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Executive Dysfunction: A Contributor to Subtypes of Violence or General Criminality?

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A thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Psychology

EXECUTIVE DYSFUNCTION: A CONTRIBUTOR TO SUBTYPES OF VIOLENCE OR GENERAL CRIMINALITY?

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by

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Abstract

Purpose: The adverse consequences of violence on society are tremendous. Several factors have been identified as potential contributors to violent crime, including deficits in executive functioning. Executive functioning is a term used to a describe number of higher-order cognitive abilities (e.g., working memory, inhibition) that are thought to be essential for appropriate, socially desirable behavior. The extent to which executive functions influence the occurrence of general criminality versus specific subtypes of crime is largely unknown. Of particular interest is the ability of executive functioning to distinguish between reactive and instrumental subtypes of violence. Whereas reactive violence is committed with the intention of harming the victim after perceived provocation, instrumental violence is committed with the intention of obtaining some kind of goal other than inflicting injury. Hence, the purpose of this study was clarify the relationship between executive functioning and subtypes of criminal offending, as well as to clarify the convergent and divergent validity of different indicators of executive functioning within the context of understanding crime. **Method:** One hundred and fifty-one adult male inmates from a federal correctional facility participated in this study. Participants completed both performance-based and self-report measures of executive functioning and their complete criminal histories were reviewed. **Results:** Consistent with hypotheses, executive functions were differentially related to subtypes of offending. Moreover, findings suggested that (a) performance-based tasks and self-report measures of executive functioning are unrelated to one another and are differentially related to subtypes of crime, (b) it is important to examine separate components of executive functioning rather than a composite score, and (c) the relationships between executive

functions and crime are not accounted for by general intelligence. **Conclusion:** Taken together, this dissertation demonstrated that executive functioning is most useful when using a crime-specific approach to understanding criminality. Future research should examine this relationship longitudinally to better understand whether this is a causal link or whether there are other pathways through which executive functioning influences the likelihood of an individual engaging in specific subtypes of violence. An understanding of the variables underlying different types of violence is a necessary precursor for risk assessment and offender rehabilitation.

Keywords: Executive Functioning, Intelligence, General Theory of Crime, Crime-Specific Approach, Reactive Violence, Instrumental Violence, Nonviolent Offending.

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Introduction

Aggression and violence have profound social, legal, and political consequences. The victims of violent crime can lose valuable possessions, their health, their ability to work, and sometimes their lives (World Health Organization, 2002). In Canada in 2008, 441,782 individuals were charged with violent offences (e.g., homicides, attempted murders, abductions, and robbery offences causing bodily harm; Statistics Canada, 2009). Although crime rates, in general, have been declining over the years, violent crime rates have been more variable and continue to account for one-fifth of offences reported by police (Statistics Canada, 2012). In 2011, relative to 2010, some types of violent crime had decreased, some had remained stable, and homicide rates had increased by 7% (Statistics Canada, 2012). In addition to the surprisingly frequent occurrence of violent offending, the annual cost of keeping an offender in a penitentiary is estimated at $87,919 per year (Public Safety and Emergency Preparedness Canada, 2005). Despite the cost, incarceration has been central to correctional systems in Canada and throughout the world. Many political leaders have suggested that incarcerating violent offenders deters them from committing additional violent acts (Clair, Faille, & Penn, 2010); however, there is considerable evidence pointing to the inability of punishment-based deterrence approaches to reduce offenders' risk of violence (Pratt & Cullen, 2005; Pratt, Cullen, Blevins, Daigle, & Madensen, 2006).

As a result of the ineffectiveness of punishment-based models, researchers are currently working to identify targets for rehabilitation that can reduce violent recidivism. Specialized programs for violent offenders may be warranted given that there is an increased likelihood of receiving a new conviction for violence after a previous

conviction for violence (Serin & Preston, 2001) and given that violent offenders can be differentiated from nonviolent offenders based on their psychosocial profiles (Lynam, Piquero, & Moffitt, 2004). However, providing a single treatment to all violent offenders may still be insufficient given the multiple etiologies of violent offending.

Violent offender heterogeneity is an issue that has received increasing consideration in recent forensic research. More specifically, it has been acknowledged that although violent offenders may present with the same general index offence (e.g., homicide), these offenders may differ in their motivations for using violence and therefore benefit from alternative courses of treatment (Robinson, 1995). One common method of discriminating between violent offenders is on the basis of whether the violent offence committed was reactive or instrumental (Cornell et al., 1996). Whereas reactive violence is committed with the intention of harming the victim after perceived provocation, instrumental violence is committed with the intention of obtaining some kind of goal other than inflicting injury (e.g., money, power, drugs, etc.). Further, whereas reactive violence occurs in the heat of the moment, instrumental violence often involves some degree of planning. Currently, researchers are investigating variables that are differentially related to reactive and instrumental forms of violence, variables that may subsequently be targets in offender rehabilitation.

Historical attempts to understand increased likelihood for later violence have focused on psychosocial risk factors in childhood, such as poor peer relationships and being low in socioeconomic status (for a review see Kashani, Jones, Bumby, & Thomas, 1999). However, rather than focusing on environmental variables, the role of individual cognitive abilities is beginning to be explored to determine whether individuals with

aggressive or violent tendencies are characterized by a certain pattern of functioning. To date, research in this area has established that incarcerated offenders and those who engage in deviant behaviour tend to be characterized by cognitive deficits, specifically in the area of executive functioning (Giancola, 2004; Herrero, Escorial, & Colom, 2010; Hoaken, Shaughnessy, & Pihl, 2003; Marsh & Martinovich, 2006; Raaijmakers et al., 2008; Séguin, Nagin, Assaad, & Tremblay, 2004; Séguin, Pihl, Harden Tremblay & Boulerice, 1995; Villemarette-Pittman, Stanford, & Greve, 2002; Yuedall, Fromm-Auch, & Davies, 1982). Executive functioning (EF) is an umbrella term used to describe a compilation of higher order cognitive abilities and will be discussed in greater detail below. A handful of studies have further examined whether executive abilities are differentially associated with violent versus nonviolent antisocial behaviours. Several studies have concluded that individuals who engage in violent behaviours are more impaired in EF than individuals who engage exclusively in nonviolent antisocial behaviour (Baker & Ireland, 2007; Barker et al, 2007; Miura, 2009).

Given that EF has been associated with violent behaviour in general, it is of interest whether there are differences in this relationship for specific subtypes of violent behaviour. Much less research has been conducted in this area, and the research that has been done has been characterized by significant variability in the measurement of EF. Researchers have used a variety of methods to assess EF, including both performance-based tasks and behaviour rating scales, despite research suggesting that these methods are weakly related to one another (for example, Rabin et al., 2006). Moreover, there have been a vast number of different performance-based measures used and there is a great deal of variability in the specific components of EF that they purportedly assess. Despite

being made up of several related but separate abilities (Godefroy, Cabaret, Petit-Chenal, Pruvo, & Rousseaux, 1999), researchers infrequently discuss the specific components of EF that are associated with aggression and violence. Instead, they refer to EF as though it were a unitary construct, ignoring the fact that different measures assess different components.

Research has inconsistently suggested that reactive aggression may be differentiated from instrumental aggression on the basis of executive abilities. However, in addition to the variability in EF measurement, the majority of studies have explored the aggression of children and adolescents or of adults in the community who commit relatively less severe acts of aggression. There is a necessity for research to examine the unique EF profiles of reactive and instrumental violence in offender populations. Therefore, the current research was undertaken to clarify the relationship between EF and subtypes of violence in adult inmates, as well as to elucidate the convergent and divergent validity of different indicators of EF within the context of crime.

Important Definitions

Before reviewing the relevant literature and addressing the major goals of this dissertation, several definitions need to be provided. Baron and Richardson (1994) defined *aggression* as "any form of behaviour directed toward the goal of harming or injuring another being who is motivated to avoid such treatment" (p. 7). *Violence*, on the other hand, will be defined as behaviour involving an intentional act of physical aggression against another individual that is likely to cause physical injury (Meloy, 2006) Aggression and violence are terms often used interchangeably; however, though similar, these terms are not synonymous. Whereas all violent acts are considered aggressive, the

opposite is not true. Aggression can result in both psychological and physical harm, while violence, as defined here, results exclusively in physical harm. In the literature, aggression is mainly an empirical term used by researchers who are investigating the harmful behaviour of individuals in the community (including children). Violence is mainly a forensic term used by researchers investigating the behaviour of incarcerated offenders. The focus of this dissertation is largely on the behaviour of incarcerated offenders, and therefore, I will primarily refer to violence herein. However, when reviewing the existing literature, I will retain the original terminology (i.e., aggression or violence) in order to express the nature of the behaviour referred to in the original publications.

An important distinction for the current dissertation is that between violent criminal behaviour and nonviolent criminal behaviour. Violent crime involves intentional harm-doing using physical means that is against the law (e.g., assault and homicide; Felson, 2009). Nonviolent crime involves various forms of oppositional rule violations that do not result in the victim being physically harmed (e.g., theft, drug offences, and fraud; Felson, 2009). Behaviours that violate societal laws are referred to as antisocial, deviant, and delinquent interchangeably throughout this dissertation.

Another important construct that requires defining is EF. Executive functioning will be defined as "… a multifaceted neuropsychological construct consisting of a set of higher-order neurocognitive processes that allow higher organisms to make choices and engage in purposeful, goal-directed, and future oriented behavior" (Suchy, 2009, p.106). Suchy (2009) also suggests that "executive functioning confers an evolutionary advantage by freeing an organism from innate, hard-wired drives and reflexes, as well as

from over-practiced, over-learned, and prepotent responses" (p.106). There is disagreement about the specific abilities that are subsumed under the definition of EF (see Table 1 for descriptions of several of the most commonly used indicators of EF and the components that they purportedly assess). However, three abilities that are frequently mentioned include working memory, inhibition, and shifting (or cognitive flexibility; Pennington, 1997; Miyake et al., 2000).

Shifting involves cognitively shifting back and forth between multiple tasks, operations, or mental sets (Miyake et al., 2000). The shifting process requires an individual to disengage from a task set that has become irrelevant and then to engage with a newly relevant task set (Miyake et al., 2000). *Working memory* allows an individual to monitor and code incoming information for relevance to the task at hand, and then to revise the information held in working memory by replacing old, no longer relevant information with newer, more relevant information (Morris & Jones, 1990). Finally, *inhibition* reflects an individual's ability to deliberately inhibit dominant, automatic, or prepotent responses when necessary (Miyake et al. 2000). It should be noted that in the literature review that follows, specific components of EF will not be identified as they are not frequently discussed in forensic research. As mentioned previously, many researchers fail to distinguish between separate components of EF, and instead, refer to it as though it were a unitary construct.

