internees from a number of different perspectives, including psychosocial and cognitive functioning, educational situation and rehabilitative needs. Individuals are admitted to evaluation wards either from emergency wards or directly from social services, and typically stay for eight weeks before being discharged or transferred.

The duration of the stay at emergency and evaluation type wards are rarely above eight weeks which, as we will come to in a bit, impedes participation in the present thesis project. Nonetheless, these types of wards account for about 70% of the individuals admitted to SiS facilities.

Treatment wards accommodate the remaining 30%, or around 350, of the internees at SiS. These are individuals urgently in need of highly specialized care. The treatment provided at these wards is especially adapted to their particular individual needs, often based on information gleaned from their stay at an evaluation ward. The types of treatment available include interventions such as Aggression Replacement Training, Cognitive Behavioral Therapy, and Functional Family Therapy, as well as regular schooling. The length of stay at these wards is not limited in a legal sense, although the average internee at a treatment ward stays for about five months.

This thesis is about the young people in the care of SiS, and primarily those placed in treatment wards. These individuals often have a history of maladaptive behavior and have placement durations of sufficient length to accommodate process-based cognitive training interventions. In the next chapter, we will expand on this by examining the notion of cognitive training and how it may be implemented in this context.
6. Cognitive training

Recent decades have seen a surge in research on the variability of human cognition. This effort was spurred on by findings suggesting cognition being not as static as had previously been presumed, thus offering the prospect of training. These recent efforts have taken place in both clinical and non-clinical settings, and with various aims. Directly modifiable cognitive functioning would have broad implications in a number of contexts, including the rehabilitation of traumatic brain injuries (Serino et al., 2007), the alleviation of age-related cognitive decline (Sandberg, Rönnlund, Nyberg, & Stigsdotter Neely, 2014), and the improvement of scholastic prospects (Joni Holmes & Gathercole, 2014). As such, this concept has in recent times attracted much interest, both in scientific and public discourse.

Memory training advertisement in Popular Mechanics, November 1918
The notion of cognitive training is founded on two phenomena, *plasticity* and *transfer*, which we will be looking at in the next two sections. Thereafter we will acquaint ourselves with the layout of training interventions in general, and design factors following from the initial two concepts in particular. This chapter will then close with a brief review of previous cognitive training research, both on young people and on antisocial populations.

### 6.1 Plasticity

The idea of imposing specific environmental demands in the form of training in order to improve or modify mechanisms of human cognitive functioning rests on the notion of plasticity (Green & Bavelier, 2008; Kelly, Foxe, & Garavan, 2006). By definition, plasticity is a reaction to a prolonged mismatch between the capacity of the cognitive functioning and the imposed external demands on it (Lövdén, Bäckman, Lindenberger, Schaefer, & Schmiedek, 2010). It is thus an extension of the flexibility exhibited by cognitive functions in their adaptation to the task at hand (Ischebeck, Zamarain, Egger, Schocke, & Delazer, 2007) and differs from cognitive flexibility, which operates within the current capacity.

### 6.2 Transfer

One of the main challenges in cognitive training endeavors concerns generalizability. That is, to what extent progress in training settings can be said to affect untrained tasks, and ultimately everyday functioning. This concept is called *transfer*.

As the trainee performs the tasks laid out in the training setting, his or her cognitive abilities are engaged by them. Performance and proficiency with the tasks improves over time, as is to be expected when training is consistently applied to just about anything over time. The key issue is however, if, following training, improved performance is also observed in other, untrained areas which are dependent on similar cognitive processes. If so, a transfer is said to have occurred (Noack, Lövdén, & Schmiedek, 2014).

#### 6.2.1 Range of transfer

In the context of cognitive training, the concept of transfer ranges from near to far or (of equal meaning) narrow to wide. While a somewhat coarse scale, it still serves to illustrate the scope of changes taking place. Far transfer can be said to have occurred if improvement is apparent in everyday experience, removed from the formal testing situation. It would also be detectable by cognitive instruments addressing the same underlying construct but otherwise dissimilar to the ones used in the testing situation. As the transfer range moves from far to near, the assessment methods of the underlying cognitive constructs become
increasingly more similar to the initial assessment, both with regard to the test setting and instrument modality. For instance, near transfer could involve the change of modality in a free recall memory task, going from single digit items to single letter items.

The reasoning behind studying a broader range of possible transfer effects is to be better able to disentangle effects of the skill and test-taking experience from actual improvements in the underlying ability. This addresses the tendency of training benefits to be highly localized, or as it is sometimes denoted, the “curse of specificity” (Green, Strobach, & Schubert, 2014). Furthermore, the pattern of improvements across the transfer range would provide vital clues as to what type of improvements are related to what characteristics and conditions of the training (Diamond & Ling, 2016).

6.2.2 Neural mechanisms of plasticity and transfer
A proposed mechanism underlying how plasticity enables transfer is the functional overlap of the nervous system (Emerson & Cantlon, 2012). Functional overlap is the observation that similar cognitive operations have a tendency to be processed in the same, or proximal, neural structures (Wager, Jonides, & Reading, 2004). From this, the proposition follows that plasticity induced changes may affect other cognitive operations associated with the same neural structure (Li et al., 2008). This has been indicated by cognitive training studies featuring brain imaging (Jaušovec & Jaušovec, 2012). Moreover, Dahlin and colleagues (E. Dahlin et al., 2008) were able to show near transfer following training of the executive component updating, coupled with neural changes to the striatum. The observation that this brain region was activated in two separate updating tasks is relevant for the notion of functional overlap as a prerequisite for transfer.

6.3 Layout of training interventions
Here it is relevant to note that the notion of transfer is particularly important in process-based types of training, referring to interventions targeting underlying cognitive processes rather than specific skills and abilities. The reasoning here is that actual training gains would be indicated by manifest performance improvements on tasks and abilities that are dependent on the same cognitive constructs as those trained.

The choice of training paradigm depends upon several factors, including the population involved and the breadth of the ability and/or deficit being addressed. In the present thesis, I study adolescents who are interned. This is a population with a range of cognitive deficits, including the executive functions. It is presently
unclear to what extent improvements to these functions would make a difference in their everyday functioning. Hence, the case for considering the process-based approach is that it addresses these underlying factors.

This is in contrast to the paradigm of strategy training where the focus is on directly improving concrete skills and processes relating to what we are already doing, or want to be doing. This endeavor has historically had a stronger tendency toward focusing on narrower, more specific training goals, often concerning episodic memory functioning (Neely & Bäckman, 1993, in Sandberg, 2014). This may include explicit training in skills and methods enabling the trainee to be better at remembering things (Stigsdotter & Bäckman, 1989), handling negative affect (Creswell, Way, Eisenberger, & Lieberman, 2007), or social functioning, (Helmond, Overbeek, & Brugman, 2012). As such, it has also been employed in rehabilitative settings but, as noted, it does not address underlying cognitive deficits common in antisocial adolescents.

Indeed, an intervention using process-based training arguably seem suited given the population at hand. So how would one go about such a study? A typical pattern across several fields of inquiry is that early findings are subsequently re-examined using more stringent designs, both for verification and to further the initial examination. In prior research on process-based cognitive training, a number of design limitations have been identified (H. E. Kirk, Gray, Riby, & Cornish, 2015; Rabipour & Raz, 2012). These include the lack of adequate control groups, a profusion of disparate constructs for executive functioning (Brocki, Nyberg, Thorell, & Bohlin, 2007; Snyder, Miyake, & Hankin, 2015) and a dearth of ecologically valid measures (Simons et al., 2016). To this end, a number of design features have been suggested to be of particular relevance when examining process-based executive functions training (Diamond & Ling, 2016). In the following sections, we will examine three (multiple tasks, adaptive training, & control groups) of these design elements of particular importance for the study at hand.

6.3.1 Multiple tasks for each theoretical construct
All neuropsychological tasks tap multiple cognitive processes simultaneously. There is always “impurities” (P. Burgess, 1997) in the form of parallel processing by other functions and abilities than the ones under investigation. This makes both estimation and training of discrete constructs difficult using singleton tasks. The Unity/Diversity model of executive functioning is based on an effort to overcome this issue by using latent variable analyses applied to extensive batteries of neuropsychological tasks. The reasoning here is that different tasks engage underlying cognitive processes to a different extent. By using multiple
such indicators, these underlying processes can be gleaned using analytic methods assessing the latent level. However, in the context of many a research project, interned population or otherwise, there is rarely sufficient resources to achieve the level of power required for latent level analyses (but see Schmiedek, Lövdén, & Lindenberger, 2010; Stepankova et al., 2014). Rather, researchers rely on the use of theory-based task batteries with several constituents aimed at the same underlying construct. This allows for a more accurate estimation of the underlying construct. More importantly, this allows for better resolution of any occurrence of transfer unto separate constructs. Also, the outreach of transfer gains can be estimated by using tasks assessing both near, and increasingly farther, transfer. This by allowing the researcher to examine how far a transfer effect can be detectable, and if a transfer occurs across all tasks tapping a construct or more sporadically (Sandberg et al., 2014). At the furthest end of the transfer spectrum is everyday life experience. As this is at least implied in the aims of training studies, it should also be considered in the design. Multiple assessments, from near to far transfer, is also relevant for follow-up assessments. The longevity of far transfer effects is crucial in order to demonstrate enduring practical benefits of the training outside of the purely academic context.

6.3.2 Adaptive training and training volume
During the course of recurring cognitive operations, adaptation occurs. In the experimental setting, this manifests itself in how the same level of performance requires less and less effort to maintain. For this reason, several paradigms feature adaptive difficulty order to engage the cognitive abilities of the trainee continuously throughout the training. To reiterate, the reasoning is that environmental requirements needs to be continuously kept above the capacity of the available cognitive resources at hand in order for plasticity-induced changes to occur (Lövdén et al., 2010). It has been stressed that training needs to adapt to both improving and diminishing performance, as both too easy and too difficult training run the risk of deteriorating participant motivation. Several methods of adaptation have been employed: trial-by-trial adaptation and session-by-session adaptation, as well as criterion-based or baseline calibration, to mention but a few. Despite this, a clear picture of which pattern of adaptation is the most productive has yet to emerge. It is apparent however that pushing beyond current cognitive limits is necessary for any type of improvement to occur, although the ideal way of doing this is as of yet undetermined (Diamond & Ling, 2016). Now, no matter how cunningly we keep the requirements above the cognitive capacity of the trainee, there is also the matter of maintaining this state of affairs a sufficiently long time for plastic changes to occur (Lövdén et al., 2010). While there are studies reporting transfer effects after very short training interventions (Van der Molen, Van Luit, Van der Molen, Klugkist, & Jongmans, 2010), the
general trend is that larger volumes of repeated training give more significant, and more lasting, effects (Diamond, 2013). This has been shown in a host of intervention studies including cognitive training (Schmiedek et al., 2010), physical interventions (Davis et al., 2011) and skill training (Ericsson & Towne, 2010).