Now that the variables of interest have been defined, I turn to an overview of theory that is relevant to the present study. I will begin by discussing a generalist approach to understanding crime and aggression. Next, I will review crime-specific approaches to understanding violent crime, and subtypes of violent crime more

Table 1

Measures of Executive Functioning

Measure[a]	Description	Executive Functioning Components Assessed
Performance-Based Measures		
Wisconsin Card Sorting Task (Heaton et al., 1993)	Participants are asked to sort a deck of 64 cards into four categories as identified by stimulus cards. The cards can be sorted by colour, form, or number, and participants are given feedback regarding the accuracy of their performance. Every time a participant gets 10 consecutive sorts correct the sorting rule changes without the participant knowing.	Shifting, Inhibition, Concept Formation
Controlled Oral Word Association Test (Benton & Hamsher, 1976)	Participants are asked to name as many words as they can think of that start with specific letters from the alphabet. Participants are given one minute and must keep several rules in mind (e.g., cannot use proper names of people or places).	Verbal Fluency, Shifting, Working Memory, Monitoring
Trail Making Test (Reitan & Wolfson, 1985)	Participants are first asked to draw lines sequentially connecting 25 encircled numbers distributed on a sheet of paper. Next, participant must alternate between numbers and letters (e.g., 1, A, 2, B, 3, C, etc.).	Working Memory, Shifting, Attentional Vigilance
Porteus Maze (Porteus, 1965)	Participants are required to navigate their way through eight maxes without lifting their pencil from the paper.	Working Memory, Inhibition, Planning
Tower of Hanoi (Goel & Grafman, 1995)	Participants are required to manipulate several disks onto three rods in order to recreate given configuration, across three levels of increasing complexity.	Planning
Go/no-go task (Newman, Widom, & Nathan, 1985)	Participants are asked to press a key when a "go" stimulus is presented (e.g., the letter X), but to inhibit that response when a "no-go" stimulus is presented (e.g., the letter O). "Go" stimuli are presented at a higher rate than "no-go" stimuli so as to establish a prepotent response.	Inhibition
Stroop Test (Stroop, 1935)	Inhibition trials involve presenting participants with a list of colors printed in dissonant ink colors and then asking them to inhibit the response of reading the words in favor of naming the dissonant ink colors used to print each word.	Inhibition
Behaviour Rating Scales		
Behavior Rating Inventory of Executive Function (Roth et al., 2005)	Parents and Teachers complete 86 items asking about a child's self-regulation as reflected in specific problem behaviours at home and school. For older participants they complete a self-report version of the questionnaire.	Inhibition, Shifting, Initiation, Emotional Control, Planning, Organizing, Monitoring, Working Memory

[a]This is not intended to be a comprehensive list of all measures available that assess executive functioning, but instead, is a sample list of measures used by researchers of the reviewed studies.

specifically. I will also discuss EF and how it relates to crime theories as well as the empirical support for it being related to criminality, violence, and subtypes of violence.

Generalist Approach to Understanding Aggression and Violence

Although there is a substantial body of literature that suggests there are a number of unique predictors of different types of offending (these will be reviewed shortly), a more parsimonious explanation would be that there is a root cause of criminality, or of a propensity for deviance more generally. Armstrong (2005) purports that the widespread generality in offending, found in studies examining offence patterns, provides evidence that a general causal process is sufficient to explain a great deal of variation in offence type patterns. Evidence for a general causal process of crime and deviance also comes from the results of factor analytic approaches to crime data, which illustrate that much of the variation in diverse criminal and delinquent behaviours can be attributed to a single underlying factor (Donovan & Jessor, 1985; Donovan, Jessor, & Costa, 1988; Rowe and Flannery, 1994).

One example of a generalist theory of crime that has been the focus of considerable attention and debate is Gottfredson and Hirschi's (1990) general theory of crime. According to this theory, individual differences in a single latent trait, *self-control*, can explain individual differences in propensity for all types of crime (e.g., both violent and nonviolent). Self-control is conceptualized as "the tendency to avoid acts whose long-term costs exceed their momentary advantages" (Hirschi & Gottfredson, 1994, p. 3). It follows from this theory that individuals low in self-control are more likely than are individuals with high self-control to seize opportunities to engage in

criminal and other equivalent acts that have immediate benefits but long term costs (e.g., smoking, gambling, cheating on tests, or other risk-taking behaviour). According to Gottfredson and Hirschi, differences in type of offending that cannot be explained by individuals differences in self-control are simply an artifact of different environmental opportunities (e.g., living close to a bank and therefore being at an increased risk of robbing a bank). It follows from the general theory of crime, and from generalist approaches more broadly, that violent offenders are no different from nonviolent offenders; rather, these individuals have simply been faced with different criminal opportunities throughout their lives. The definition of individual criminal propensity as a general tendency towards a variety of criminal and delinquent acts calls into question the utility of crime-specific explanations of aggression.

An implication of the general theory of crime is that the risk factors for violence should be no different than the risk factors for other types of crime. A frequently cited and well-designed study by Farrington (1991) provides some support for this position. Farrington followed 411 males from the age of 8 until they were 32 years of age. After looking at the relationship between offending patterns and a variety of social, biological, psychological, and family variables, Farrington concluded that violent offenders were virtually identical to nonviolent offenders throughout their lives. Farrington argued that "violent offenders are essentially the most extreme offenders in frequency and seriousness" (p. 25) and that "the causes of aggression and violence must be essentially the same as the causes of persistent and extreme antisocial delinquent, and criminal behaviour" (p. 25).

Using a variety of methods, a number of researchers have similarly concluded that violent and nonviolent offenders do not differ in their background characteristics. They argue that offence frequency is the only area in which 'violent' and 'nonviolent' offenders differ, meaning that offenders who commit more crimes increase the variety of offence types that they commit which is more likely to include a violent offence (Capaldi & Pattterson, 1996; Lattimore, Visher, & Linster, 1994; Osgood, Johnston, O'Malley, & Bachman, 1988; Piquero, 2000). Taken together, studies in support of a generalist approach to understanding crime and deviance challenge the utility of alternative theories of crime that are specific to particular types of offending, such as violence. Advocates of a generalist approach to understanding criminality would hypothesize that any predictor of crime, including executive functioning, would be equally related to all types of crime and not specifically to violence.

Executive functioning as a predictor of criminality and deviance more generally. Ogilvie, Stewart, Chan, and Shun (2011) proposed that "neuropsychological impairments may be a key mechanism mediating the effects of genetic and psychosocial influences on antisocial behaviour" (p. 1064). Impairments in the neuropsychological processes of EF have been the focus of a great deal of research examining contributors to antisocial behaviour. Impairments in EF are thought to increase the risk of an individual engaging in antisocial behaviour through decreasing inhibitions, impairing an individual's ability to anticipate consequences and evaluate punishments and rewards, and by reducing an individual's capacity to generate socially appropriate behaviour in challenging or unfamiliar situations. (Giancola, 1995; Seguin, 2008). Moreover, researchers have argued that the similarity between EF impairments in brain-injured

patients to features of antisocial behaviour suggests that EF processes are important in understanding the etiology of antisocial behaviour (Ogilvie et al., 2011)

A large number of studies have examined the relationship between EF and antisocial behaviour. In 2000, Morgan and Lilienfeld reviewed the literature to clarify the relationship between executive abilities and antisocial behaviours because, until then, the many extant studies had produced inconsistent conclusions. In their meta-analysis of 39 studies, they found that individuals who took part in antisocial behaviours (including violent and nonviolent acts) performed .62 standard deviations worse on measures of executive abilities than individuals who did not. This was the case despite controlling for age, sex, ethnicity, and intelligence. Since then, researchers have found that EF can distinguish between adult and adolescent offender and non-offender groups (Bergeron & Vallient, 2001; Hoaken, Allaby, & Early, 2007), and that it is also associated with delinquency in college students and individuals in the community (Villemarette-Pittman et al., 2002; Giancola, 2004; Séguin et al., 2004). A more recent meta-analysis examining the findings from 126 studies similarly found that antisocial groups performed significantly worse on measures of EF when compared to controls (Ogilvie, Stewart, Chan, & Shum, 2011).

What can be taken from the above literature is that individuals who engage in deviant behaviour and those who are incarcerated display deficits on measures of EF. What is less clear is whether EF best predicts criminality and deviance in general, or whether it is more appropriately considered in a violence-specific approach to understanding criminality.

Criticisms of generalist approaches to understanding violence. Contrary to Gottfredson and Hirschi's (1990) assertion that variability in offending occurs solely because of opportunity, a large number of studies have found evidence for offence specialization, in that some individuals are more likely to commit a certain type or category of offence (e.g., assault or violent offences more generally; Brennan, Mednick, & John, 1989; Deane, Armstrong, & Felson, 2005; Holland, Levi, & Beckett, 1982; Lo, Kim, & Cheng, 2008; Lynam et al., 2004; Peterson, Pittman, & O'Neal, 1962; Schwaner, 1998; Stander, Farrington, Hill, & Altham, 1989). The evidence in support of specialization is of relevance in light of arguments that "specialization implies heterogeneity among offenders on more than one underlying theoretical construct" (Farrington, Snyder, & Finnegan, 1988, p. 462). Accordingly, and as will be reviewed next, experts in the field have been interested in identifying individual differences in psychological, biological, or social variables that can account for differences in offending patterns, and they have indeed identified variables that predict whether an individual will commit a violent versus a nonviolent criminal act (e.g., Arseneault, Tremblay, Boulerice, Seguin, & Saucier, 2000; Kennedy, 2006; Lynam et al., 2004; Parker, Morton, Lingelfelt, & Johnson, 2005; Unterstein, 2007). Collectively, results from these studies suggest that some predictors of violent behaviour can be quite different than those that predict nonviolent criminal behaviour, and in fact, that there may be unique predictors of subtypes of violence.

So while there is some support for a generalist approach to understanding crime and deviance, in light of a growing body of research supporting violence-specificity, the potential implications of individual characteristics and their relationships to specific

forms of crime should continue to be considered. One individual variable that comes up repeatedly is EF. The next section will review crime specific approaches to understanding aggression and violence as well as the importance of EF in these models.

Crime Specific Approaches to Understanding Aggression and Violence

Given the wide range of behaviours that are subsumed under the antisocial umbrella, it is not surprising that there is a great deal of variation across individuals who engage in deviant and criminal behaviour. When trying to understand crime and deviance, several researchers have developed explanations that focus explicitly on aggression and violence, assuming that the causal processes explaining individual variation in aggression and violence are different in some way from those explaining other forms of deviant behaviour.

Differences between violent versus nonviolent behaviour. Reiss and Roth (1993) posed the important question "what differences are there between people who commit violent acts and those who commit more general delinquent criminal or antisocial acts?" (p. 391). If individuals who commit violent acts comprise a criminal subgroup with shared characteristics, then researchers may be able to study these variables for purposes of understanding, predicting, and preventing violent offending.

In a comprehensive review of the distinctions between physically aggressive and non-aggressive delinquent behaviour, Burt (2012) demonstrates that these two dimensions of behaviour are associated with distinct patterns of development, etiological influences, and psychosocial correlates. For example, Burt highlights that relative to non-aggressive delinquent behaviour, physically aggressive behaviour is more stable over time, peaks in frequency earlier, is less common in adolescence, is more heritable, and is

less influenced by the environment. Moreover, non-aggressive delinquent behaviour has been shown to be more related to low constraint or self-reported trait-impulsivity while aggressive behaviour has also been associated with higher self-esteem, lower education, poorer employment history, greater substance use problems, and hostile schemas of the world (see Burt, 2012 for relevant citations).

In addition to the above mentioned variables, general cognitive functioning has been linked to violence. For example, performance on the Wechsler Intelligence Scale for Children (WISC) has been shown to discriminate between children who would later become frequent offenders, violent offenders, and frequent nonviolent offenders (Piquero, 2000). Poorer verbal abilities and difficulty reading in childhood have also been shown to be predictive of violent, but not nonviolent, criminal acts in adulthood (Kennedy, 2006). One specific cognitive variable that has been of growing interest in violence research, and that is the focus of the current dissertation, is EF. A handful of studies have examined whether EF can distinguish between violent and nonviolent behaviours. Although the findings are mixed (Greenfield & Valliant, 2007; Robertson et al., 1987), the authors of three methodologically sound studies have concluded that individuals who engage in violent behaviours are more impaired in EF than individuals who engage exclusively in nonviolent antisocial behaviour (Baker & Ireland, 2007; Barker et al, 2007; Miura, 2009). Furthermore, in a sample of federal inmates, Hancock, Tapscott, & Hoaken (2010) found that deficits in EF related to the frequency of violent offending, but not the frequency of nonviolent offending. Therefore, although definitive conclusions cannot yet be drawn, there is growing evidence that violent individuals are more impaired in their executive abilities than their nonviolent counterparts.

A number of theories of aggressive behaviour have been put forth in attempts to explain the heterogeneity within antisocial behaviour. One theory that implicates EF was presented by Moffitt (1993), who discussed two different antisocial trajectories: life-course persistent and adolescence-limited. Moffit theorizes that neuropsychological problems, including deficits in EF, are predictive of life-course persistent offenders, or individuals who begin offending early, offend for a large duration of their lives, and who engage in more serious and violent forms of offending. Moffit contrasted this with adolescence- limited offenders who do not tend to evidence deficits in neuropsychological functioning, and who limit their offending activity predominantly to the adolescent time period. The delinquent behaviour during this time is a consequence of developmental immaturity and peer influences. Because adolescent-limited delinquency is both normative and typically social in nature, this sort of offending is usually relatively minor and does not include violent acts. Several studies have confirmed that life-course persistent offenders have more neurocognitive impairments when compared to adolescence-limited offenders (Moffitt & Caspi, 2001; Raine et al., 2005).

Taken together, there appears to be compelling evidence supporting that the distinction between physically aggressive/violent behaviour and non-violent criminal behaviour is meaningful, and that they should be examined separately when studying deviant behaviour. This distinction is supported by research examining developmental, environmental, genetic, and individual difference variables. There are also theoretical explanations for why some individuals are more prone to engaging in violent behaviour. However, just as it may be problematic to conceptualize antisocial behaviour as a

homogeneous construct, it may be similarly problematic to conceptualize violence as a homogeneous construct. The review that follows will explore an approach to understanding criminality that considers the heterogeneity of violence.

Differences between reactive versus instrumental violent behaviour. Over the years there have been numerous attempts in the literature to distinguish between different subtypes of aggression and violence (for example, Hartup, 1974; Moyer 1976). Some researchers have suggested that different subtypes of aggressive behaviours should be defined on the basis of their form, for example, whether the aggression is physical or nonphysical (Tremblay, 2000) or direct or indirect (Bjorkqvist, Lagerspetz, & Kaukianinen, 1992). Still others have argued that subtypes should distinguish between the underlying motivation of the aggressive or violent act. For example, a great deal of research has distinguished between reactive and proactive aggression in children (Dodge, 1991; Dodge & Coie, 1987) or between reactive and instrumental violence in adults (Cornell et al., 1996; Miethe & Drass, 1999). As mentioned earlier, reactive violence is committed with the intention of harming the victim after perceived provocation, whereas instrumental violence (or proactive aggression in the child literature) is committed with the intention of obtaining some sort of goal other than inflicting injury, and often involves some degree of planning. Frequently used synonyms for reactive aggression include "defensive," "impulsive," "hot-blooded," and "retaliatory" aggression, while synonyms for instrumental aggression include "predatory," "proactive," and "offensive" aggression (Vitaro & Brendgen, 2005).

Theoretical distinction. Dodge (1991) brought together two dominant theories of aggression—the frustration-aggression model and social learning theory— to explain the

differences between reactive and instrumental forms of aggression. He argued in favour of both theories and provided unique etiological explanations for reactive and instrumental aggression, emphasizing that these different behavioural phenomenon are unique in their structure, topography, function, processes, and mechanisms.

The frustration-aggression model, proposed by Dollard, Doob, Miller, Mowrer, and Sears (1939) and refined by Berkowitz (1962; 1978), provides a framework for understanding reactive forms of aggressive behaviour. According to this model, aggression is an angry or hostile reaction to frustration. This frustration may result from a goal being thwarted, from a threat being made, or from anything else that the individual finds aversive, and it is often accompanied by the expression of anger. In an attempt to defend oneself or to harm the cause of frustration, an individual will use aggression. Dodge (1991) proposed that this reactive aggressive response is more likely in individuals who had early exposure to threatening stimuli that generated strong feelings of anger and fear. For example, experiences of growing up in a dangerous environment, losing a loved one, or being the object of violence might lead to hypervigilance, disruptions in one's sense of security, and fear or rage reactions. These kinds of experiences and reactions increase a child's likelihood of engaging in reactive forms of aggression later on (Dodge 1991). Alternatively, close interpersonal relationships are theoretically protective against reactive aggression, as such experiences can result in feelings of security, the potential for empathy, and an accurate understanding of others (Dodge 1991).

Alternatively, social learning theory, which was originally proposed by Bandura (1973, 1983), provides a framework through which we can understand proactive or

instrumental forms of aggression. According to this theory, individuals learn to use aggression as a way of gaining external rewards. Taking from social learning theory, Dodge (1991) proposed that instrumental aggression develops when a child's repertoire of aggressive tactics is reinforced and enhanced. For example, if a child is exposed to violence that is positively rewarded, be it on television, in their neighbourhood, or in their home, then the child is more likely to evaluate the outcomes of aggression positively and to act aggressively themselves when trying to obtain something. The child's repertoire of aggressive tactics will grow, and the child will not develop competence in nonaggressive ways of obtaining desired goals. Alternatively, competent role models are protective against instrumental aggression as they can broaden the child's repertoire of nonaggressive, prosocial responses. It should be noted that although the present study is interested in violent behaviour in adulthood, it is important to understand less serious forms of aggression in childhood and adolescence because they tend to be developmental precursors to violence in adulthood (Loeber & Pardini, 2008).

Operational distinction. Many studies examining the two subtypes of aggression suggest that they tend to co-occur, with most aggressive children engaging in both reactive and instrumental acts of aggression (Hubbard, McAuliffe, Morrow, & Romano, 2010). Continuous instrumental and reactive aggression scores correlate on average at $r = .70$ (Berkowitz, 1993; Dodge, 1991), leading some to question the value of differentiating between reactive and instrumental aggression (Bushman & Anderson, 2001).

Although reactive and instrumental forms of aggression appear to be closely related, Poulin and Boivin (2000) have suggested that this association may be inflated

due to measurement difficulties. For example, teachers and other informants are not always in a position to accurately identify the intentions of the aggressor, which would be necessary to differentiate the two types of aggression. In fact, Polman, Orobio de Castro, Koops, van Boxtel, and Merk (2007) suggested that the picture can be quite different depending on how aggression is measured. In their meta-analysis of 51 studies, the method of assessing aggression (e.g., direct observation or questionnaire) was the strongest moderator of the correlation between instrumental and reactive aggression. Specifically, when aggression was measured through direct observation, assessment with laboratory tasks, or questionnaires that clearly distinguished between forms and functions of aggression, the correlation between reactive and instrumental aggression was significantly smaller than when subtypes of aggression were measured with non-disentangling questionnaires. Polman et al. concluded that reactive and instrumental aggression can be distinguished from each other if measured accurately. Research examining subtypes of violence in adult populations have found similarly high correlations between reactive and instrumental violence when using questionnaires to assess violence (Kockler, Stanford, Nelson, Meloy & Stanford, 2006). However, when examining the official crime data of adult offenders, Cornell (1996; Cornell et al. 1996) found that coders could reliably dichotomize violent offences as instrumental or reactive. Moreover, Walters, Frederick, and Schlauch (2007) found no correlations between the frequency of reactive and instrumental violence, and Tapscott, Hancock, and Hoaken (2012) found an inverse relationship between rates of instrumental and reactive violence.

Exploratory and confirmatory factor analyses consistently yield two distinct factors rather than a single factor of violence, confirming the dichotomy (Little, Jones,

Henrich, & Hawley, 2003; Poulin & Boivin, 2000; Salmivalli & Nieminen, 2002). In addition to having been established as two separate constructs, a growing body of literature also suggests that instrumental and reactive forms of aggression are associated with unique psychosocial correlates and differential behavioural outcomes (e.g., Dodge, 1991; Stanford, Houston, Villemarette-Pittman et al., 2003; Vitaro et al., 2002).

Unique psychosocial correlates. Given that reactive aggression is viewed as an angry response to real or perceived provocation, whereas instrumental aggression is considered an intentional means of obtaining an anticipated reward, the social-cognitive processes underlying these two types of aggression are likely quite unique. Consistent with this hypothesis, research has found that when encoding situational cues, reactive aggressive children tend to focus more on aggression-relevant stimuli (Gouze, 1987), they recall more of the aggression-relevant details of a situation (e.g., Dodge & Frame, 1982), and they perceive aggression in their partners even when aggression is absent (e.g., Lochman & Dodge, 1998). Further, reactively aggressive children are less able to recognize specific intentions and motivations of others (e.g., Dodge, Price, Bachorowski, & Newman, 1990), they show a tendency to attribute hostile intentions to others in ambiguous situations (e.g., Coie, Dodge, Terry, & Wright, 1991; Dodge et al., 1990; Orobio de Castro, Merk, Koops, Veerman, & Bosch, 2005), and they have been shown to generate fewer alternative response options when faced with challenging social cues (Dodge, Lochman, Harnish, Bates, & Petit, 1997; Keltikangas-Jarvinen, 2001). Compared to reactive aggression, research has shown that instrumental aggression is positively related to self-reported levels of self-efficacy in enacting aggressive behaviours (Crick & Dodge, 1996; Dodge et al., 1997), to the expectation that aggressive behaviour

will result in positive outcomes (Arsenio, Gold, & Adams, 2004; Crick & Dodge, 1996; Dodge et al., 1997; Smithmyer, Hubbard, & Simons, 2000), and to prioritizing instrumental goals over social goals in interactions with peers (Crick & Dodge, 1996). Taken together, the above findings suggest that reactive and instrumental aggressors are characterized by unique patterns when processing social information.

There is also a growing body of literature that suggests there are unique personal (Raine et al., 2006; Vitaro, Brendgen, & Tremblay, 2002), social-environmental (Brendgen, Vitaro, Boivain, Dionne, & Purusse, 2006; Dodge et al., 1997), behavioural (Day, Bream, & Paul, 1992; Little, Jones, Henrich, & Hawley, 2003; Vitaro et al., 2002), and physiological correlates (Hubbard et al., 2002) of reactive and instrumental forms of aggression and violence. For example, instrumental violence has been associated with the callous and unemotional personality traits of psychopathy (Harpur, Hare, & Hakstian, 1989) and with lower scores on personality scales of neuroticism including subscales of anxiety, depression, self-consciousness, and vulnerability (Miller & Pynam, 2006). Moreover, individuals who engage in instrumental violence are more hostile, antisocial, and aggressive than those who engage in reactive violence (Stanford, Houston, Villemarette-Pittman et al., 2003). In contrast, reactive violence has been correlated with hyperactivity and poor social skills (McAuliffe, Hubbard, Rubin, Morrow, & Dearing, 2006) as well as higher scores on personality scales of irritability, suspiciousness, and anger control problems (Stanford, Houston, Matthias et al., 2003). Individuals who engage in reactive violence tend to be more irritable and emotionally labile (Stanford, Houston, Villemarette-Pittman et al., 2003).