Concluding on adaptiveness, both difficulty and training volume contribute to the notion of training dosage, of which a certain amount is required for plastic changes to occur. However, how substantial this dosage needs to be for different groups and types of training is still undecided (Melby-Lervåg & Hulme, 2013), and is further complicated by indications that the dose-gain relationship can be reversed in some conditions (Au et al., 2015).

6.3.3 Control groups

Even if post-test performance is systematically superior to pre-test performance, and also transferring onto both untrained tasks and everyday experience, we could not readily conclude this order of events to be caused by the training. Several other explanations could also explain the observed results. This makes causal claims on the effects of training dubious. Taking the same test twice frequently results in better performance on the second occasion. This is called the test-retest effect (Green et al., 2014). Furthermore, being subject to an intervention while also being observed can induce changes on account of the expectations it entails. This is called the Hawthorne effect (Shipstead, Redick, & Engle, 2012). Add to that, there are several additional factors from which the trainees may improve independently of the training. Separate occurrences of neural maturation, improved health, better sleep, and enhanced mental well-being, are all associated with improved executive functioning (Diamond & Ling, 2016). In order to discount unrelated external factors from those imposed by the experimental conditions, control groups can be used. There are several ways this can be implemented in investigations of cognitive training. As a rule, the background characteristics should be kept equal in all groups, and membership allocation should be as random as possible. This to prevent systematic group differences to affect the experiment. While this can be difficult to enact in studies of interned populations, is nonetheless a state to strive for, design-wise. As control groups go, a passive, or no-contact, group performs pre- and post-tests but goes about their daily lives as usual in between these two occasions. This allows for some measure of control over test-retest effects and of independently occurring maturation/rehabilitation. However, it does not account for the effects of expectation. The participants know they are not part of an experimental group receiving actual intervention. This can be avoided to various degrees by using active control groups. These can be given an unrelated treatment, such as reading or a physical activity. This does however not necessarily mean the groups are kept
equal in all but the conditional aspect, limiting the strength of the design. An active control condition can also be a treatment similar to the experiment group, but lacking in the central ingredient of inquiry. This makes it in effect a placebo treatment. In the case of cognitive training interventions, the difference between active and passive control groups can be substantial (Dougherty, Hamovitz, & Tidwell, 2016), making this design feature highly relevant. To design this latter type of active control condition can be difficult, as the intervention should be perceived as challenging without imposing the aforementioned recurring mismatch between targeted cognitive resources and task demands. Too little and the task will be perceived as boring, resulting in diminishing motivation. Too much, and the difference between experimental and control conditions dissipate, making result interpretations problematic. That being said, is nonetheless preferable to an active control group enduring an unrelated intervention (Diamond & Ling, 2016).

6.4 Cognitive training in young people

Numerous studies have been conducted examining cognitive training interventions in children and adolescents. It is reasoned that the ongoing cognitive development throughout early life signifies high levels of plasticity, in turn making it a suitable period to engage in training. Consequently, care needs to be taken in order for effects of training to be disentangled from effects of naturally occurring maturation. As noted above, this is not always done extensively in the early stages of a research field.

For instance, adaptive working memory training has been shown to alleviate challenges to mathematical ability in 10-year olds. This effect was unrelated to IQ and lasted to at least up to 6 months after the training (J Holmes, Gathercole, & Dunning, 2009). Comparable effects have been found for reading comprehension (K. I. E. Dahlin, 2011), and ADHD symptoms (Klingberg et al., 2005) in children of similar age. Indeed, children as young as 5 have been shown to benefit from training, exhibiting improved executive attention and self-regulation for at least 2 months after training (Rueda, Checa, & Cómbita, 2012).

Studies on cognitive training in adolescent populations are less numerous than in preadolescent groups. Nonetheless, positive results have been reported in alleviating intellectual disabilities (Van der Molen et al., 2010) and in improving singular executive functions (Zinke, Einert, Pfennig, & Kliegel, 2012). Certainly, adolescence remains a promising period for conducting process-based interventions (Karbach & Unger, 2014), at least in motivated samples. In the next section though, we turn to antisocial populations and examine and examine previous research and future prospects therein.
6.5 Cognitive training in antisocial populations

The connection between cognitive deficits and antisocial behavior is well established and there is a large body of research on cognitive training in both clinical and non-clinical populations. Despite this, research on this type of intervention is still rare in internment settings. In fact, at the time of writing I am aware of but one study on process-based cognitive training in interned settings. In this study, Miyaguchi and colleagues had a group of interned adolescents with intellectual disabilities perform a 26-session cognitive training program across a period of 16 weeks (Miyaguchi, Matsuura, Shirataki, & Maeda, 2012). The gains were assessed using a battery of cognitive tasks at pre-, post- and 3-month follow-up and compared against a waiting-list control group. The results of this study were indeed promising, with training gains lasting well into the follow-up assessment. However, some design features, such as passive control group and limited transfer battery, were not the most optimal design-wise. However, given the difficult context of studying interned adolescents and the prospective nature of the study, the study is nonetheless both innovative and relevant for the field. It is therefore somewhat surprising that no expansions or replications on this, rather seminal study, have been attempted. Particularly so as the results of the study were undoubtedly promising.

That being said, there is a growing appreciation for the cognitive perspective in the general field of offender rehabilitation (L. J. Cornet, 2015). At the base of this relatively new endeavor is that same broad notion that deficient executive functioning is related to a propensity towards delinquent and antisocial behavior. From this follows that better understanding of the malleability of these executive functions could provide better prospects for individuals in forensic settings (E. Ross & Hoaken, 2010). Certainly, an increasing number of studies on offender cognition do discuss their findings with regard to possible implications for interventions (Herrero et al., 2010; Miyaguchi et al., 2014). However, the complex psychosocial circumstances present in interned populations complicates assessments of this growing field. Both psychopathological comorbidities and substance abuse tend to be overrepresented as compared to non-interned populations (Ezepeleta, Keeler, Erkanli, Costello, & Angold, 2001; Paschall & Fishbein, 2002; Pihet et al., 2012). These factors tend to be related to diminished executive functioning in and of their own, thus complicating causal interpretations of both pre-intervention assessments and intervention effects in the typical sense. Nevertheless, as pointed out by Ross (2012), cognitive training shows promise within the context of psychopathological rehabilitation as well (Hodel & West, 2003; Medalia, Revheim, & Casey, 2001). Nonetheless, this growing appreciation of the cognitive perspective is manifest by an increasing tendency to incorporate measures of executive functioning in assessments of other interventions. For instance, executive functioning has been taken into
consideration with regard to both various behavior therapies (L. J. M. Cornet, de Kogel, Nijman, Raine, & van der Laan, 2014; Fishbein & Sheppard, 2006) and in attempts at strategy/skill training (L. J. M. Cornet, van der Laan, Nijman, Tollenaar, & de Kogel, 2016; Mullin & Simpson, 2007). The general trend is that improved executive functioning occurs in parallel with a decrease in psychopathological symptoms; though reoffending propensity, denoted recidivism, appear unrelated to improved executive functions. Recidivism is a common measure of intervention efficacy within the research on interned populations. However, it is not necessarily the best suited when considering interventions aimed at cognition. As Ross (2012) points out, enhanced cognition is more likely to be associated with intermittent improvements in everyday functioning, rather than more life-course related changes in maladaptive behavior in and of itself. This reasoning is naturally somewhat tentative, as the number of studies examining actual process-based cognitive training in interned populations are, in fact, very limited.

6.6 Summary

In summary, there is a substantial literature supporting the notion of a relationship between executive function deficits and antisocial behavior. There is also a large, although disputed, body of research on process-based executive functions training. This thesis makes an attempt to bridge these two. It also attempts to address a number of related methodological issues, mainly relating to measurement inconsistency and control group activity, in the process.

This ends the introduction. The following part will present the empirical studies comprising the thesis.
7. The empirical studies in this thesis

7.1 Aims

This thesis has two overall aims. Firstly, to explore higher order cognitive functions in interned Swedish adolescents and how these functions are related to everyday behavior. This ought to allow for comparisons within the samples but also to extrapolate out towards related population groups. Secondly, to examine the effects of cognitive training on both assessed cognition and everyday behavior. To these ends, cognition is examined within a theoretical framework emphasizing executive functions. This allows for the study of independent contributions by specific cognitive constructs. The thesis adopts an individual-difference perspective and compares characteristics of interned and non-interned participants. By treating interned adolescents as a single, albeit heterogeneous, clinical group, the focus is placed on overarching cognitive characteristics rather than features related to specific recurring diagnoses within this group.

The thesis features three empirical studies. The first two are cross-sectional and aimed at assessing a number of cognitive constructs and associated behaviors. The third study is aimed at examining the effects of a training intervention on said constructs.

7.2 Research questions

7.2.1 Study I

The purpose of the first study was to compare interned and non-interned adolescents with regard to cognitive functioning, as framed within the Unity/Diversity model of executive functioning (Nordvall, Jonsson, & Neely, 2016). The study also investigated how the participants themselves perceived their cognitive functioning, and to what extent these perceptions were reflected in actual performance-based measures.

Specific research questions included:

- Are the cognitive deficits suffered by interned adolescents, general or specific to separate executive functions?

- How do interned adolescents perceive their own cognitive function in everyday life?
- What are the relationships between separate executive functions and specific aspects of everyday cognitive functioning?

**7.2.2 Study II**
The second study examined how various aspects of impulsivity differed between interned and non-interned participants and how these aspects related to cognitive functioning (Nordvall, Neely, & Jonsson, 2017).
Specific research questions included:

- If and how do interned and non-interned adolescents differ with regard to various aspects of self-reported impulsivity?

- How do aspects of self-reported impulsivity relate to executive functioning?

- Can group differences in aspects of self-reported impulsivity be attributed to executive functioning?

**7.2.3 Study III**
The third study examined the effects of a process-based cognitive training intervention on measures of performance-based executive functions, scholastic abilities and self-reported cognitive functioning.
Specific research questions included:

- What effects do an extended period of process-based cognitive training have on both trained and untrained measures of executive functioning, and scholastic abilities?

- Do interned and non-interned adolescents differ in their training gains?

- How do the participants perceive the effects of the training with regard to everyday executive functioning?

- Is cognitive training a feasible rehabilitative method in juvenile justice settings?

**7.3 Participants**
All three studies are based on the same sample, consisting of one group of interned and one group of non-interned adolescents. All participants were initially recruited for a project concerning cognitive training, Study III, is an intervention study using both pre-intervention and post-intervention data. Study
I and Study II are based on pre-intervention data. The final number of participants in each study will be presented in more detail in subsequent sections.

The interned adolescents (N = 43) were recruited among individuals in the care of the Swedish National Board of Institutional Care (Statens Institutionssstyrelse; SiS). Criteria for inclusion was Swedish speaking, a minimum of 10 weeks estimated placement, an absence of explicit aggressive behavior and, at least three drug-free weeks prior to participation. Recruitment and the application of criteria was performed at the discretion of the staff at each individual participating facility.

The adolescents participating in the present thesis were recruited from a total of eight treatment type facilities, dispersed throughout Sweden. To reiterate, SiS facilities differ in focus between three types of care: emergency, investigation, and treatment. Due to the placement time requirement (minimum 10 weeks), the adolescents participating in the present thesis where exclusively recruited from treatment type facilities. Emergency and investigation type facilities operate with shorter placement times, between two and eight weeks, rendering the internees at these facilities not suitable for participation. Of the total number of internees being discharged from a SiS facility in 2012, 344 out of 935, or 37%, had been residing at a treatment type facility.

Of the forty-three interned participants, 17, or ~40%, were female which is somewhat more than the average proportion, 32%, of females in the care of SiS. With regard to their first language, 17% of the participating interned adolescents reported a first language other than Swedish as compared to 26% for SiS as a whole. The age distribution of the interned group (M = 17.3  SD = 1.80) was somewhat above the SiS mean (15.9 years).

In summary, the sample of interned adolescents studied in the present thesis was somewhat older, had a higher proportion of both females and native Swedish speakers than the SiS mean. Nevertheless, these age and gender dispositions are in line with the official statistics on SiS facilities of the treatment type, which are noted to have a higher proportion of females and older internees (Dahlström, 2013). The higher proportion of naive Swedish speakers is likely due to an effect of the language requirement, meaning that a portion of the internees with a non-Swedish first language were not sufficiently proficient in Swedish to enable their participation.

The non-interned adolescents (N = 40) were recruited from local upper-secondary schools using posters. In as far as possible, the aim was to achieve a similar distribution of background variables as the interned adolescents. The
non-interned group had a similar age distribution \((M = 17.5 \ SD = 1.28)\), and proportion of non-Swedish first language speakers of 20%. The gender distribution was even (50% female) though.

### 7.4 Procedure

Upon recruitment, the participants were informed of the project aims and extent and gave informed consent, all in accordance with the Declaration of Helsinki (DoH). For participants younger than 15 years old, the consent of their legal guardians was also obtained. To reiterate, the express purpose at the time of recruitment was participation in a project concerning cognitive training (Study III). The studies were approved by the regional board of research ethics.

Thereafter, the participants underwent pre-intervention testing. This testing was performed individually and featured methods hailing from three different theoretical traditions: *performance-based cognitive testing*, *performance-based scholastic ability testing* and *self-reports*. The tests are presented in Table 1 and were administered in the same order for all participants. Studies I and II were cross-sectional and relied solely on data from these pre-intervention tests.

After pretesting, the participants went on to the training intervention itself. The training was web-based and was distributed across 28 sessions, taken over approximately 10 weeks. The training sessions featured a total of eight tasks developed to tax the cognitive processes associated with the following theoretical frameworks: The three executive functions in the Unity/Diversity framework was taxed by two tasks each. In addition, the two memory maintenance systems, visuospatial and verbal memory, in the Baddeley working memory model, were taxed by one task each. Tasks were alternated so that, four of the eight tasks were used every other training session. A summary of the training tasks is presented in Table 1. Depending on assigned condition, the participant trained either on an adaptive-difficulty experimental version of the training program, or a low-difficulty placebo version.

Finally, after completing the training, the participants once again took the same tests as had been used in the pretest. This allowed for an assessment of eventual *transfer*, i.e. the extent to which the training had generalized to non-trained testing tasks tapping the same cognitive constructs. In the event of training having an effect on underlying cognitive functioning, this should be observable by way of transfer effects. This topic was addressed in Study III, using both pre-intervention and post-intervention test data.

To note, criterion tasks are present in both training and testing in order to assess direct effects of the training effort. These will be marked as such in the section below.
7.5 Methods
In this section we will have a look at the instruments employed in this thesis, beginning with the training tasks, followed by performance-based testing tasks, scholastic ability, and ending with the self-reported instruments.

7.5.1 Training tasks

7.5.1.1 Inhibition tasks
Counting Stroop Task (Bush et al., 1998). In this task, the participant was to make speeded responses as to how many items were presented on screen. The items consisted of digits with either equal or differing values from the number of items presented. The experimental version saw an increase in items with differing values across the training sessions. The placebo version did not feature items with differing values.

Flanker Task (Lindqvist & Thorell, 2008; Stins, Polderman, Boomsma, & de Geus, 2005). Here, the participant was to make speeded indications of the direction of the centermost item in an array of arrows. The experimental version featured center arrows both conforming, and non-conforming, to the surrounding arrows. The placebo version contained only conforming arrows.

7.5.1.2 Shifting Tasks
Alternating Runs Task, letter version (Rogers & Monsell, 1995). In this task, the participant is required to categorize letters according to two continuously alternating sets of rules. Either by the location in the alphabet or by vowel/consonant distinction. Experimental version alternated the sets of rules between every other item whereas the placebo version alternated the rule set every other 33 items.

Plus-Minus Task (Miyake et al., 2000). This task requires the participant to either add or subtract a single-digit number to a two-digit number item as fast as possible. The experimental version of the task alternated between addition and subtraction every other item throughout the task. The placebo version kept the arithmetic operations in separate blocks.

7.5.1.3 Updating tasks
Keep Track Task (Miyake et al., 2000). In this task, the participant was shown a sequence of words in different categories, both targets and distractors. At the end of the sequence, the participant was to provide the last shown word in each target category. The experimental version had sequences with multiple words in each
target category. The placebo version only featured a single word for each target category, with all other words being distractors.

Letter memory running span (Miyake et al., 2000; Pollack, Johnson, & Knaff, 1959). In this task, the participant was to indicate which four items were presented last out of a sequence of letters. The experimental version had letter sequences of random, but increasing length. The placebo version required the participant to indicate three letters out of a sequence length between 3 and 5 items. This task also occurred in a criterion version, as described below.

7.5.1.4 Maintenance Tasks
Spatial Span Task. In this task, the participant was to repeat back sequences of spatial locations in a 4x4 grid. The sequence length was dynamic in the experimental version and predetermined in the placebo version. This task also occurred in a criterion version, as described below.

Word Span Task. This task required the participant to indicate the order of presentation for a sequence of words. Adaptation of difficulty followed the same pattern as the Spatial Span Task above.
Table 1. Task to function mapping. Manually administered tasks are in italics.

<table>
<thead>
<tr>
<th>Function</th>
<th>Training tasks</th>
<th>Criterion tasks</th>
<th>Transfer tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhibition</td>
<td>Counting Stroop</td>
<td>Color Stroop Incongruent</td>
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<tr>
<td></td>
<td>Flanker</td>
<td>D-KEFS Color-Word Interference 3</td>
<td></td>
</tr>
<tr>
<td>Shifting</td>
<td>Letter Memory Alternating Runs (letters)</td>
<td>Letter Memory Alternating Runs (digits)</td>
<td>D-KEFS Color-Word Interference 4</td>
</tr>
<tr>
<td></td>
<td>Plus-minus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Updating</td>
<td>Running Span</td>
<td>Running Span</td>
<td>n-Back</td>
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<tr>
<td></td>
<td>Keep Track</td>
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<tr>
<td>Maintenance</td>
<td>Spatial Span</td>
<td>Spatial Span</td>
<td>Digit Span</td>
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<td></td>
<td>Word span</td>
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<td>WISC Digit Span</td>
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<td>Speed</td>
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<td>WISC Coding</td>
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<td>Fluid intelligence</td>
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<td>Color Stroop Neutral</td>
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<td></td>
<td></td>
<td>WISC Matrices</td>
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</tbody>
</table>

7.5.2 Testing tasks

7.5.2.1 Inhibition tasks
Color Stroop Task (MacLeod & MacDonald, 2000; Stroop, 1935). The participants are shown a sequence of words and are required to indicate the color of the lettering for each item. (MacLeod & MacDonald, 2000; Stroop, 1935). Items can be regular words or color words which are either the same or different from the color of the lettering. The dependent variable is reaction time for correctly answered items.

D-KEFS Color-Word Interference Task, Condition 3 (Delis, Kaplan, & Kramer, 2001). In this task, the participant was to verbally name stimuli in four different conditions. The conditions 1 and 2 required color naming and word naming, respectively. This task, Condition 3, was the Stroop condition. Here, the participant was to name the color of the ink of conflicting color words. Dependent variables were the raw completion time and the inhibition cost contrast score, being the difference between conditions 3 and 1.
7.5.2.2 Shifting Tasks
Alternating runs, number version. The participant was to apply two sets of rules alternatingly to presented stimuli, much like the letter version of this task. In this version though, the stimuli were digits. Dependent variables were the raw reaction time for correctly answered items preceded by a change in rules, and a shift cost contrast score. The latter was the difference in response time between trials with or without an immediately preceding rules change.

D-KEFS Color-Word Interference Task, Condition 4. The participant was to repeatedly switch between reading color words, and naming the ink color of the color words. These were conflicting with the word. Dependent variables were the raw completion time and the shift cost contrast score, being the difference between conditions 4 and 3.

7.5.2.3 Updating Tasks
n-Back Task (Jaeggi, Buschkuehl, Perrig, & Meier, 2010; Nyberg, Dahlin, Neely, & Bäckman, 2009). In this task, the participant is required to indicate whether or not a presented item is the same as previous item presented at a specific position earlier in the sequence. The difficulty of the task depends upon how far back in the sequence this previous item was presented, usually 1, 2 or 3 positions prior. Dependent variables were the accuracy with which the participant answered, as well as contrast scores between high and low difficulty.

Letter memory running span, criterion task version. This was a test version of the training task. It is nearly identical, but featured a fixed number of trials in order to provide data appropriate for between-subjects analysis.

7.5.2.4 Maintenance tasks
Digit Span. Here, the participant is to repeat back a sequence of single digit numbers. The sequence length increase throughout the task until the participant fails two subsequent trials. The dependent measure of this task is the highest correctly completed sequence length.

Spatial span task: This is a criterion version of the training task with the same name. The sequence length increase throughout the task until the participant fails two subsequent trials. Dependent measure was the highest sequence length in which the participant successfully answered.

WISC Digit Span (Flanagan & Kaufman, 2004). A manually administered task from the Wechsler Intelligence Scale for Children, administered according to standard procedures. The dependent variable was the scaled score.
7.5.3 **Scholastic ability**

These tasks were employed to assess occurrences of far transfer from improved cognitive functioning onto unrelated abilities relating to executive functioning.

Word decoding task (Svensson & Jacobson, 2006): In this task, the participant is presented with short textual items. The spaces between the words have been removed in the items and the participant is to identify the component words in each item. This is done for as many items as possible during a fixed time period. Dependent variables are the number of correctly identified words.

WISC Arithmetic task (Flanagan & Kaufman, 2004). A task for mental arithmetic from the Wechsler Intelligence Scale for Children. The participant was given arithmetic questions of incremental difficulty until failing to provide two correct answers in a row, or there are no more questions. The dependent variable was the scaled score, which allowed for coalescing of differing ages in the analyses.