In addition to having unique correlates, instrumental and reactive forms of aggression also appear to have different developmental trajectories. Fite, Raine, Stouthamer-Loeber, Loeber, and Pardini (2010) examined the associations between aggression in adolescence and psychosocial adjustment in adulthood. These researchers found that reactive aggression in adolescence was uniquely associated with negative emotionality (e.g., anxiety) during adulthood, while instrumental aggression in adolescence was associated with psychopathic features and antisocial behaviour in adulthood. Heilbrun, Heilbrun, & Heilbrun (1978) found that murderers whose violence was classified as reactive were more likely to fail on parole than those whose murders were instrumental in nature. Researchers have also established that instrumental aggression in childhood predicts delinquency in adolescence (Vitaro et al., 2002; Vitaro, Gendreasu, Tremblay, & Oligny, 1998; Brendgen, Vitaro, Tremblay, & Lavoie, 2001), whereas reactive aggression predicts later dating violence (Brendgen et al., 2001). Interestingly, when examining moderators, Brendgen and colleagues found that parental supervision at age 15 moderated the relationship between instrumental aggression and delinquency, and that maternal caregiving at age 15 moderated the relationship between reactive aggression and dating violence.

Executive Functioning and Reactive versus Instrumental Violence. There is additional support from the psychophysiology, cognitive neuroscience, and neurobiology literature for the distinction between reactive and instrumental forms of violent behaviour. Researchers have implicated distinct neurological anomalies, areas of the prefrontal cortex, and neural circuitries in human reactive aggression as compared to instrumental (Anderson, Bechara, Damasio, Tranel, & Damasio, 1999; Blair, 2001; Blair,

Mitchell, & Blair, 2005; Blair, Morris, Frith, Perrett & Dolan, 1999; Grafman, Schwab, Warden, Pridgen, & Brown 1996; Raine, Ohil, Stoddard, Bihrle, & Burchsbaum, 1998).

Giancola (2000) purported that the relationships between neurological abnormalities and aggression are mediated by the failure to adaptively use executive functions, an argument that if correct, raises the question of whether EF is differentially related to subtypes of violent behaviour. Much less research has been conducted in this area, with the majority of studies having focused on the aggression of children and adolescents. As will next be established, there has also been a great deal of variability in the methodology used in this small literature base, including considerable variability in how EF and aggression have been operationalized.

Research in the child and adolescent literature has been somewhat consistent in suggesting that impairments in EF are more characteristic of reactive aggression than instrumental aggression. Giancola and colleagues (1996) found that relative to non-aggressive children, deficits in EF characterized children who engaged in reactive aggression. However, these authors did not examine the relationship with instrumental aggression. Jones (2007) examined the relationship between EF and reactive and instrumental aggression in a community sample of school-age boys. His results suggested that impaired inhibition was associated with reactive aggression but not instrumental aggression. Similarly, Ellis and colleagues (2009) used performance-based measures of EF and found that children who engage in reactive aggression were lagging in EF, whereas instrumental aggression was not associated with deficits. Using a parent-report measure of EF (Behavior Rating Inventory of Executive Function; BRIEF), White, Jarrett, and Ollendick (2012) also found that EF was associated with reactive but not

instrumental aggression. Furthermore, these relations were above and beyond those accounted for by gender, age, ADHD diagnosis, IQ, or psychotropic medication status.

However, not all research has consistently found support for a unique relationship between EF and reactive aggression. For example, unlike other researchers, Broder (2004) found that both instrumental and reactive aggression in school-age boys were negatively related to teacher-reported EF on the BRIEF, specifically on the Inhibit, Shift, and Working Memory scales. A possible explanation for this discrepancy comes from the fact that, in this study, aggressive subtypes were determined by teacher ratings on a questionnaire. As mentioned previously, correlations are usually quite high between reactive and instrumental aggression obtained from questionnaire-based studies because respondents are unaware of the reactive-instrumental distinction and, as a result, unknowingly attend to only the form of aggression assessed in the items (verbal vs. physical aggression; Poleman et al., 2007). Consistent with this hypothesis, the correlation between instrumental and reactive aggression in Broder's study was quite high (r = .68). Consequently, the teachers in Broder's study may have rated children high on both reactive and instrumental items, not because children used aggression to serve both functions, but simply because children used physical aggression. The results may be better interpreted then as EF being associated with general aggression, but not with specific subtypes.

Few researchers have examined the relationships between reactive and instrumental aggression and EF in adults, and even fewer have examined more severe forms of violent behaviour. In one study, Stanford, Greve, and Gerstle (1997) found that college students who self-reported engaging in reactive aggression were characterized by

deficits in EF compared to those who denied engaging in reactive aggression. In one of the only studies comparing instrumentally aggressive adults to non-aggressive controls, Stanford, Houston, Villemarette-Pittman et al. (2003) found no differences between the groups on several performance-based measures of EF; however, there was one exception with a single subscale of the Wisconsin Card Sorting Task, where the instrumentally aggressive group exhibited greater failure to maintain set than controls. Haberle (2011) examined how EF was differentially related to self-reported reactive and instrumental aggression in university students. Results demonstrated that reactively aggressive individuals performed more poorly than both instrumentally aggressive individuals and controls on measures of EF including the Trail Making Test, the Tower of Hanoi, the Verbal Fluency Test, and the Stroop Task. Consistent with previous work, instrumental aggressors did not differ significantly from normal controls on these measures.

Using a small sample of adult inmates, Broomhall (2005) compared the executive abilities of instrumental (n=13) and reactive (n=12) violent offenders (categorized based on their index offence) and found that reactive violent offenders displayed impairments on scores from subtests of the D-KEFS including the Verbal Fluency Test and the Colour Word Interference Test, but not on the Design Fluency Test. The instrumental group demonstrated functioning that was largely intact. Finally, examining similar aggressive subtypes (predatory versus irritable) Levi, Nussbaum, and Rich (2010) found that irritable offenders (analogous to reactive) were impaired on two tasks of inhibitory control whereas predatory (similar to instrumental) were impaired on one measure of inhibition that added a motivational component.

Although much of the executive functioning-violence literature comes from studies that used a global index of violence (Scarpa & Raine, 2000), there is nonetheless preliminary evidence suggesting unique relationships between EF and reactive violence. However, in the few studies that have examined EF and subtypes of violence or aggression, researchers have not always compared subtypes but instead have examined only reactive or only instrumental acts. Alternatively, many researchers have categorized individuals as "reactive" or "instrumental" based on a variety of criteria, and they have measured EF inconsistently, meaning that they have used different methods of assessment and a variety of different tasks. Much of the evidence base on EF and subtypes of violence comes from unpublished doctoral dissertations (e.g., Broder, 2004; Haberle, 2011; Jones, 2007). With the exception of Broomhall (2005) and Levi et al.'s (2010) small samples of inmates, most researchers have examined these relationships in community participants. Given the importance of identifying variables that distinguish between reactive and instrumental violence in offender samples, there is a need for research to further examine the unique contribution of executive functions to these subtypes of violence.

Theoretical link between executive functioning and violence. Despite the preliminary research evidence linking EF to subtypes of violence, there is a paucity of theory explaining why deficits in EF might predispose an individual to criminal behaviour, violence, or reactive violent behaviour more specifically. For example, Séguin and Zelazo (2005) highlighted that in cases where the development of EF is atypical, children continue to display high levels of physical aggression, but researchers

do not provide an explanation of why this is the case. Although a theoretical link has not yet been proposed, I will review one possibility below.

Several researchers have highlighted the importance of executive functioning in models of social problems solving (e.g., Zelazo, Carter, Reznick, & Frye, 1997). Social problem solving refers to "the process of problem solving as it occurs in the natural environment or real world" (p. 11, D'Zurilla, Nezu, & Maydeu-Olivares, 2004). Researchers have emphasized how executive functioning directly influences an individual's ability to solve social problems, which subsequently impacts social/interpersonal outcomes (Eslinger, Grattan, & Geder, 1995). While they have not directly implicated criminal or violent behaviour specifically, it is easy to imagine how executive abilities such as inhibitory control, working memory, and shifting would be necessary to navigate through a social encounter, as well as how deficits in these abilities could lead to violence, particularly reactive violence.

A social problem solving model that has received a great deal of attention, and may be useful in helping researchers understand the link between EF and violence, is one that was created by Dodge (1986) and reformulated by Crick and Dodge (1994). According to this model, when an individual is presented with a social stimulus, several mental processes are activated (or fail to be activated) that contribute to how the individual responds. In the first step of this model, the individual attends to and organizes relevant information about the social stimulus (*encoding of cues*). Second, the individual makes attributions of causation, affect, and intent to the stimulus and evaluates the relevance of the stimulus in order to make personal meaning of it (*interpretation of cues*). Third, the individual identifies his or her objectives (*clarification of goals*).

Fourth, the individual either constructs one or more new responses or accesses previously constructed responses from memory (*response access or construction*). Finally, the individual assesses the response options in order to select a response for behavioral enactment (*response decision*) and then actually enacts the response (*response enactment*). Perhaps deficits in EF influences the different steps involved in social problem solving which subsequently put an individual at risk of responding to situations violently.

For example, when faced with a new or ambiguous social situation, such as being pushed in a crowded noisy nightclub, an individual needs to *interpret the social cues* and try to determine the motives of the individual responsible for the push before generating potential responses. An individual impaired in inhibition may be unable to inhibit an automatic or prepotent response such as pushing the other person back, and rather than generating several possible interpretations of the push, react immediately with violence before assessing other response options. Moreover, an individual must also hold the social cues in their working memory while determining how they should respond, which simultaneously requires shifting (or cognitive flexibility) to generate a variety of response options. For an individual with deficits in shifting, they may be unable to generate alternative attributions or more prosocial response options when in the *response construction* and *response enactment* stages of processing social information. Impairments in working memory may prevent them from updating their working memory with more recent social cues (e.g., the individual turning apologetically to grab some napkins) and may instead generate a response based on the first social cues they processed (the drink being spilt on them). Furthermore, after reacting more aggressively

than the situation called for, the individual with EF deficits may provoke the victim to also respond more aggressively, thereby escalating what was originally an innocuous and non-threatening social situation to one that involves violence.

As mentioned previously, research has in fact demonstrated that aggressive children process information in social situations differently than nonaggressive children (Crick & Dodge, 1996; Orobio de Castro, Veerman, Koops, Bosch, & Monshouwer, 2002) and it seems that different aspects of social-information processing play unique roles in reactive and instrumental aggression. In fact, research has demonstrated that individuals who engage in reactive violence actually generate fewer response options when faced with challenging social situations (Dodge et al., 1997; Keltikangas-Järvinen, 2001). Furthermore, there is some preliminary evidence to suggest that executive abilities may influence an individual's propensity for using different subtypes of violence through their influence on how they process social information and solve problems. For example, Tate, Fenelon, Manning, and Hunter (1991) suggested that deficits in shifting may lead to problems in social communication and social interactions. Similarly, McGann, Werven, and Douglas (1997) proposed that deficits in EF could impair an individual's ability to solve problems in social contexts, particularly in novel and unpredictable social situations. Insufficient social problem solving capacities resulting from impairments in inhibition, shifting, and working memory may predispose individuals to engage in violent behaviour, specifically reactive violence.

Research has found that EF has been associated with delinquency and criminality, with violent behaviour in general, and preliminary research findings suggest that it may be associated with reactive violence more specifically. However, more research is

needed before definitive conclusions can be made and before suggestions regarding risk assessment and offender rehabilitations can be provided. The next section will review the construct of EF, relevant theory, and issues around development and measurement.

Overview of the Concept of Executive Functioning

The construct that became known as EF got its start with case examples of individuals with serious brain injuries such as the well-known Phineas Gage. Phineas Gage is the most popular example of an individual who displayed severe behavioural changes as a result of damage to the frontal cortex of his brain (Damasio, Grabowski, Frank, Galaburda, & Damasio, 1994). Patients with such damage exhibited difficulty controlling or regulating their behaviour, and as a result, they were very much impaired in their daily living. Although able to perform well on other cognitive tasks, including tests of intelligence (Shallice & Burgess, 1991), they displayed deficits on tests of organization, set-shifting, and goal-directed behaviour (Damasio et al., 1994).