Single-digit Arithmetic Task (Barrouillet & Lépine, 2005; Hecht, 2002; Trbovich & LeFevre, 2003). An arithmetic task in which the participants were verbally presented with arithmetic operations featuring addition and subtraction. The operations increased in length throughout the task until the participant failed thrice in a row. The dependent variable was the number of correct responses.

7.5.4 **Self-reports**

In order to assess everyday experiences of the participants, two self-report instruments were used: the Behavior Rating Inventory of Executive Function (BRIEF) and the UPPS, the latter being an acronym for Urgency, (lack of) Premeditation, (lack of) Perseverance, and Sensation Seeking.

There are several reasons for complementing performance-based cognitive measures with self-reports. First and foremost, it provides a standardized way to gain an insight as to how the participants themselves perceive their own functioning. It is undoubtedly relevant to know if performance-based individual differences are discernable to the individuals themselves. In other words, are the participants aware of how their own functioning rate with that of others?

Secondly, the relevance is evident both from a diagnostic perspective and from an intervention evaluation perspective. Both screening procedures and developmental prognostics have the potential to benefit from increased knowledge on how the individual perceives their behavioral traits. It is also of substantial use to be able to evaluate how the effects of an intervention is perceived by the recipient. Intervention results ought to be interpreted cautiously if performance-based improvements are lacking self-assessed acknowledgement.
and, conversely, if perceived benefit is coupled with a lack of performance-based improvement. In the present project, the use of standardized forms was also warranted by both overall design choices and practical considerations, barring more in-depth means of assessing the perspective of the participants.

Preferably, the information gathered using self-reports should have been augmented and corroborated with corresponding reports from teachers, parents, and social workers (when applicable). This would have allowed for a more nuanced representation of the everyday functioning within the aspects of inquiry. However, practical considerations rendered this approach unfeasible, particularly so given the more quantitative inclination of the present project. With regard to parents, the availability, cooperation, and capacity was predicted to be insufficient. At least so for the interned portion of the present sample. This was subsequently confirmed by both SiS facility staff and internees alike. With regard to teachers, variants of the same complicating matter were apparent for both interned and non-interned participants. This amounted to the teachers not having the sufficient time to accumulate familiarity with the everyday functioning of the participants. In the case of the internees, this was the consequence of a limited length of incarceration and the daily activities being dispersed between several staff categories, of which the teachers are but one. Teachers of the non-interned participants generally taught multiple classes. This limited their opportunities to interact with the participants sufficiently to allow for accurate responding on instruments of the type employed in this project. Also, the non-interned participants were recruited individually, so their teachers were not involved with the project and could not be counted on to consent to participation. Notwithstanding all this, the adolescents enrolled in rehabilitative programs have been noted to provide self-reports willingly and truthfully, making them particularly suited in this context (Ginner Hau, 2010).

7.5.4.1 BRIEF
The BRIEF-SR (self-report) is a standardized self-rating instrument containing 80 items within nine separate subscales, measuring various executive functioning in everyday settings (Guy, Isquith, & Gioia, 2004). The subscales are Inhibit, Shift, Emotional Control, Monitor, Working Memory, Plan/Organize, Organization and Task Completion, and Monitor. The option to split the Shift subscale into one Behavioral and one Cognitive component was also implemented, for a total of ten subscales. Each item in the instrument is a statement of an everyday situation, and the participant is to respond if the situation recurs often, sometimes, or never, on a three-point Likert scale. The item scores are then accumulated to their respective subscales, such that greater scores reflect higher levels of self-perceived executive dysfunction. This thesis used the raw scores as dependent variables in order to maintain variance. BRIEF
has been shown to be sensitive for a number of clinical conditions of relevance to the inquiry at hand. These include attention deficit hyperactivity disorder (Gioia, Isquith, Guy, & Kenworthy, 2000; Toplak, Bucciarelli, Jain, & Tannock, 2008), traumatic brain injury (Wilson, Donders, & Nguyen, 2011), and pathological gambling habits (Reid, McKittrick, Davtian, & Fong, 2012). Furthermore, it has been shown to have of content, convergence, and divergent validity (Walker & D’Amato, 2006), be sensitive to change over time (Rabin et al., 2006) and have miniscule variance attributable to gender (Roth, Isquith, & Gioia, 2005).

7.5.4.2 UPPS

In order to assess impulsivity, the UPPS Impulsive Behavior Scale was used. It is a self-report instrument developed in response to the recently proposed notion of impulsivity as a multi-faceted construct (Whiteside & Lynam, 2001; Whiteside, Lynam, Miller, & Reynolds, 2005). The UPPS is the acronym of the component unidimensional impulsigenic traits assessed: Urgency, (lack of) Premeditation, (lack of) Perseverance and Sensation Seeking.

Urgency is the propensity to act rashly under negative affect. Premeditation, or the lack thereof, is the inability to employ forethought. Conversely, Perseverance and its absence is the inclination to abandon tedious tasks. Predispositions to seek out novel situations and experiences is represented by Sensation Seeking.

The first three facets tend to intercorrelate, being all related to distractibility and dyscontrolled behavior, whereas the last one, Sensation Seeking tend to be largely independent (Duckworth & Kern, 2011; Magid et al., 2007).

The instrument is composed by 44 items, all having a four-scale four-point Likert scale structure (1 = strongly agree, to 4= strongly disagree). Each item sums up into one of the four facets. Some items are reverse scored in order to avoid response bias. In order to simplify results presentation, all facets were made to run in descending order with increased levels of perceived impulsivity. Alpha reliabilities for the four facets have been demonstrated to be acceptable, with .89, .87, .83 and .85 respectively (Whiteside et al., 2005).

It has been argued that the UPPS is a useful tool in surveying these types of behaviors and predispositions in psychopathological and maladaptive populations. In regard to antisocial behavior, univariate associations has been shown with discrete UPPS facets (Pihet et al., 2012; Sargeant et al., 2012). This has also been shown for aggression (Derefinko et al., 2011), attention disorders (Miller, Derefinko, Lynam, Milich, & Fillmore, 2010) and borderline personality disorders (DeShong & Kurtz, 2013; Jacob et al., 2010).
8. Statistical analyses

8.1 Study I
Firstly, I wanted to examine variance specifically attributable to the executive functions described in the Unity/Diversity model. This was achieved by performing a one-way analysis of covariance (ANCOVA) on the executive functions, entering the measures for perceptual speed and fluid intelligence as covariates. Consequently, the measures the three executive functions were analyzed separately, and Bonferroni-correction was used to account for this. The alternative of performing an MANOVA instead was discarded due to missing data issues in order to keep the sample size as intact as possible. ANCOVA was chosen rather than multivariate analysis of variance (MANOVA) due to missing data issues caused by technical problems, participant refusal, and various data losses stemming from the human factor.

Secondly, I used MANOVA to analyze the BRIEF subscales. Self-reported measures has been noted to be less susceptible to missing data issues in internment settings (Ginner Hau, 2010), and this was definitely the case here. Thirdly, Pearson’s correlations were used to probe for relations between the performance-based and the self-reported measures.

8.2 Study II
The difference in impulsivity ratings between interned and non-interned participants were analyzed using a multivariate analysis of variance (MANOVA). Here, the four impulsigenic traits of the UPPS instrument were entered as dependent variables, with internment status (interned, non-interned) entered as between-subjects factor. The sample sizes of the groups were unequal so I used Pillai’s trace (V) in the multivariate analysis. Box’s M was not evaluated for the same reason (Tabachnick & Fidell, 2001).

Then I examined relations between impulsigenic traits and the three performance-based executive functions. Here, I decided to reduce the number of comparisons by calculating composite scores of the latter. To achieve this, two measures for each executive function were z-transformed and the composites were computed from the mean of these two z-scores. Having done this, Pearson’s correlations were then used to analyze the relationship between the UPPS facets and the executive function composites. Lastly, four regression analyses were used to examine the specific contribution of performance-based executive functioning onto the impulsigenic traits. To this end, the three composites were entered simultaneously as predictors with to each of the four UPPS facets, acting as dependent variables.
8.3 Study III
This study was aimed at examining intervention effects at the level of the underlying cognitive constructs rather than on the level of individual instruments. The analyses were therefore conducted on composites calculated on the cognitive constructs under inquiry (Jonasson et al., 2017): executive functioning, memory maintenance and perceptual speed, as well as a criterion task composite. Contrast scores were avoided when calculating these composites, as the mixing of contrast and raw scores have been theorized to inflate the risk of introducing spurious results (Nordvall et al., 2016).

The construct composites were computed in the following manner: First, I z-transformed the performance-based task results for all time points (in this case pre- and posttest; T1 & T2). Importantly, these z-scores were standardized using the mean and standard deviation of the pre-test for all calculations in the following fashion:

\[ Z_{T1} = \frac{X_{T1} - MT1}{SDT1}; \]
\[ Z_{T2} = \frac{X_{T2} - MT1}{SDT1} \]

This allowed the composites to capture change over time. Also, tasks with reaction time or completion time as dependent variable was reversed in this step, so that higher performance was universally represented by ascending values. Secondly, separate function composites were then computed from the average z-scores of its component tasks. Lastly, the construct composites were computed from average z-scores of the function composites. This last step allowed for equal weighing of functions assessed by differing numbers of instruments.

Thereafter, two types of analyses were.

Firstly, I compared the two (EF training, placebo training) experimental conditions used in the non-interned group in order to determine if they had resulted in difference in training gains. This was achieved by performing separate ANCOVAs for each construct composite, using the posttest scores as dependent variable, experimental condition (EF training, placebo training) as between-group factor and pretest scores as covariate. By controlling for pretest performance, the effects of randomly occurring pretest differences can be mitigated (Dimitrov & Rumrill, 2003; Senn, 2006).

Secondly, I examined if the pretest-posttest gains differed between interned and non-interned participants receiving EF training. This was achieved using separate Group x Time repeated measures ANCOVAs and ANOVAs. ANCOVAs were used to analyze performance-based cognitive composites. The
use of covariates in the form of the perceptual speed composite and a fluid intelligence task, was intended to control for cognitive processes not included in the Unity/Diversity model. This in a manner similar to Study I. ANOVAs were used for the criterion composite and the far transfer measures of scholastic ability and self-reported executive functioning.

In order to nuance the pretest-posttest gain analyses, I also analyzed progression throughout the training period. This was done by z-transforming training task data in the same way as had been done with the pre- and posttest measures. This time I used training period quartile means as time points for each measure. Using these I was able to perform Group x Time repeated measures ANOVAs to compare training progression between interned and non-interned participants. These training measures were examined both in isolation, and as a unified grand mean.
9. Results

9.1 Study I

The results from this study showed that the interned adolescent performance on executive function tasks was quite substantially poorer than the non-interned performance. This is certainly in line with previous research (Ogilvie et al., 2011) concerning the relationship between executive function and antisocial behavior, with the additional contribution that this relationship remains after controlling for fluid intelligence and perceptual speed. However, the results did not indicate any group differences in the reaction to increased task load for any of the executive functions. Both interned and non-interned adolescents showed a similar decrease in performance as task difficulties increased.

When considering how the participants perceived on their executive functioning, the internees did report experiencing more problems. Out of the nine subscales on the BRIEF instrument, the internees reported lower levels of everyday functioning on four. The most extensive issue here was with situations relating to the subscales Behavioral Shift and Inhibit. Smaller, but nonetheless relevant group effects were also found for the BRIEF subscales Working Memory and Completion of Tasks.

Despite the interned adolescents both performing and reporting poorer executive functioning, the correlational analyses reveled but a few significant relations. Additionally, a number of these correlations ran in opposite directions from performance-based instruments tapping the same construct. The separate methodologies assessing inhibition did correlate however.

In conclusion, Study I demonstrate that interned and non-interned adolescents differ both on performance-based and on self-reported measures of executive functioning and that results from these two methodologies are only sporadically associated. This further emphasize the relevance of the executive functions perspective in studying antisocial behavior, but also the importance of employing comprehensive methodologies in doing so.

9.2 Study II

The results from this study indicated interned and non-interned adolescents differed with regard to three out of four impulsigenic traits in the UPPS instrument. The internees reported more problems in the UPPS facets of Urgency, Premeditation, and Perseverance. Of these three, the most substantial effect was found for Premeditation which is a trait relating to the ability to think
ahead and predict the consequences of one’s actions. This is in line with previous studies on impulsivity in antisocial adults (DeShong & Kurtz, 2013; Lynam & Miller, 2004; Miller et al., 2003) indicating these observations hold for adolescents as well. Surprisingly, the groups did not differ with regard to Sensation Seeking as has been indicated in previous studies (Derefinko et al., 2011; DeShong & Kurtz, 2013).

In order to examine how executive function may contribute to impulsigenic traits, I performed regression analyses which confirmed executive functioning, particularly updating, explained a substantial proportion (approx. 18%) of the variance in UPPS Premeditation, again suggesting a connection between trait-based impulsivity, executive functioning, and antisocial behavior.

In conclusion, the study showed that interned and non-interned adolescent differ in how they perceive their various impulsigenic traits. Traits related to cognitive control and the ability to manage negative affect, but not sensation seeking differed between the groups. Finally, a substantial amount of variation in premeditative ability was accounted for by executive functioning.

9.3 Study III

In this study, I examined the effects of process-based executive functions training in a number of different domains: on trained and untrained performance-based measures of executive function, on tasks tapping scholastic ability, and finally on self-reported executive functioning.

With regard to non-interned participants assigned to either the EF training experimental condition or the placebo-training control condition, no differences in gains were observed in any of the domains under inquiry. Training task gains were obviously not comparable on account of the study design, but both transfer task gains and scholastic ability gains, and self-reported gains were equal across experimental conditions. It should be noted however, that the placebo group was instructed to strive for faster training performance. Transfer driven by a plastic response to taxation of the perceptual speed cannot thus not be discounted in this study.

When comparing gains between interned and non-interned participants both receiving EF training, the first thing to note is that only the latter group made any sizeable progress throughout the training sessions as assessed by the training tasks. By large, this pattern was also repeated for the criterion measures. By contrast, the non-interned group progressed substantially across training sessions as well as on the criterion task.

By this token, even the limited pretest-posttest non-trained task
improvements must be interpreted with ample caution. Indeed, the only significant improvement observed was to perceptual speed. After controlling for this and for fluid intelligence (Nordvall et al., 2016), no effect remained neither in executive functioning, nor in memory maintenance.

Turning to the scholastic ability measures, both interned and non-interned participants improved by similar magnitudes on the word decoding tasks but not on the arithmetic tasks.

In the self-reports, all participant groupings perceived similar improvements to their everyday executive functioning. The amounted to modest improvements in the ability to plan and organize everyday life, as assessed by the BRIEF subscale Plan/Organize and a somewhat smaller improvement was also observed in the BRIEF subscale Working Memory. These improvements were also uncorrelated to the performance-based gains.

In summing up, it can be concluded that narrow improvements do occur, but do so largely irrespective of training progression and experimental condition. It could thus not be confirmed that the current improvements to previous cognitive training study designs provided tangible benefits over what can be more readily accounted for by other factors, such as effects of expectation, motivation or repeated testing.

9.4 Results summary
This thesis has compared interned and non-interned adolescents with regard to performance-based and self-reported measures of executive function, and also investigated effects of process-based training on these measures. At pre-test, the performance of interned adolescents was poorer than their non-interned counterparts but deficits specific to any one executive function was not discernable. In their self-reports, the internees expressed more perceived problems with inhibiting behaviors and managing unplanned prompts to shift from a planned activity. They also indicated it harder to resist urges related to negative affect, lower premeditative ability and more issues with persevering in prolonged tasks.

There were a number of connections between the performance-based, and the self-reported accounts of executive functioning, though not as prevalent as might be expected. Of particular interest is nonetheless that the majority of group effects in self-reported constructs was related to the executive function updating. This function has previously been suggested to be antecedent of antisocial behavior.

As for the training intervention, the only substantial improvement was to perceptual speed, which occurred irrespective of training progression or experimental condition (EF training or placebo training). This is mirrored by the
posttest self-reports whose rather modest gains were also unrelated to both experimental condition and training gains. Because of this, I am hesitant to attribute the training gains reported here to improvements in underlying cognition.

In conclusion, executive functioning and trait-based cognition are related to some degree, and both associate to antisocial behavior as operationalized by internment status. Process-based cognitive training can however not be determined to feasibly affect or alter these relations.
10. General discussion

The overall aim of this thesis was to examine aspects of cognition in adolescents in the care of the Swedish National Board of Institutional Care (Statens Institutionssstyrelse, SiS), and the extent a process-based cognitive training intervention could prove a viable rehabilitative tool in these settings.

The impetus for the present endeavor brings together developments in two strands of cognitive science. Firstly, recent advances in cognitive training have spurred extensive efforts to investigate the mechanisms behind, and prospects of, process-based interventions. The underlying assumption is that human cognition will adapt to a prolonged mismatch between resources and demands, a mechanism called plasticity. This in turn can be applied in the form of training to improve cognitive functioning. The second strand is the recent renaissance of neuropsychology in the study of antisocial behavior. Cognition, and particularly executive functioning, enable us to perceive, evaluate, and choose appropriate courses of action. Diminished ability to do so relates to suboptimal outcomes and have been associated with antisocial behavior. As such, cognitive science offers a meaningful complement to traditional sociological theories on antisocial behavior, as has been increasingly acknowledged in recent years.

These two strands were put into practice in the present thesis. The data collection was conducted between 2012 and 2016 on a number of facilities for compulsory treatment of adolescents with a history of antisocial behavior. For comparison and control, a number of non-interned adolescents also underwent the same treatment. This thesis has presented the gathered data in two cross-sectional studies and one intervention study. In these studies, the cognitive aspects were represented and assessed both by performance-based measures and by self-report measures. This allowed for examination of the relationship between cognitive functioning and how it is perceived by this group and also how aspects of personality relate to cognition in the investigated groups.

For the purpose of this chapter, the remaining discussion will be divided into four parts. The conclusions from the assessed measures will be addressed first, followed by the training results and their implications. Thereafter, the discussion will move on to address limitations. Finally, there will be a note on the practicalities of studying interned adolescents in the Swedish context.
10.1 Aspects of executive functioning in interned youth

10.1.1 Performance-based measures in Study I and Study II
One of the things I investigated in the first study was to what extent performance-based executive functioning was generally or specifically deficient in interned youth. The data the interned group performed at a lower level across all functions, indicating a general rather than a specific deficit. This was somewhat surprising, as the executive function updating had previously been suggested as specifically relevant in a study on interned adults (Herrero et al., 2010). As we will get to shortly, the executive function updating is decidedly interesting with regard to antisocial behavior. However, this is not on account of it being specifically impaired in interned adolescents. There are a number of reasons why our study differed from the previous one on this issue. Our main argument related to the task impurity problem (P. Burgess, 1997). This is the issue of cognitive operations virtually always requiring multiple processes to resolve. Indeed, imagining a cognitive operation relying on but a single process is about as difficult to envision as an entirely novel color. In terms of performance-based neuropsychological assessment, this means tasks tap more than one cognitive process. There are various ways researchers attempt to control for this. In this thesis I alternated between two such methods, as dictated by necessity. Firstly, the theoretically related cognitive constructs perceptual speed and fluid intelligence were controlled for in the statistical analyses of Study I (see statistics section). In that case, the two controlled constructs were assessed by separate tasks. Secondly, I also used contrast measures from the tasks assessing the actual executive functions. Contrast measures are obtainable from instruments with more than one cognitive load level, and acquired by subtracting the higher load performance with the lower load performance. In theory, the minuend removes non-relevant processes and the resulting difference will be a closer representation of the function targeted by the instrument. Now, in the Herrero study, both contrast measures and absolute measures were used more or less interchangeably. The two executive functions inhibition and shifting were assessed by contrast scores, whereas the executive function updating was also assessed by absolute scores. This could have led to those results being unduly influenced by non-executive cognitive processes.

Relating to our own study, the interned adolescents displayed a markedly lower processing speed. With the employed tasks having differing requirements on account of this process, not controlling for it would certainly have obfuscated the part of the results relating to executive functioning. One conclusion drawn from this is that methodological stringency is required in order to optimize the benefits rendered by using factorially derived multi-part theoretical framework of executive functioning in clinical settings.
That being said, I did use both contrast scores and statistical controls in Study I and this might be argued as overly conservative. However, the aim of the study was to specifically examine the executive functioning and thus management of confounding processes was prioritized at this point.

So, what does this tell us of executive functioning in interned adolescents and what are the effects for clinical practice? When considering the performance-based measures in isolation, the results presented here indicate no additional benefits of employing an executive functions framework over the standardized neuropsychological assessments already used in interned settings. The present inquiry can however not account for the relevance of individual assessment of specific neuropsychological impairments. That being said, there are additional benefits to be had when considering performance-based and self-reported assessments in conjunction. We will however first have a look at the conclusions drawn solely from the self-reported instruments in Study I and Study II before moving on to this discussion.

10.1.2 Self-report instruments in Study I and Study II
First off, when considering how the interned adolescents perceived their own executive functioning (Study I), there were large and consistent differences compared to the non-interned group. Of the nine BRIEF subscales considered, Inhibit and Behavioral Shift was the most prominent with Working Memory and Completion of Tasks showing somewhat smaller differences. The situations and behaviors described in the items of the Inhibit subscale relate to the control or inhibition of undesirable behaviors, also linking it readily to the executive function inhibition. The Behavioral Shift subscale is principally about adapting to changing contingencies, particularly when a preexisting plan or course of action needs to be altered. Smaller, but nonetheless relevant group effects were also found for the BRIEF subscales Working Memory and Completion of Tasks, indicating interned adolescents perceive themselves as having problems in remembering and following through on everyday tasks. These types of activities can certainly be argued to require substantial additional resources of executive character: to halt or inhibit the ongoing activity, to encode the new set of conditions and shift attention towards planning and implementing them. Sure enough, problems in these particular areas have been acknowledged in discussions with facility staff and are also in line with observations on adolescents with ADHD (Toplak et al., 2008) and in children with prefrontal brain damage (Anderson, Anderson, Northam, Jacobs, & Mikiewicz, 2002; Rasmussen, Almvik, & Levander, 2001).