This early research led neuropsychologists to suspect that the frontal lobes of the brain may be largely responsible for EF. In fact, the sequential improvement of executive abilities throughout childhood has been shown to coincide with the growth and development of the frontal lobes (Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001). Similarly, the decline in executive functions at the other end of the life span has been associated with anatomical changes in the brain during normal aging (Jurado & Rosselli, 2007). The view that the frontal lobes are entirely responsible for EF is now thought to be overly simplistic (Elderkin-Thompson, Ballmaier, Hellemann, Pham, & Kumar, 2008; Monchi, Petrides, Strafella, Worsley, & Doyon, 2006; Stuss, et al. 2002), but the point remains that the frontal lobes have been implicated in both executive

abilities and violence. Moreover, physical aggression is characteristic of young children; however, it becomes less frequent with increasing age (Tremblay et al., 1996), a change that coincides with the marked improvements in EF observed during this time frame (Zelazo & Müller, 2002).

Since the time of Phineas Gage, the construct of EF has received a great deal of attention and has become somewhat better understood. However, as mentioned previously, there is currently no agreement on a conceptual framework or definition of EF and there is disagreement about the specific abilities that are subsumed under the definition of EF. Three abilities that are frequently mentioned include working memory, inhibition, and shifting (or cognitive flexibility; Pennington, 1997; Miyake et al., 2000).

Executive functioning's broad and vague definition has given the construct a reputation of lacking scientific substance (Miyake et al., 2000). Pennington (1997) attempted to clarify the dimensions of EF empirically in order to make the construct more useful for research purposes. Through factor analytic studies, four dimensions emerged, three of which correlated with specific neuropsychological tests traditionally used to measure EF: inhibition, working memory, and shifting set. The fourth dimension correlated with language ability and will not be discussed further.[1] In a second part of this study, Pennington found that these three dimensions of EF could distinguish between different forms of psychopathology, such as autism, ADHD, and fragile X syndrome, thereby providing further evidence of their validity. Pennington concluded that the identification of these three dimensions of EF provided empirical validation of the hypothesis that EF is better conceptualized as composed of distinguishable dimensions

[1] Pennington concluded that they had succeeded in measuring at least three distinguishable dimensions of executive functioning. A reading test loaded strongly on the fourth factor and Pennington did not discuss this factor in subsequent analyses which examined specific disorders and executive functions.

than as a unitary construct. These three dimensions also provided researchers with somewhere to start when deciding which executive abilities to examine in subsequent research.

Miyake and colleagues (2000) developed a theoretical account of how executive functions are organized and what roles they play in complex cognition. Miyake et al. focused on three of the most frequently postulated executive functions in the literature, and the same three identified by Pennington (1997). Miyake et al. gave two justifications for focusing on these three particular functions. First, in comparison to other frequently discussed executive functions like "planning," the three selected executive functions were simpler, lower-level functions that could be operationally defined fairly precisely. Second, the selected executive functions could be assessed using a number of existing, well-studied, and simple tasks. Researchers conducted confirmatory factor analyses on tasks thought to tap each targeted executive function, and results demonstrated that executive functions were clearly distinguishable (Miyake et al., 2000). Further, the full three-factor model produced a significantly better fit to the data than any other one- or two-factor models. However, the three executive functions were not completely independent, as moderately high correlations were observed between the three factors (.42-.63). Miyake and colleagues emphasized that they chose to focus on these three abilities, not because they believed they were the only three or the most important, but because they are the most commonly discussed and easily measured. Although the three abilities that Miyake et al. focused on can be succinctly defined, there are a number of difficulties associated with assessing EF that will be reviewed below.

Measurement of executive functioning. The lack of an agreed upon definition for EF has posed problems for test development, assessment, and research. Specifically, there is no "gold standard" indicator of EF that can be used as the criterion for evaluating supposed executive function measures (Royall et al., 2002). Currently, the validation of EF tests is based solely on the criterion of them being sensitive to frontal lobe damage, but the precise nature of the executive functions necessary for accurate performance on these tasks is unspecified (Miyake et al., 2000). Moreover, it is difficult to integrate current research findings on EF given the variability in measures used. Each of the commonly used measures of EF (for examples refer back to Table 1) purportedly assess "executive functioning", but appear to be very unique tasks, with different psychometric properties (Chaytor, Schmitter-Edgecombe, & Burr, 2006). Further complicating matters is that two different approaches have been taken to assessing EF, one approach being to use performance-based tasks and another being to use self-report or behavior rating scales. Performance-based tasks are objective and provide an assessment of performance or problem-solving competence, as judged by the products of an activity. In contrast, self-report measures and behaviour rating scales in the child literature, are subjective ratings and require the individual (or someone close to them) to provide information about their perceptions of how they approach various challenges. Using one or the other of these two approaches is problematic given the weak relationships that previous researchers have reported between these methods of EF assessment (Mahone, et al., 2002; Rabin et al., 2006; Vriezen & Pigott, 2002). This makes comparing results from studies using different methods of assessment difficult.

Although still debated (see De Frias, Dixon, & Strauss, 2006), many experts in the field agree that EF is a non-unitary construct, made up of a number of related but separate cognitive abilities (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000; Salthouse, Atkinson, & Berish, 2003). Therefore, different tests of EF may reflect different executive abilities. Consistent with this suggestion, a number of studies have reported patterns of low intercorrelations between different tasks of EF (e.g., Lehto, 1996). It is possible that some components of EF are impaired in individuals who engage in different subtypes of violence and that others remain intact or are less impaired. Therefore, it is important for researchers to administer a battery of measures in order to adequately assess each of the abilities separately.

Currently, when researchers in the forensic field assess "executive functioning," they typically administer one or two performance-based measures but rarely discuss the individual components of EF assessed. In fact, many researchers use a composite score whereby they sum across the separate tasks that they use rather than focusing on the specific components that are impaired (for example Giancola, 2004). However, even when multiple tests are administered and interpreted, many popular tests of EF only provide global summary scores instead of isolating and quantifying the specific features of executive functions (e.g., inhibition, working memory; Jurado & Rosseli, 2007). Researchers have attempted to resolve this problem by creating batteries, such as the Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001), that provide a large number of scores representative of the separate processes required to complete a task. Given this development in neuropsychological assessment, future forensic researchers should explicitly identify which components of EF they intend to

measure in their investigations of the underlying abilities implicated in different subtypes of violence. Moreover, a comprehensive battery of EF measures should be included in any investigation attempting to measure this elusive construct.

Chan, Shum, Toulopoulou, and Chen (2008) discussed a number of problems with current performance-based measures of EF, particularly focusing on the issue of ecological validity. Ecological validity refers to the degree to which results from the laboratory generalize to the real world. There are sometimes only moderate relationships between tasks of EF encountered in a research setting and naturalistic tasks of EF encountered in everyday life (Chan, Shum, Toulopoulou, & Chen, 2008). Given the problems associated with many performance-based measures of EF (Chan, et al. 2008; Chaytor & Schmitter-Edgecombe, 2003; Jurado & Rosselli, 2007), self-report measures of EF should be considered for inclusion in batteries of EF, in conjunction with performance-based measures. The use of a self-report measure with an offender population may be particularly useful because, in comparison to clinical populations, offender populations tend to evidence more subtle cognitive deficits, which are not always detectable by performance-based measures (Burgess, Alderman, Evans, Emslie, & Wilson, 1998; Sbordone, 2000; Shallice & Burgess, 1991).

More research needs to be aimed at both understanding the true nature of executive abilities, as well as at developing ecologically valid measures of EF. Until then, it seems important that forensic researchers who are examining the relationship between EF and violence include both performance-based and self-report measures in their assessment batteries.

Executive functioning and intelligence. Despite the observation that some individuals with EF deficits remain able to perform well on measures of intelligence (Shallice & Burgess, 1991), EF is nonetheless often correlated with intelligence (Miyake, Friedman, Rettinger, Shah, & Hegarty, 2001; Salthouse, Atkinson, & Berish, 2003). This correlation is likely because general intelligence encompasses complex reasoning and problem-solving abilities (Carroll, 1993), which in turn are thought to relate, possibly equally, to all executive functions. Furthermore, evidence from functional neuroimaging indicates that the prefrontal cortex plays a central role in both EF (Miller, 2000; Miller & Cohen, 2001) and general intelligence (Bishop et al., 2008). In fact, using a technique known as voxel-based lesion-symptom mapping, Barbey and colleagues (2012) found that intelligence and EF largely depend on shared neural functioning. Researchers have also examined the relationship between subcomponents of EF and intelligence separately. For example, Friedman et al. (2006) found that intelligence was most closely related to working memory (sharing 41-48% of the variance), whereas inhibition and shifting were not closely related to intelligence (sharing between 2-14% of the variance). Findings suggest that there seems to be some overlap between certain executive functions and general intelligence, but not between all, and so EF and intelligence deserve separate examination in research.

In addition to being related to one another, intelligence and EF have also both been connected with aggression and violence (Ellis et al., 2009; Giancola et al., 1996; Maguin & Loeber, 1996; Sharp et al., 1995). Delinquent behaviour is often associated with academic problems (Hinshaw 1992, Maguin & Loeber 1996, Maughan 1994), and so Loeber and Hay (1997) purported that it is possible that aggression may be due, in

part, to low general intelligence. Research has shown that intellectual functioning is negatively related to aggression and delinquency (Sharp et al., 1995; Maguin & Loeber, 1996), as well as to violent behaviour later on in life (Farrington, 1989). Given the shared neural circuitry between EF and intelligence, as well as their shared association with aggression and delinquency, it seems important that researchers examining EF and violence also include a measure of intelligence. This helps first, to ensure that any differences in EF are not simply a function of the samples' different levels of intelligence and second, to further examine the relationship between intelligence and subtypes of violence given that no one has examined this specifically.

Objectives for the Current Study

At this point, the relationships between executive functions and subtypes of violence are not well understood. Much of the existing literature on the correlates of violence has not considered different subtypes, and the little research discriminating between subtypes of violence has focused primarily on acts committed by children and adolescents or on acts committed by individuals in the community. Therefore, the overall objective of this dissertation is to better understand whether there are unique relationships between subtypes of violence and executive functions in a sample of incarcerated adult offenders. More specific goals for this dissertation included:

1) Clarifying the relationship between EF and criminal offending - is executive functioning a useful construct in predicting specific subtypes of criminal offending (e.g., reactive versus instrumental violent offending) or is it better thought of from a generalist approach as being related to rates of crime and delinquency more generally?

2) Clarifying the convergent and divergent validity of different indicators of EF within the context of crime.
    a. Are self-report and performance-based measures of EF similarly related to criminal offending?
    b. Is it necessary or helpful to examine separate components of EF, or is it equally informative to use a composite score of EF when examining the relationship with offending?
    c. Can relationships between EF and crime be accounted for by general intelligence, or is general intelligence uniquely associated with criminality?

Most research investigating executive abilities in offenders has tended to dichotomize inmates as violent versus non-violent or as reactive versus instrumental. Although it would be convenient to have distinct reactive violent, instrumental violent, and nonviolent subgroups, this is not what researchers tend to observe in reality (Lo, et al., 2008). Many inmates have engaged in multiple subtypes of offending and so examining relationships at the offence level is more informative in the early stages of research to avoid making arbitrary groups. Therefore, in the present study, inmates' entire adult criminal histories were reviewed, and each offence was coded as reactive violent, instrumental violent, or non-violent. These lifetime estimates of offending may provide more reliable estimates of propensities towards violence than has been available in past research, where individual differences in subtypes of violence were determined from a single most recent (e.g., Broomhall, 2005) or most severe offence (e.g., Woodworth & Porter, 2002). Negative binomial regression analyses were used to assess

whether particular executive abilities were predictive of the frequency of different subtypes of offending. Hierarchical linear modeling was also used to examine whether executive abilities were related to the likelihood of committing one type of offence over another (e.g., a reactive violent offence over an instrumental violent offence). This complimentary analytic approach allowed both the rates and the proportions of each type of offence to be considered.

The current study used official crime data to obtain information about inmates' criminal histories. While official data has been criticized on the grounds that it underestimates total offending (Hood & Sparks, 1970), is associated with measurement error as a result of plea bargaining (Murrie, Cornell, Kaplan, McConville, & Levy-Elkon, 2004), and reflects police bias (Shwaner, 1998), self-report data has been similarly criticized for being subject to both under-and over-reporting (Dunford & Elliot, 1984; Dunning, Heath, & Suls, 2004). Bursik (1980) argues that an offender who commits few offences is likely to have better recall than a frequent or high rate offender, resulting in a rough estimate of offending patterns that may be systematically biased. Because serious violent crimes carry more serious interpersonal and legal sanctions than other criminal acts, they may be particularly subject to the effects of social desirability biases and demand characteristics resulting in underreporting (Henggeler et al., 1993). Given the focus of the current study on violent offending specifically, the accuracy of estimates of rates of violent offending was prioritized, and official crime data was used. Moreover, self-reports were thought to be particularly unreliable in the current study given that some inmates would have had to report on a criminal career that had spanned over 40 years.

Incarcerated adult men were recruited for this study because men are the perpetrators of over three quarters of violent crimes in Canada and the United States (Federal Bureau of Investigation, 2007). Many studies examining correlates of violent behaviour have focused their investigations exclusively on men (e.g., Broomhall, 2005; Greenfield & Valliant, 2007; Miura, 2009). Consequently, sampling from men provided a large enough sample of violent offences to detect possible differences in the relationships with executive functions.

Finally, multiple measures of EF were employed, including both performance-based and self-reported behavioural ratings. The currently most reliable and valid measures were selected to assess the construct of EF. First, performance-based assessment of EF was done using subtests from the Delis-Kaplan Executive Function System (D-KEFS; Delis et al., 2001), which provides a wide range of scores thought to assess separate executive functions. Second, the Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A; Roth, Isquith, & Gioia, 2005), a self-report measure of EF, was selected because it is thought to measure EF in an individual's everyday environment and because it has been shown to be sensitive to subtle changes (Rabin et al., 2006). As outlined previously, Miyake et al. (2000) provided a strong rationale for focusing on specific components of EF, and for the same reasons, set-shifting, working memory, and inhibition serve as the focus in the present dissertation.

Goal 1 – Clarifying the relationship between executive functioning and criminal offending. Given mixed findings in previous research (e.g., Broder, 2004; Broomhall, 2005; Ellis et al., 2009), the first objective of the current study was clarify the relationship between EF and criminal offending. The extent to which executive abilities

were associated with rates of criminal offending in general, as well as with nonviolent and violent offending, and reactive violent and instrumental violent more specifically were explored. It was of interest whether EF was a useful construct in predicting specific subtypes of criminal offending or whether it was related to crime more generally. Consistent with a crime-specific approach to criminality, it was expected that EF would be uniquely associated with reactive violence, but not to instrumental violence or nonviolent offending. Such findings would be consistent with what previous researchers have found (Giancola et al., 1996; Jones, 20007; Stanford et al., 1997; White et al., 2012). In addition to examining subtypes of violence, the current study also included a composite measure of frequency of violence in order to demonstrate how such a general index, which is often used in research examining EF and offending, may result in misleading findings.

Most previous research has not examined the more specific relationships between antisocial behaviour and separate executive functions. Given that very little is known about specific executive functions I hypothesized that impairments in all three assessed components of EF, specifically inhibition, shifting, and working memory, would be associated with reactive violence. It was not expected that impairments in these executive functions would be characteristic of instrumental violence or of nonviolent forms of offending.

Potential covariates were considered if they were suspected to account for a portion of the predicted variance in an outcome measure. Variables of interest included characteristics of the individual such as age or the total number of years incarcerated, as well as characteristics of the offence such as whether the offence was committed while

intoxicated or, if the offence was violent, the severity of violence. Previous research has shown that both age and years incarcerated are significant predictors of rates of offending. For example, Sampson and Laub (2003) followed individuals from childhood until age 70 and found that crime decreased with age. Similarly, Gottfredson and Hirschi (1986; 1990) reported that individuals commit fewer crimes as they age, regardless of stable between individual differences. Regarding years of incarceration, research suggests that the more time an individual has spent incarcerated, the higher their rates of offending after release (e.g., Gendreau, Goggin, & Cullen, 1999).

In addition to individual characteristics, a number of researchers have also suggested that substance intoxication might be relevant to subtypes of aggression. For example, Kingsbury, Lambert, and Hendrickse (1997) suggested that stimulant intoxication may increase the risk for reactive aggression, either due to an increase in arousal or negative emotional states, or through a decreased "stimulus threshold" at which an individual will respond aggressively. Giancola, Josephs, Parrott, and Duke (2010) proposed that *alcohol myopia* may be a mechanism that explains alcohols link to aggression and violence. Alcohol is thought to reduce an individual's attentional capacity and, consequently, to narrow the range of cues to which an individual can attend (Steele & Joseph, 1990). Therefore, in some situations, alcohol narrows the attentional capacity to focus on perceived aggressive cues and increases the likelihood of an individual engaging in reactive aggression (McMurran, 2011).

In terms of violence severity, Chase, O'Leary, and Heyman (2001) found that men who engaged in instrumental violence were more severe in their partner violence than men who engaged in reactive violence. In contrast, Tapscott et al, (2012) found that

reactive violent offences were more severe than instrumental violent offences in an adult forensic sample. Moreover, Hancock et al. (2010) found that severe violence was associated with greater executive dysfunction, highlighting the importance of considering the severity of violence when examining an inmate's history.

Taken together, it seems important that intoxication at the time of the offence, severity of violence, age of the individual, and the number of years they have been incarcerated be taken into consideration when examining the relationships between executive functions and subtypes of violent offending.

Goal 2 – Clarifying the convergent and divergent validity of different indicators of executive functioning within the context of crime. Given the variability in how the construct of EF has been operationalized and defined in the forensic literature, the second goal of this dissertation was to better understand EF within the context of crime. First, in order to advance understanding of the convergence (or lack therefore) between different methods of measuring EF and the clinical utility of these measures in understanding criminality, I examined the associations among performance-based D-KEFS subtests and the self-report BRIEF-A ratings. As mentioned previously, many studies have found few or no significant associations between behaviour ratings made by parents and performance-based measures of EF in children and adolescents (Bodnar, Prahme, Cutting, Denckla, & Mahone, 2007; Mahone, et al., 2002; McAuley, Chen, Goos, Schachar, & Crosbie, 2010; Toplack, Bucciarelli, Jain, & Tannock, 2009; Vriezen & Pigott, 2002) or between self-ratings and performance-based measures in adults (Biederman et al., 2008; Rabin et al., 2006).

Based on previous research it was not expected that performance-based measures of EF would be correlated with self-reported ratings of EF, but it was hypothesized that they would evidence similar relationships with subtypes of crime. Both types of measures were developed to assess separate components of EF and so, theoretically, there was no reason to hypothesize that they would be differentially related to criminality. Moreover, little is known about how self-reported EF relates to crime so no unique hypotheses could be made.

The second question of interest was whether it was necessary or helpful to examine separate components of EF or whether it was equally informative to examine a composite score of EF when exploring the relationship with offending. Although the present dissertation adopted a conceptualization of EF that included separate components, there continues to be a debate in the literature as to whether the construct of EF is better conceptualized as unitary, with all executive functions reflecting the same underlying ability, or whether it is nonunitary, with each component reflecting a distinct process. Currently, there seems to be some evidence to support both sides of the argument (e.g., De Frias, Dixon, & Strauss, 2006; Duncan, Johnson, Swales, & Freer, 1997; Godefroy et al., 1999; Lehto, 1996; Parkin & Java, 1999). As mentioned earlier, forensic researchers have inconsistently assessed EF, with some using a composite score summing across multiple measures (Giancola, 2004) and others examining individual scores from multiple measures (Broomhall, 2005). Given the growing body of literature suggesting that the construct of EF consists of separate abilities and that different tasks of EF have low intercorrelations (Lehto, 1996; Miyake et al., 2000; Salthouse et al., 2003), it was

hypothesized that examining separate executive functions would provide more accurate information than a single composite score.

Finally, the third question of interest was whether relationships between EF and crime could be accounted for by general intelligence or whether general intelligence was uniquely associated with criminality. Given that research has demonstrated low shared variance between several executive abilities and intelligence (Friedman et al., 2006), I hypothesized that EF would have influences on crime above and beyond the influences of general intelligence. Consistent with previous research (e.g., Maguin & Loeber, 1996; Sharp et al., 1995), it was also hypothesized that intelligence would be related to criminality in general, but no specific hypotheses were made regarding subtypes of crime because no previous research has examined this relationship.

Method

Participants

The sample for the present study consisted of 155 adult male inmates from Fenbrook Institution, a federal prison in Gravenhurst, Ontario. Of the 155 inmates who completed the battery, two inmates were excluded from all analyses due to pleas of not criminally responsible on their only criminal offences (both of which were severely violent). When the two researchers reviewed the descriptions of these two offences, they found that the type of violence could not be confidently coded, as mental illness was a confounding factor. Two additional inmates were excluded because their only criminal offences had been committed when they were under the age of 18, whereas the present study only examined offences committed at or after the age of 18.

Inmates serving in a Canadian Federal institution have received sentences of two years or more and are, therefore, more likely to have committed violent offences than those incarcerated in Provincial institutions. Fenbrook institution is a medium security facility and housed 448 inmates at the time of participant recruitment. Approximately 75% of the inmates recruited had served a sentence for a violence-related crime at some point in their lives. Inmates who had committed either violent or non-violent crimes were included in this study. Participants ranged in age from 21 to 70 years (M = 35.25, SD = 11.07) and had completed between 5 and 20 years of education (M = 11.47, SD = 2.00). The most frequent marital status of inmates was single (49%), and a large minority identified as White (49%; see Table 2 and Table 3 for detailed offending characteristics and group demographics). These sample demographic characteristics

Table 2

Offending Characteristics of the Current Sample.

Characteristic	*M*	(SD)	Range
Number of Years Served in Current Term	2.78	(4.58)	.05 – 30.28
Total Years Incarcerated	4.57	(5.70)	.32 – 31.24
Frequency of Offending	9.40	(9.22)	1 – 49
Frequency of Nonviolent Offending	7.8	(9.01)	0 – 47
Frequency of Violent Offending	1.59	(1.7)	0 – 12
Frequency of Reactive Violent Offending	.83	(1.43)	0 – 12
Frequency of Instrumental Violent Offending	.72	(1.01)	0 – 6

Note. N = 151.

Table 3

Ethnicity, Marital, and Employment Status of the Inmates

Characteristic	Frequency (%)
Ethnicity	
White	74 (49%)
Black	25 (17%)
Aboriginal	36 (25%)
Asian	11 (7%)
Hispanic	1 (1%)
Other	4 (3%)
Marital Status	
Single	74 (49%)
Married/Cohabitating	64 (42%)
Separated/Divorced	13 (9%)
Employment Status Prior to Incarceration	
Employed	41 (27%)
Unemployed	77 (52%)
Unknown	33 (22%)

Note. $N = 151$.

(e.g., ethnicity, marital and employment status) are representative of those of the larger population of Canadian federal inmates (Trevethan & Rastin, 2004).