Now, we move on to how the aspect of impulsivity (Study II) was perceived by the participants. As anticipated, the interned participants reported more impulsive
behavior than their non-interned counterparts. The group differences were found in the three UPPS facets relating to behavioral dyscontrol: Urgency, Premeditation, and Perseverance. The largest effect was for Premeditation. However, the impulsigenic trait Sensation Seeking did not differ between groups, in contrast to previous research indicating this class of behaviors to be elevated in antisocial groups. The interpretation made that this was due to ongoing developmental processes in which adolescents typically do pursue agency and new experiences. This in turn might elevate the propensity of most adolescent participants to rate Sensation Seeking as higher. This ties in with the observation that factorially derived instruments developed for assessing impulsivity in adult populations can differ with regard to factor structure when applied to under-age groups (Leshem & Glicksohn, 2007). To note, the interned adolescents live under imposed constraints and are not able to pursue the activities described in the items loading on the Sensation Seeking facet.

In conclusion, these results fit well with previous research as well as with informally provided descriptions made by both staff and internees. Interned adolescents perceive themselves as more prone to act rashly under negative affect, to act without forethought and to abandon tedious tasks. These results also fit the BRIEF self-reports, particularly on account of the Inhibit and Behavioral Shift subscales. The pattern emerging in the self-reported data is a familiar one, with the interned participants exhibiting difficulty in planning for, adapting to, and persevering in, their environment. This inability to formulate appropriate goal-directed behaviors also result in negative emotionality and a reversal to maladaptive prepotent behaviors. None of this is exactly new insights within the field of adolescent antisocial behavior in itself. However, these findings suggest a stable pattern of self-perceived behavior which in turn do indicate this type of instrument yield useful and ecologically valid data. This would also promote a furthering of this research by studying the prospect of using standardized self-report instruments to individually tailor rehabilitative efforts.

10.1.3 Considering performance-based and self-reported measures in conjunction
As mentioned, the choice to use both performance-based and self-report measures to assess executive functioning was made with the intent of investigating how deficits are expressed in everyday life. However, as noticed in Study I, the correlations between the two types of measures were sparse and occasionally also oppositional. This was interpreted as lending support to the notion of separate levels of cognitive analysis, as discussed by Toplak and colleagues (2013). By this token, the main reason for the lack of uniformity between performance-based and self-reported cognitive tasks is because they
address fundamentally different things. The former addresses the efficiency of various cognitive processes, whereas the latter address how the individual interprets and pursues everyday goal states.

That said, all of the four aforementioned BRIEF scales did correlate with the n-Back task, tentatively suggesting a special status for the executive function updating. To note, this is not to say updating is especially challenged in groups with a history of antisocial behavior vis-a-vis other executive functions. Rather, the observed group difference in updating appears to display a higher correspondence to everyday difficulties as experienced by the participants themselves. This observation is further emphasized by the fact that the very same pattern emerges in Study II; when considering the relations between impulsivity and executive functioning, updating was associated with the impulsigenic traits UPPS Premeditation and UPPS Urgency. These were the self-reported variables most prominently differing between interned and non-interned participants. I was also able to demonstrate a substantial portion of the variance in UPPS Premeditation to be explained by performance-based executive functioning, of which updating was the most notable component.

The fact that updating recurrently relates to clinically relevant self-reported constructs which themselves differ between interned and non-interned participants is undoubtedly an interesting observation. This is also underscored by previous research associating updating with antisocial behavior (Herrero et al., 2010). Even though the specifics differ between their study and ours, I would nonetheless argue that updating remains the most promising lead for future studies of the cognitive underpinnings of antisocial behavior. Additionally, the executive function shifting was associated with the impulsigenic trait UPPS Urgency, the propensity to act under negative affect. There is a tentative connection to Study I here as well, in that the interned participants reported having trouble adapting to changing contingencies in everyday life and, as described by facility staff, experienced adverse emotional reactions when compelled to do so. Nonetheless, this connection should be interpreted cautiously as the relationship was not explicitly supported in Study I. Furthermore, I know of no other studies in which the executive function shifting has been related to aspects of impulsivity. A somewhat related aspect of executive functioning, the inhibition of a prepotent response, has previously been related to acting under negative affect though (Cyders & Coskunpinar, 2011; Gay, Rochat, Billieux, d’Acremont, & Van der Linden, 2008).

Finally, it should be noted that the lack of relationship regarding UPPS Sensation Seeking conforms to previous reports (Romer et al., 2011). This is in line with the predictions made by both striatal imbalance model (ibid.) and the dual systems model (Steinberg, 2010) concerning differing neurological correlates and developmental trajectories for the various impulsigenic traits. See Study II for an extended discussion on the subject.
10.1.4 Summary of the cross-sectional studies
Summing up the discussion on the cross-sectional studies, the interned participants exhibited substantially poorer executive functioning when compared to the non-interned participants. This effect was general rather than specific. Furthermore, the interned participants reported a number of rather specific problems regarding their everyday executive functioning and impulsivity. The emerging picture is basically one of impaired adaptive ability; the interned participants express difficulty in planning ahead, in controlling impulses, diverging from said plans, and in managing when changing contingencies forces a deviation from their current course of action. In and of themselves, these findings are not new. They do indicate however that standardized self-report instruments assessing the constructs in question are ecologically valid and relevant in the context of juvenile justice. This opens up an interesting venue for future studies in investigating the prospect of incorporating cognitive self-report data for the individual tailoring of rehabilitative measures.

Finally, I found scarce relations between the performance-based and the self-reported assessments. The main exception being the executive function updating which was consistently related to self-reported constructs differing between interned and non-interned participants. This last find puts the spotlight on updating in regard to future investigations.

10.2 Cognitive training in Study III
The relationship between diminished cognitive functioning and antisocial behavior is long established. Recent studies suggest process-based cognitive training can invoke neural plasticity, raising the prospect of using it as a rehabilitative tool. Antisocial behavior, particularly of the life-course persistent type (Moffitt, 1993), takes a great toll on both society and the individual. Conversely, the positive impact would be substantial if this type of cognitive training would prove a feasible tool in juvenile justice settings. This was the principal idea in launching the present research project (Study III). It did yield a number of interesting finds relating to the training intervention, and also indicated a few venues for future research. However, the reader will do well not to get the hopes up overmuch. It should be noted at the onset that the collected data cannot readily support the notion of process-based cognitive training as a universal rehabilitative tool.

The structure of this part of the discussion will be as follows: firstly, we will look at the training results in the various non-interned control conditions. Then we will look at how interned and non-interned participants differed in their response to the training. Thereafter, we will look at how the participants perceived the training effects, as illustrated in the self-report data. Lastly, we will touch on the
implications of these results for the general. Issues of feasibility, limitations, and challenges to this type of design will be addressed in the section after this one.

One of the criticisms raised at the early studies of cognitive training was the lack of active control conditions (Diamond & Ling, 2016). The aim of active control conditions is to keep the intervention experience for the participants as close as possible to the experimental condition, thus only lacking in the aspect under scrutiny by the study. The present study examined the effects of adaptively taxing specific executive functions. Consequently, the control condition was designed as a placebo training intervention. It was to present the participants with seemingly adaptive tasks while maintaining low executive demands. The placebo tasks could certainly be performed faster and more accurate, as was instructed to the participants in this condition. Nonetheless, the executive demands remained highly disparate compared to the experimental EF training condition. Also, the use of active control condition was limited to the non-interned participants for practical purposes. That meant results would have to be extrapolated onto the interned participants. Nevertheless, higher baseline cognitive functioning has been associated with greater training gains (Foster et al., 2017). By this account, the non-interned participants would provide the best conditions to observe contrasts stemming from differing experimental conditions.

But there were none.

There were certainly pretest-posttest improvements to the performance-based transfer tasks. However, I could not observe any difference in these improvements between the participants in the experimental EF training condition compared to those in the placebo training condition. These results held for the executive function composite, for the supplemental measures of memory maintenance and perceptual speed, and also for the scholastic measures. There are at least two mutually non-exclusive interpretations to this pattern of results; either that the two conditions were equally effective, or that other factors caused the observed effects. For the first interpretation to be true, the main driving force behind induced plastic change to underlying cognitive abilities would have to be independent from environmental demands. Certainly, the role of perceptual speed has been suggested as being an important underpinning to higher cognitive functioning (Salthouse, 1996, 2005). Along this line of reasoning, a plastic response driven by enhanced demands on perceptual speed could tentatively provide a mechanism accounting for the results found here. Given the substantial bulk of research done on cognitive training, and given the relatively stable trajectories of human cognition across the life-span, this simply does not seem plausible. If substantial improvement to perceptual speed would stem from something as fundamental as persistent attention and tempo training, the human
condition would certainly be very different.

The second interpretation regarding other factors appears more sensible. Particularly the test-retest effect (Green et al., 2014) would certainly provide ample explanation for both pretest-posttest gains and lack of group differences in the present study. I am thus strongly hesitant to ascribe causal claims to any particular features of the experimental conditions.

Then I proceeded to compare performance-based training and transfer task improvements between interned and non-interned participants. The pattern which emerged was one where the interned group made virtually no progress throughout the training period, in stark contrast to the non-interned group which did progress substantially. Despite this, the only transfer task improvement found was in perceptual speed and this occurred to a similar degree in both groups. The same pattern was observed in the measures relating to scholastic ability; with similar improvements to word decoding ability and no improvements to arithmetic ability. The reasons for this pattern of results, in spite of considerable disparity in training progression, are unclear. This may be due to a higher potential for improvement in the interned group, or perhaps due to the higher baseline cognitive functioning (Foster et al., 2017) of the non-interned group, a combination of the two, or something else entirely.

Nevertheless, this pattern or results is hardly conducive with the theory of environmentally induced plastic changes to underlying cognitive functioning. The improvements occur promptly and apparently irrespective of any preceding mismatch between cognitive demands and resources. Rather, this pattern is more reminiscent of a test-retest effect. These results are partially in line with previous studies, where positive results have been reported in studies with limited experimental control (Burraston, Cherrington, & Bahr, 2012; Miyaguchi et al., 2012), but more rarely in studies with greater experimental control (L. J. M. Cornet et al., 2015; E. Ross, 2012).