Materials

Executive functioning. Executive functioning was assessed using three performance-based tasks from the Delis-Kaplan Executive Function System (D-KEFS; Delis, et al., 2001), as well as with a self-report measure, the Behaviour Rating Inventory of Executive Functions, adult version (BRIEF-A; Roth, Isquith, & Gioia, 2005).

D-KEFS Subtests. The D-KEFS is a battery comprised of nine subtests that comprehensively assess key components of EF. In light of the available data on the

psychometric properties of the D-KEFS, this battery is considered among the most valid means of assessing EF (Baron, 2004; Homack, Lee, & Riccio, 2005). The D-KEFS subtests use a game-like format, and no corrective feedback is provided; this format is intended to reduce unproductive discouragement and frustration caused by repeated negative feedback during testing (Homack et al., 2005). Only three of the nine subtests were administered, but because the D-KEFS subtests were designed to stand alone, the decision to reduce the battery was not expected to alter any psychometric properties. The three subtests that were administered were the Verbal Fluency, Colour-Word Interference, and Trail-Making tests. These specific subtests, described in more detail below, were selected for two reasons: First, scores on these subtests reflected the three executive functions that were of interest in this study (shifting, inhibition, and working memory), and second, these subtests are newer versions of EF tasks that are frequently used in the literature, such as the Controlled Oral Word Association Task (COWAT; Ruff, Light, Parker, & Levin, 1996), the Stroop Test (Stroop, 1935), and the Trail Making Test (Reitan & Wolfson, 1985). Given this latter point, the current results could be more easily compared with past research findings.

The Verbal Fluency Test consists of three conditions: Letter Fluency, Category Fluency, and Category Switching. During the Letter Fluency condition, participants are asked to generate as many words as they can that start with a specific letter (i.e., *F*, *A*, and *S*). For Category Fluency, examinees are asked to list as many words as possible that belong to a particular semantic category (i.e., animals and boys' names). Finally, in the Category Switching condition, examinees are asked to generate words, alternating between two different semantic categories (i.e., fruit and furniture). Each trial is timed, and the examinee

is allowed 60 seconds to generate as many words as they can. In addition, while generating words, participants simultaneously follows a number of rules (e.g., they cannot repeat the same word). This test measures participants' ability to generate words fluently in an effortful, phonemic format (Letter Fluency), from overlearned concepts (Category Fluency), and while simultaneously shifting between overlearned concepts (Category Switching; Delis et al., 2001). Selected scores from the Verbal Fluency test measure working memory and shifting.

The second subtest, the Colour-Word Interference Test, consists of four conditions. The first two conditions provide a baseline measure of the two basic skills that were required to complete the higher-level tasks: naming of colour patches and reading of colour-words. In the third condition, participants are shown a list of different colour words that are typed in incongruent colours of ink. Participants are required to speak aloud the ink colour while refraining from reading the written word (e.g., if the word appearing on the list is *blue* and is printed in red ink, the correct response would be "red"). This condition measures inhibition, as participants must inhibit reading the words in order to name the dissonant ink colours that the words are printed in (Delis et al., 2001). The fourth condition requires the examinees to switch back and forth between naming the dissonant ink colours and reading the words. Each of these conditions is timed, and errors are recorded. Selected scores from this task measure inhibition.

Finally, the Trail Making test was administered; this task consists of 5 conditions including visual scanning, number sequencing, letter sequencing, number-letter switching, and motor speed. The first three conditions and the fifth condition provide baseline measures of the basic skills that are required to complete the higher-level tasks.

In the Visual Scanning condition, participants cross out all the 3's that appear on the response sheet. In the Number Sequencing condition, participants draw a line connecting the numbers 1–16 in order; distractor letters appear on the same page. The Letter Sequencing condition requires participants to connect the letters A through P, with distractor numbers present on the page. In the Number-Letter Switching condition, participants switch back and forth between connecting numbers and letters (i.e., 1, A, 2, B, etc., to 16, P). Finally, the Motor-Speed condition requires participants to trace over dotted lines connecting circles on the page as quickly as possible, in order to gauge their motor drawing speed. Each condition is timed and is preceded by a short practice trial. In all conditions, examinees are told to work as quickly and as accurately as possible and errors were recorded. Scores from Condition 4 of the Trail Making test are purported to assess participants' flexibility of thinking or 'shifting'. Administration of the three D-KEFS tests took approximately 25 minutes.

As mentioned previously, the three executive abilities examined in this study were shifting, inhibition, and working memory. The scores used to evaluate inhibition were the scores from conditions 3 and 4 from the Colour Word Interference task. These two scores involved deliberately stopping a response that is relatively automatic. The scores used to evaluate shifting were the total score from condition 4 of the Trail Making Task, the switching accuracy score from the Verbal Fluency task, and the errors score from the Colour Word Interference Switching Condition. Finally, the scores used to evaluate working memory were the repetition errors score and the set-loss errors score, both from the Verbal Fluency task. A repetition error was recorded when a participant repeated a word that they had previously provided and a set-loss error was recorded when a

participant provided a word that violated the category rule (e.g., saying "phone" after being instructed to provide words starting with F). These two scores involve constantly monitoring and updating information in working memory.

Psychometrics of the D-KEFS. The D-KEFS has a large normative sample that is demographically and regionally matched with the United States population. Internal consistency reliabilities are variable for composite scores on the Verbal Fluency Test (from .32 to .90), Colour-Word Interference Test (.62 to .86), and the Trail-Making test (.59 to .91; Delis et al., 2001). The test-retest reliability estimates of the D-KEFS, obtained using an average administration interval of 25 days, are impressive but variable across age groups. In addition, the D-KEFS has been shown to have significant, albeit small correlations with other neuropsychological tests of EF (e.g., the California Verbal Learning Test and the Wisconsin Card Sort Task; Delis et al., 2001).

BRIEF Scales. The Behavior Rating Inventory of Executive Function-Adult Version (BRIEF-A; Roth, Isquith, & Gioia, 2005) is a 75 item self-report measure of EF, which takes approximately 15 minutes to complete. Each item requires participants to indicate, using a 3-point scale, how often a behaviour has occurred during the past month (1 = *never*, 2 = sometimes, 3 = *often*). The BRIEF-A has nine clinical scales to measure executive functions, as well as three validity scales. However, only the Inhibit, Shift, and Working Memory scales were included in this study and are discussed herein. The Inhibit scale contains 8 items that measure behavioral regulation or the ability to not act on an impulse (e.g., "I have problems waiting my turn"). The Shift scale contains 6 items that measure the ability to shift behaviorally or cognitively from one situation, activity, or aspect of a problem to another, as the circumstances demand (e.g., "I have trouble

thinking of a different way to solve a problem when stuck"). The Working Memory scale contains 10 items that assess the capacity to hold information in mind for the purpose of generating a response or completing a task (e.g., "I have trouble with jobs or tasks that have more than one step"). The three validity scales, labeled Negativity, Infrequency, and Inconsistency, were examined to identify individuals who had provided potentially invalid responses. Scores on the Inconsistency scale indicate the extent to which the inmate answered similar BRIEF items in an inconsistent manner relative to the clinical samples. The Negativity scale measures the extent to which the inmate answered selected BRIEF items in an unusually negative manner relative to the clinical sample. Finally, scores on the Infrequency scale indicate the extent to which the inmate endorsed items in an atypical fashion relative to the combined normative and clinical samples. For example, marking *Often* to Item 10 ("I forget my name") is highly unusual, even for adults with severe cognitive impairment.

Scores from the BRIEF-A scales are age-adjusted and usually presented as *T* scores, where higher scores indicate more impairment and a score at or above 65 indicates clinically significant impairment. However, because the component scores from the D-KEFS variables (which will be discussed below) were *z*-scores, all BRIEF scores were converted to *z*-scores as well to facilitate interpretation. In addition, the signs of the *z*-scores were reversed so that lower scores indicated worse performance in order to be consistent with the D-KEFS.

Psychometrics of the BRIEF. The BRIEF-A has a large normative sample, including adults from a wide range of racial, ethnic, and educational backgrounds, and it has been shown to be sensitive to subtle executive changes (Rabin et al., 2006). As well, the BRIEF-A scales are internally consistent: In the current study, the estimates of

Cronbach's alpha ranged from acceptable to good (i.e., .73–.82; see Table 4). These estimates were comparable to the values of internal consistency presented in the BRIEF-A manual (Roth et al., 2005), which were between .73 to .84.

Table 4

Descriptive Statistics for the Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A)

Scale	Number of items	Cronbach's alpha
Inhibit	8	.82
Shift	6	.73
Working Memory	8	.82

Note. $N = 151$.

Intelligence. Intelligence was measured using the Kaufman Brief Intelligence Test, Second Edition (KBIT-2; Kaufman & Kaufman, 2004), which can be administered in approximately 30 minutes and provides Verbal and Nonverbal scores, plus a composite IQ score. Test items were designed to be free of cultural and gender bias. Scores from the KBIT are age-adjusted and usually presented as standard scores with a mean of 100 and standard deviation of 15. However, because the component scores from the D-KEFS and BRIEF variables were *z*-scores, all KBIT scores were converted to *z*-scores which were used in subsequent analyses.

Psychometrics of the KBIT-2. The KBIT-2 manual reports that internal consistency reliability estimates range from .86 to .96 on the Verbal Score, .78 to .93 on the Nonverbal Score, and .89 to .96 on the IQ composite. The KBIT-2 has been shown to have good construct validity by correlating (in the moderate to high range) with well-established tests of cognitive ability (the Wechsler Intelligence scales) and academic

achievement (Wide Range Achievement Test: Third Edition, Kaufman Test of Educational Achievement: Second Edition). Likewise, validation studies have established that special populations (e.g., individuals with intellectual disabilities, traumatic brain injury, or in gifted programs) differ from the normative sample in the expected direction (Kaufman & Kaufman, 1990; 2004). See Table 5 for a list of abbreviations of all the scores used from the executive functioning and intelligence measures.

File Review

Only after an inmate had completed the test battery was his file reviewed. Two primary researchers independently reviewed inmates' complete adult criminal histories through the Offender Management System (OMS), which is the computerized case file management system that is used by the Correctional Service of Canada and the National Parole Board. OMS files contain data on a variety of sentence and case information, including work and educational programs that were part of the inmate's correctional plan, progress reports, conditional release decisions, community assessments, as well as incident reports, risk assessments, and movement/security level. Intraclass correlation coefficients were calculated for all variables coded by the two raters and are reported in the relevant sections.

Coding violent and nonviolent offences. For the purpose of this study, violence was defined as "behaviour involving an intentional act of physical aggression against another individual that is likely to cause physical injury" (Meloy, 2006, p. 539). Examples of offences meeting this definition of violence include the following: murder, attempted murder, manslaughter, and assault. Other acts that are considered to be violent

Table 5

List of Abbreviations.