Now we move on to the self-reported effects of the training intervention. Following the trend set by the performance-based assessments, there were pretest-posttest improvements reported, but in absence of any difference between experimental conditions or internment status. The two observed improvements were indistinguishable across the various participant groups. The first finding was an improvement in the BRIEF subscale Plan/Organize. Items relating to this subscale principally concern the ability to organize and plan for everyday life. These are behaviors requiring proactive memory and premeditative action, and consequently executive functioning. However, this increase in self-reported ability was uncorrelated with the actual gain in any one performance-based variable, and also with the pretest-posttest change in the
UPPS variables. The improvement of such a particular aspect of everyday executive functioning is certainly a noteworthy finding. Still, this was a relatively extensive training intervention requiring a certain amount of personal responsibility. Every completing participant have done so by being able to plan and organize their training, and they are no doubt well aware of this. Would it not be surprising if there was no effect on how these completing participants perceived their effort? The same can be said for the second observed improvement in BRIEF Working Memory. The study was explicitly aimed at cognitive training so the absence of an effect from expectation would have been equally surprising.

In summary, both the interned and the non-interned participants reported similar improvements in two of the nine BRIEF subscales. These self-reported improvements were unrelated to performance-based ones, and to internment status. Taken together, these observations further strengthen the notion of a detachment between intervention and observed posttest effect. Moreover, no changes were observed in the BRIEF subscales Behavioral Shift and Inhibit, two self-reported behaviors which previously have been indicated as specifically related to antisocial behavior (Nordvall et al., 2016). Some conclusions can be drawn from these results. The present thesis lends support to the use of standardized self-report instruments cognitive training studies. These fill an important role as they provide information if and how training impacts the subjective everyday experience of the trainee. This is particularly relevant in clinical populations where specific problems are identifiable, and can be targeted for rehabilitation. However, for full benefit, better designed control conditions are needed in order to disentangle expectation effects and the general effects of continuous effort. Finally and perhaps most importantly, the absence of effects to the previously identified critical subscales do call into question to what extent everyday maladaptive behavior can be alleviated by process-based executive functions training.

Summing up the observed effects of the process-based executive functions training, I have shown that performance-based improvements occur independently of experimental condition in non-interned adolescents. I have also demonstrated limited performance-based improvements in both participant groups receiving adaptive training. However, these improvements must be contrasted with a highly disparate training progression between said groups. The self-reported instruments show a similar pattern with improvements occurring independently of either experimental condition, internment status, or performance-based improvements.

Could this pattern of results be readily attributable to training effects generalizing into improved cognitive functioning? I cannot readily give an affirmative answer
to this question. Conversely, I also cannot provide further recommendations for process-based executive functions training in the juvenile justice context. Based on the disputable effects and large attrition rates observed here, I would recommend the prospective researcher to consider more effective rehabilitation methods for study. Maintaining close attention to the executive function updating while doing so, is likewise recommended.

10.3 Limitations and a note on the practicalities of studying interned adolescents

In this section, I will briefly touch upon the limitations of the component studies followed by a more general discussion on issues which can be encountered in studying interned adolescents.

In general, all three studies are underpowered and feature a very heterogeneous interned group. The interned participants have highly varied backgrounds differing in several potentially relevant characteristics, including socio-economical, medical/neuropsychological and legal aspects. For both practical and legal reasons, I was unable to access the specifics of much of this information. This is in line with the current trend in Swedish administrative policies, in which registry data is becoming increasingly hard for researchers to come by (Ginner Hau, 2010). Then again, subdividing the sample further based on any one of the background variables would have reduced the power to insupportable levels. Taken together, these issues certainly hamper the ability to detect meaningful differences between experimental conditions and participant groupings. I fact, it could even be questioned if the study design is at all suited for the inquiry at hand. Is it feasible to investigate and train of underlying cognitive constructs in such a small and diverse group? To answer this, we must consider the practicalities of the subject matter. Sample sizes in studies of interned adolescents are known to be a difficult matter (Syngelaki et al., 2009). In our case, this was not made easier by recruiting all participants with the intent to partake in the training intervention, in turn endangering representativeness in the cross-sectional studies. That being said, when the goal is to investigate interned adolescents as a unified group, heavy handed clustering may be permissible. For that purpose, the present design was deemed to be adequate. As it turned out, the fact that group differences were relatively stable across assessed executive functions was informative itself.

When it comes to problems typically afflicting intervention studies in interned and forensic settings, the present thesis was by no means spared. Adolescents can be challenging to study over time in and of their own, and interned ones are no less so. Here follows an account over some of the issues which have been present in the present thesis and what impact these have for the interpretation of the
results. It is my hope that this account, no matter how incomplete, will provide some aid for prospective researchers in the present field.

10.3.1 Follow-up measurements

The incorporation of follow-up assessments is a useful design element in any intervention study entertaining ambitions of inducing a long-term effect. In the case of process-based cognitive training, the issue of how long transfer effects are distinguishable is eminently relevant. Both the effort and the opportunity cost of training needs to be weighed against the notion of benefit over time. This benefit should preferably be quantifiable to a degree sufficient for making the choice to undergo training an informed one. This holds both for efforts aimed at improving aspects of deficient cognition as well as prohibiting the decline of established functions. If transferred training gains require maintenance or continuous interventions lest they diminish this would need to be included in that consideration as well.

For this reason, the conducting of follow-up assessments is one of the issues incorporated in the current drive to improve experimental stringency within the field of cognitive training. In studies of interned adolescents though, this is unfortunately not always possible. The present thesis is a case in point, with the featured studies having the posttests taken immediately upon finalizing the training period, and no additional follow-up assessments being made. Long-term follow-ups were rendered unfeasible due to a combination of practical and legal reasons.

Practical, in the sense that the interned participants could be discharged on short notice, and also that they were often eager to obtain the financial compensation for their participation. Because of this, it is certainly possible that training-induced changes to executive functioning would not yet have had the opportunity to manifest itself. This is particularly the case for self-reported measures, as the amount of everyday experience after the intervention was minimal immediately at post-test.

In terms of the law, I was barred from contacting the participants for follow-ups after their compulsory care had concluded, meaning that both effect-preservation and any effects on recidivism remain unknown. These are certainly issues to consider when designing future studies.

10.3.2 Recruitment

The second point regards the issue of participant recruitment. One recurring question in forensic rehabilitation studies that arises is in regards to the representativeness of the sample (E. Ross, 2012). Participation, particularly extensive intervention studies, involve considerable effort and thus require motivation for improvement or change. This may not necessarily be the most
distinguishing feature of this group. Studies thus run the risk of sampling a subgroup consisting of the most disciplined and motivated individuals. If so, it is also quite possible that such a subsample could exhibit cognitive functioning superior to their non-participating peers, ultimately obfuscating potential study effects. While likely beneficial for reducing attrition, such a subsample would be less representative of the larger interned population. In the cases where the participants of a study are compared to their non-participating peers, this has a distinctly negative impact on the validity of the study (E. Ross, 2012). This issue is related to the application of inclusion and exclusion criteria and to the general recruitment procedure.

In the present thesis, the actual recruitment was conducted by the person acting as project contact on the permanent staff at each separate SiS facility. This process included interpretation and application of the selection criteria (i.e. not explicitly aggressive, sobered up, and with a minimum 10 week planned placement) as well as approaching, informing, and consulting potential participants. This, along with any subsequent pre-test procedure, was done in parallel with their everyday duties at the facility. As the required effort on part of the contact person was substantial, this has implications for the consistency of the recruitment process. In short, there was an opportunity cost associated with recruiting a non-completing participant. Many contact persons later described how they took this into consideration when evaluating the uneven influx of internees to their respective facilities. This is not necessarily a deviation from the initial study design, although in the case of the cross-sectional studies based on pre-measurement data is certainly a condition to consider. It is quite possible that the observed effects would have been more pronounced had the sample been based on all incoming internees, rather than the ones accepting participation in the training. Then again, the decision to entrust recruiting to the contact persons was not done without careful consideration. The main reasoning being that they had the best understanding of the placement situation. They also had a personal and ongoing contact with the available internees, and was thus able to make on-site estimations of the prospects of the individual trainee. Forensic rehabilitation is a context in which such practical considerations are preeminently relevant. Choosing a workable recruitment strategy may very well be the difference between a completed and an abandoned study.

Before moving on, a short note on the number of facilities participating in the study. As has been mentioned, the youth care services provided by SiS are provided by a number of separate, specialized facilities dispersed throughout Sweden. Those interned in these facilities are the 4% of the most pressing cases of youth proscribed compulsory care by social services or the juvenile justice system. As the present thesis investigated general characteristics of this rather
heterogeneous group, it was decided to involve as many facilities as possible in
the project. This was done to maximize the available sample size, which at the
time was a priority. In doing so, the ability to investigate specific subtypes of
internees is severely curtailed. Provided the challenges associated with obtaining
a sufficiently large sample in the first instance (more on that below), this was
judged a sensible venue of approach. Additionally, the ability of a single
individual researcher to monitor and control design integrity and training
progress is reduced when the number and dispersion of involved facilities is
increased.

The alternative would be to work closer with a fewer number of
facilities. Again, this would result in more specific information regarding the legal
backgrounds of the internees. This, coupled with either a substantially reduced
sample size or a greatly increased time required to collect data, meant that such
an alternative was not feasible under the circumstances under which this thesis
was authored. Nonetheless, these are design considerations to be made in
interned settings, and the types of questions answerable will follow the choices
made.

10.3.2 Compensation
Related to recruitment, is the case of compensation. Some form thereof, often
monetary, is common in intervention research contexts. This serves as an
incentive for recruitment and to spur participants to persevere in their efforts. In
the case of interned populations however, unrewarded interventions are often
already ongoing as part of the everyday rehabilitative practice. This warrants
careful consideration for several reasons, one of the more pressing being the
threat to validity introduced by compensation. The reasoning here is that results
obtained using financial compensation may not be as readily replicated once
research is to be incorporated into unrewarded everyday clinical practice.
Conversely, the issue of financial compensation also introduces the risk of
recruiting largely unmotivated participants, only in it for the reward. In this case,
their adherence to the intervention could be less than what was intended for the
study design. The issue of intervention adherence in interned settings is an
ongoing but understudied issue (Helmond et al., 2012), and it remains an open
question as to how it should be interpreted. On the one hand, low adherence could
lead to underestimation of intervention effects. In the other hand, it also begs the
question if and how higher levels could be attained in the first place provided the
particular circumstances in interned settings. This is, at any rate, a more pressing
issue in intervention studies, as opposed to cross-sectional studies where
endurance is less of a prerequisite for participation.

This could certainly have been an issue in the present thesis. The
compensation was initially set to SEK 500, but was later increased to SEK 1,000.
The reasoning behind the increase was in response to a high attrition rate in the
intervention aspect of the study, as well as general complaints concerning the reward level. Certainly, these types of changes are to be avoided if at all possible as it complicates inferences regarding sample characteristics. In this case, the increase was implemented well in between participants to ensure no individuals receiving different levels of compensation was present at a facility at the same time. While practical considerations certainly complicate comparisons between the two levels of compensation, the attrition rate appeared to markedly diminish after the change. However, as is evident in Study 3, the actual training progression displayed by a large portion of the interned participants was very low. Very little effort or improvement can be seen past the first quarter of the training sessions, whereas the gain between pretest and posttest is well on par with the high-progressing non-interned participants. While this certainly disputes the link between training gains and subsequent transfer to untrained tasks, it also raises a question relating to the topic at hand: Why, if not for the financial compensation, did these participants remain in the intervention despite putting forth what could be interpreted as merely a symbolic effort? The sensation of being part of a scientific study and engaging in “special” activities should not be discounted, but it is nonetheless difficult to envision this as sufficient in absence of a concrete financial compensation at the end. Resolving the whole extent of this question is beyond the scope of this thesis, but as a design factor in interned settings, it definitely warrants careful consideration.

10.3.3 Attrition
The issue of unmotivated participants remaining in the study is paralleled by the issue of participants dropping out during the course of the study. Much in the same way as Goldilocks, eschewing porridge both too hot and too cold, the doctoral student prefers neither issue but must still try to finish the dissertation before the bears come home.

The term attrition is used here to describe this phenomenon. In intervention research on interned populations, high attrition levels are commonplace. This study saw an overall attrition rate for the interned adolescents in the vicinity of 50%, which is by no means uncommon in these settings (Lösel, 2001). If any advice is to be given at this point, it would be to plan data collection accordingly. In the cases where extensive test batteries are required, such as in studying transfer effects onto executive functions, both test design and recruitment procedure needs to be adapted to reduce the cost of attrition as much as possible.

In the present thesis, accurate documentation of the causes proved unfeasible due to a host of practicalities but in general did divide roughly into three categories: factors relating to either (1) the participant, (2) the facility, or (3) external directives.
1) In the participant category are several of the causes commonly associated with attrition in non-clinical settings, including loss of interest and changing priorities. These could be mundane, such as finding the training boring, or needing to focus on compulsory school curriculum. There were also less mundane individual factors causing attrition, including returning return from furlough with cognitive functioning impaired by substance abuse, or failing to return altogether. There were occasions where a participant either developed, or was exposed to, aggressive behavior which prompted security measures incompatible with continued participation. There were a number of occasions where project equipment was damaged or destroyed, but overall this proved a smaller obstacle than anticipated. All these causes are challenging to plan for on the design stage and also difficult to categorize when performing drop-out analyses. However, a more personal admittance procedure to the project, and closer contact to the investigator have been proposed to influence program success (Diamond & Ling, 2016).

2) With regard to attritional factors relating to the facility, there are a few I consider particularly worth mentioning. The main issue encountered in the present project has been organizational restructuring efforts on the ward type structure mentioned in chapter 5. Changes in the focus on wards rendered them unsuitable for the intervention on several occasions. This either due to a shortening of the duration internees stayed there, or by complicating recurring access to the intervention. Internees could also unexpectedly be shifted between wards with similar results. These factors are largely outside of the control of an external researcher. Nonetheless, if one recommendation is to be made, it is unquestionably to take some time to get to know the organizational structure, staff turnover rates (more on the staff below), and the current planning of the facility itself.

3) Finally, the attrition category relating to what I choose to denote ‘external directives’, in that they originated outside of the facilities themselves. There were instances when an internee, for some reason or another, was discharged ahead of the planned time, usually following a decision made by the social services. At these times, the discharging procedure is swift and rarely affords the possibility of post-assessments or the like. Nevertheless, I have consulted social work researchers which have informed me that admittance and discharge procedures in juvenile settings are quite an intricate subject, fully sufficient for a dissertation in and of itself. As such, I have no qualms about passing over this matter for some other doctoral student to examine.

To this type of attrition belong also a number of occasions where internees were transferred between facilities. This could be due to a vacancy at a
specialized treatment facility or rehabilitative progress at the current one. There were also a number of transfers owing to a sudden need for drug rehab. Lastly, there was one occasion where an entire facility was unexpectedly disbanded for budgetary reasons. This occurred mid-intervention but the affected participants did manage to complete the training before the decision was implemented. Nevertheless, a number of planned participations had to be canceled. These are all occurrences outside of the influence of the researcher, and cannot readily be prevented as such. These types of events are naturally difficult to foresee, though some mitigation can probably be achieved by researching facilities and associated authorities beforehand.

If nothing else, knowing the realm of possible outcomes already at the design stage is probably beneficial to the study integrity. And now you do know. Congratulations.

Before moving on, a note on the attempts to incorporate an interned active control group in the study. Had this succeeded, the study would have allowed for comparison between experimental and placebo treatments within the interned adolescents. Indeed, while there is certainly a case for caution due to a lack of difference between experimental conditions in the non-interned groups, this case would have been more solid with the addition of an interned placebo group. Again, baseline cognitive functioning have been shown to make a difference with regard to training gains (Foster et al., 2017). Therefore, the similarly sized gains made by the interned group vis-à-vis the non-interned, should preferably have been contrasted with an interned placebo group. Particularly so as we have already discussed causes unrelated to training, mainly within the interned group. Add to this, the presence of ceiling effects in the non-interned groups which cannot readily be ruled out. Alas, this was not to be and I had to resort to extrapolating from the performance of non-interned adolescents. This is a weaker design no doubt, but one that was more feasible given the constraints at hand. The initial intent was to randomize experimental conditions on facility level and subsequently re-randomized in parallel with internee turnover procedures. However, recruiting participants proved more difficult than anticipated, attrition was very high among those actually recruited, and the impression was that attrition was particularly pronounced in the interned placebo group. At this point, it was decided to prioritize the establishment of an interned experimental training group of sufficient size to allow for the planned statistical analyses. This was for the data collection to be containable within the thesis project, a non-trivial factor at the time. Once this group was sufficiently large, randomization was to be resumed in order for both conditions to be studied. As it were, I never did reach this point and the present study is undoubtedly underpowered. I can but reiterate the particular conditions associated with the study of this group, along with a recommendation to plan accordingly. The contrast to the non-interned groups
are also rather informative as there was no difference in attrition rates between experimental and placebo conditions there.

10.4 Working with facilities for troubled youth

I would like to conclude this section with some observations on the cooperation between academia and facilities housing interned adolescents. This is within a Swedish context, though from a methodological perspective this may very well be applicable elsewhere. As with any study in which the researcher is external to the organizational context of the focus of the inquiry, there are likely some conflicts of interest. The organization being studied has to balance both everyday activities along with the interests of the researcher. This is in and of itself a complex topic, therefore the present discussion will be limited to the question of staff roles and the use of a formal contact person.

As already mentioned, the geographical dispersion of the facilities made it unmanageable to conduct assessments and run everyday project presence personally. These tasks therefore fell on facility staff (whereas I managed training and coaching of staff, training progress monitoring, and data gathering of the control group). For this reason, the contact persons at the individual facilities became exceedingly important to the thesis project. This had at least two important consequences. Firstly, the recruitment, training, and coaching of the contact persons became crucial. When it came to recruitment, I found that recurring contact with the trainees and educational level was success factors. Both teaching staff and psychologists did fit this role whereas caretakers and administrative staff did not. The latter did either not have the time or opportunity to maintain contact with the trainees, or they found it challenging to coordinate and administer the training throughout the program. This was irrespective of initial motivation or instruction efforts by me, which was somewhat unanticipated. Nonetheless, interventions administered within the educational context by teaching staff have been noted to be beneficial in correctional settings (Ginner Hau, 2010). With regard to instruction and training of contact persons, I continuously refined the process (while endeavoring to keep participant instruction constant). Whenever possible, I travelled to the facilities to introduce the theory behind cognitive training, the program, the hardware and the training procedure. This both to ensure the method was as equivalent as possible at all times, and also to establish a personal relationship for the performance phase of the training project. When this was not possible, telephone, supplemented by both video and written materials, was used. While certainly not optimal, this worked well enough if the contact persons were given opportunity to acquaint themselves with the training program. The written instructions were continuously updated with frequently asked questions. That being said, a project wiki, or comparable resource, would possibly have been a better and more user-friendly supplement. As the facilities began to recruit trainees, the relationship to
the contact persons became one of ongoing coaching. This was initially a bi-weekly informal check-up which successively evolved. First so by adding an element of progress tracking on the training web server, then by implementing an increasingly detailed call log. This latter development served both as a check-list of things to do, training developments, trainee status, and thus also as memory notes for the next round of check-ups. Increasing detail level meant that the log would also ease the transition between contact persons. This unfortunately became a frequent occurrence and relates to the second of the two consequences of the contact person focus: the vulnerability to staff turnovers. Working closely with interned adolescents has been described as both highly rewarding, and likewise very challenging. The teaching staff are teachers by profession and often make similar salaries as their colleagues in regular schools, despite the added complexity of the pupillage. Add to this the remote location of most of the SiS facilities, complicating commute. These factors add up to a situation with high staff turnover rate, with both teaching staff and psychologists often on sick leave or pursuing less demanding jobs. For the purposes of a research project then, having a readiness and a routine for the loss of a contact person, is crucial. When it happened, the call log and the instruction routines meant that the transition was relatively seamless. Contributing to this was the sense of responsibility and genuine interest in the vast majority of the contact persons which meant they spontaneously endeavored to find and instruct their replacement before moving on.

In the next and final chapter of this thesis, I will be presenting a few concluding remarks and propositions for future research.
11. Future directions

This thesis is part of the ongoing broadening of the field of criminology in which traditional sociological theories are currently being complemented by aspects of cognitive psychology (L. J. Cornet, 2015; E. Ross & Hoaken, 2010). Notable examples of this are the cogent role of developmental trajectories (Moffitt, 1993), and research on the neural underpinnings of antisocial behavior (Raine et al., 2005). While these venues of approach have furthered our knowledge considerably, there are ample opportunities to expand this endeavor further. By employing well-grounded theoretical frameworks for cognition, we can gain a better understanding of how, when and why some members of society adopt deviant and maladaptive behaviors. This thesis also contributes to this ongoing effort by proposing the executive function updating as particularly relevant for future study. This is with regard to its closeness to the real-life conditions as indicated by recurring association to self-reported experiences from interned adolescents.

In terms of rehabilitation, I am hesitant to advocate process-based cognitive training as an all-purpose tool in internment settings. That being said, there are worthwhile endeavors to be had, should an empirically proven training intervention suitable for compulsory care become available. The effects of cognitive training have been noted do be mediated by personality and temper (Studer-luethi, Bauer, & Perrig, 2016) which opens up the prospect of standardized screening for suitable candidates for intervention. This is also partially in line with the relationship between cognitive functioning and impulsigenic traits described in Study II, even though I did not find any mediating effects of the pre-training self-reports onto the subsequent training gains.

Based on the results presented, there are a number of venues where I would encourage a theory based application of executive functioning. Firstly, I would consider investigating strategy training aimed at self-regulation (Piquero, Jennings, & Farrington, 2010), and to what extent this is mediated by executive functioning. Not only is this in line with the overarching importance of self-regulatory skill noted by Moffitt and colleagues (Moffitt et al., 2011), but is would likely suit the compulsory care context better.

Secondly, the relationship between antisocial behavior and other facets of neurophysiological functioning, including resting heart rate (L. J. M. Cornet et al., 2015), are exciting aspects of this emerging field needing more research.
References


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