Abbreviation	Variable Name
$BRIEF_{INH}$	Behavior Rating Inventory of Executive Function – Inhibition Scale
$BRIEF_{SHIF}$	Behavior Rating Inventory of Executive Function – Shift Scale
$BRIEF_{WM}$	Behavior Rating Inventory of Executive Function – Working Memory Scale
$DKEFS_{INH}$	Delis Kaplan Executive Function System – Inhibit Component Score
$CWIT_{C3}$	Colour-Word Interference Test – Condition 3 (Inhibition)
$CWIT_{C4}$	Colour-Word Interference Test – Condition 4 (Inhibition/Switching)
$DKEFS_{SHIF}$	Delis Kaplan Executive Function System – Shifting Component Score
TMT_{C4}	Trail Making Task – Condition 4 (Switching)
VF_{SA}	Verbal Fluency Task – Switching Accuracy
$CWIT_{C4TE}$	Color-Word Interference Task – Condition 4 (Switching) Total Errors
$DKEFS_{WM}$	Delis Kaplan Executive Function System –Working Memory Component Score
VF_{RE}	Verbal Fluency Task – Repetition Errors
VF_{SLE}	Verbal Fluency Task – Set-Loss Errors
$KBIT_{VER}$	Kaufman Brief Intelligence Test – Verbal Score
$KBIT_{NONV}$	Kaufman Brief Intelligence Test – Nonverbal Score
$KBIT_{TOT}$	Kaufman Brief Intelligence Test – Total Score

according to the Criminal Code of Canada (e.g., causing death or bodily harm by criminal negligence, impaired driving causing bodily harm or death) were coded as nonviolent in the present study because, although harmful and reckless, such offences were not committed with violent intent or any physical contact on behalf of the offender. Additional examples of offences that were coded as nonviolent include fraud, possession or trafficking of a controlled substance, mischief, theft, and breaking and entering.

While coding offences there were times when multiple offences had occurred on the same date. In coding these offences, whenever there was evidence of a crime being a separate event it was coded as such, regardless of whether the events had the same offence date. Whenever crimes were related (e.g., an assault and possession of an unregistered firearm), they were coded as a single crime and the details of the crime were coded based on the most serious offence. Whenever there were multiple crimes with the same conviction date and there was insufficient information to determine whether the crimes were related or unrelated to one another, they were coded as a single offence (with the most serious crime being coded).

Coding type of violence. Coding of type of violence was based on a modified version of Woodworth and Porter's (2002) conceptualization of reactive and instrumental violence. Woodworth and Porter considered violence to be *reactive* if either (a) it immediately followed a provocation or interpersonal conflict, but there was no apparent goal other than to harm the victim or (b) it began immediately following provocation and subsequently resulted in an external gain other than causing physical harm. An example of the first scenario is when an offender starts a fist-fight in response to having their foot stepped on in a night club. An example of the second scenario would be if the offender who started the fist-fight in response to his foot being stepped on then stole his victim's wallet.

Woodworth and Porter (2002) considered violence to be *instrumental* when either (a) it was clearly goal-oriented and there was no evidence of any immediate situational provocation or (b) it was initiated to achieve an instrumental goal, but then escalated in response to an unplanned event that occurred during the crime. An example of the first

scenario would be an offender physically assaulting someone in order to take their wallet. An example of the second scenario would be if an offender was physically assaulting someone in order to take their wallet, and then shot them after they started yelling at him. It should be noted that provocation may precede instrumental violence if time has passed after the provocation, as in the case of planned revenge. Although some researchers have considered planned revenge to be reactive (e.g., Cornell et al., 1996), the most recent evidence suggests that violence committed with the primary goal of harming the victim can be considered to be instrumental if there is clear period during which the offender could have calmed down (Woodworth & Porter, 2002).

When there was insufficient information in an inmate's file to code the type of a violent offence, the raters coded type of violence as unknown. Both raters agreed that the type of violence was unknown for four of the violent offences reviewed, and one rater coded an additional nine violent offences as being of unknown type. For these nine offences, the ratings of the second rater were used. The four unknown offences were excluded from subsequent analyses. To provide a measure of inter-rater reliability, the intraclass correlation coefficient (ICC) was calculated. ICCs were calculated using the two-way random effects model and an absolute agreement definition, both for single ratings (ICC_1) and averaged ratings (ICC_2). Cicchetti and Sparrow's (1981) guidelines were used to evaluate the obtained ICCs, where values less than .40 were considered poor, those between .40 and .59 were fair, .60 to .74 were good, and .75 to 1.00 were excellent. Across the remaining violent offences, the ICC_1 and ICC_2 for type of violence were .83 and .91, respectively. When the raters disagreed on whether the offence characteristics were reactive or instrumental, the offence was dichotomized as

instrumental, which is consistent with previous research in which a history of instrumental violence is given precedence over a history of reactive violence (e.g., Cornell et al., 1996).

Coding severity of violence. All adult violent offences were coded by both raters for severity according to Cornell's (1996) guidelines. That is, severity of violence was coded along the following 6-point scale: 1 (*assault without injury;* e.g., a slap, pulling of the hair), 2 (*minor injury*; e.g., bruises, minor medical treatment), 3 (*serious injury requiring substantial hospital treatment*; e.g., broken limb, rape, gunshot wound to the leg), 4 (*severe injury resulting in lasting impairment or life-threatening injury*; stab wounds, gunshot wound to the head), 5 (*homicide*), and 6 (*extreme homicide*; e.g., multiple killings, killings involving mutilation). Across the severity ratings, the ICC_1 and ICC_2 for severity of violence were .97 and .98, respectively. When the severity of violence rating differed between raters, the two ratings were averaged and then rounded up. The raters never differed by more than 1 point on their ratings of severity.

Coding intoxication during violent offences. Both raters coded whether there was any evidence (yes/no) that the offender was intoxicated at the time of the offence. Sources of information reviewed included documented self-reports of the offender, police reports, and witness reports. However, intoxication status could only be coded for violent offences, as the OMS contains more details on violent offences than nonviolent offences. Across the intoxication ratings, the ICC_1 and ICC_2 for were .84 and .91, respectively.

Procedure

Data collection with the offender sample was approved by the Office of Research Ethics at the University of Western Ontario (Appendix A) and by the Research Board at

the Correctional Service of Canada (Appendix B). Inmates were selected for perspective participation at random from the prison directory. Potential participants were approached by the experimenters, under the supervision of a correctional officer, and given a brief overview of the study. If the inmate was willing to participate, an appointment was scheduled. At the time of the testing session, a thorough description of the study was provided in the form of a letter of information (see Appendix C), and a verbal discussion ensued in which any of the inmates' questions were addressed. For inmates who wished, the letter of information was read aloud by the experimenter. Before the participant signed the informed consent (see Appendix D), the voluntary nature of the study was made explicit, as was the fact that participation had no bearing on any subsequent correctional decisions.[2] Finally, the researchers explained that they would not be providing any feedback to the inmates regarding whether responses were correct or incorrect. Feedback was withheld in order to avoid questioning about performance and to avoid affecting performance on later tests.

Of the 448 inmates incarcerated at Fenbrook at the time of this study, 303 inmates (68% of the inmate population) were randomly invited to participate in the study, among whom 155 (51%) agreed to participate and 148 (49%) refused, were unable to participate, or did not meet the inclusion criteria (i.e., proficiency in English and normal or corrected-to-normal vision). Reasons that inmates provided for not participating included the following: feeling sceptical of the research process and the level of confidentiality (n = 16), conflicting work/school/programming schedules (n = 23), medical conflicts (e.g., a surgery; n = 3), unwillingness to make the time commitment (n = 7), and a release date

[2] This study was conducted alongside another study, and this larger battery is reflected in the letter of information and the consent form.

that was scheduled to arrive before participation could be completed (n = 5). Sixty-eight inmates refused to participate but did not provide a reason. A number of inmates agreed to participate, but it was later determined that they did not meet the inclusion criteria of proficiency in English (n = 15), or they failed to show up to their appointment (n = 11).

Upon completion, the participants were administered four measures of EF, as well as the KBIT-2. Order of task administration was counterbalanced. As prescribed by the Correctional Service of Canada, inmates were unable to receive compensation for participation. The overall time to complete this battery of measures was approximately 1-1.5 hours. To prevent experimenter bias, no questions regarding current or past criminal activities were asked during the testing session. Demographic information such as marital status, occupation prior to incarceration, date of birth, and years of education was taken from the inmates files.

Analytic Rationale

Poisson-class regression. The present study investigated the frequency of offences that inmates had committed over the course of their adult lives. Therefore, the dependent variable of interest is a count variable, which reflects the occurrence of discrete events and, thus, must take the form of non-negative integers (e.g., 0, 1, 2…). Count data present a challenge to researchers in the correctional and forensic fields; however, these challenges can be managed with statistical techniques designed specifically for this type of data (Hutchinson & Holtman, 2005; Walters, 2007).

The problem in analyzing count data is that, as non-negative integers, count data typically form a positively skewed heteroskedastic distribution (Walters, 2007). Given this non-normal distribution, the fundamental assumptions of traditional (ordinary least-

squares) regression are violated by count data. The benchmark model for fitting count data is the Poisson distribution, and the standard regression model for analyzing count data is the Poisson regression. For a comprehensive review of Poisson-class regression see Hutchinson and Holtman (2005) or Walters (2007).

Similar to ordinary least-squares regression, the Poisson model has its own set of assumptions, which can be problematic depending on the data set (Walters, 2007). Because of these assumptions a less restrictive model, the negative binomial regression, was used. Negative binomial regression is in the Poisson-class of regression models, meaning that it possesses the same strengths, but it has fewer restrictions. Negative binomial regression differs from Poisson regression by including both an error term, to allow for unobserved heterogeneity, and a dispersion parameter (α), to allow for a larger conditional variance (Walters, 2007). Negative binomial regression is preferred when data are overdispersed (i.e., when $\alpha > 0$) because it produces more robust standard errors. Poisson regression is preferred over negative binomial regression when the data are equidispersed (i.e., when alpha equals zero) because the former produces a more parsimonious model.

An estimate of the dispersion parameter can be calculated through STATA (the likelihood-ratio chi-square test that alpha equals zero) which indicates whether a Poisson or negative binomial model is the more appropriate model for any given analysis based on whether the data is over/underdispersed. The *LR* $\chi 2$ tests of alpha in the following analyses were significant, indicating that the data were overdispersed and were more appropriately modeled through negative binomial regression than through Poisson regression.

Hierarchical linear modeling (HLM). In order to answer the question of whether intelligence and EF are more or less associated with different subtypes of offending, hierarchical linear modeling (HLM) was used. Multilevel modeling was needed because the data were multilevel and interdependent in nature. A brief explanation of HLM is provided below. For a comprehensive review of the mathematical theory, equations, and conditions underlying HLM see Woltman, Feldstai, MacKay, and Rocchi (2012).

Research in psychology is increasingly involving what are often referred to as 'multilevel data' (Nezlek, 2008). Such data sets are sometimes referred to as 'nested' or 'hierarchically nested' because observations at one level of analysis are nested within observations at another level (e.g., individuals can be nested within groups, or observations can be nested within individuals). The data collected for the present study is an example of observations, or offences, nested within an individual.

When working with multilevel data it is important to analyze them using techniques that take into account this nesting. Results may be inaccurate if analyses do not take into account the multilevel nature of the data (Nezlek, 2001; 2008). HLM is a complex form of ordinary least squares (OLS) regression and accounts for the shared variance in hierarchically structured data (Woltman et al., 2012). Rountree, Land, and Miethe (1994) explained that in HLM procedures, the models explain the hierarchical structure of the data by using submodels and nested error terms to account for effects and sources of variation at different levels of analysis. HLM accurately estimates lower level slopes (e.g., offence level) and their implementation in estimating higher-level outcomes (e.g., offender level). The present study used HLM methods to determine how different

forms of offending were influenced by variables at Level 1, or the offence level (e.g., intoxication during the offence, severity of violence), as well as by variables at Level 2, or the offender-level (e.g., cognitive variables like intelligence and EF, age of the inmate, number of years incarcerated). For multilevel modeling, the statistical program HLM (version 6.02a, Raudenbusg, Bryke, & Congdon, 2005) was used.

Results

Preliminary Analyses

Missing data. Tabachnick and Fidell (2007) reported that if a small number of data points (5% or less) are missing in a random pattern, then the problem is not serious and any procedure for handling missing values yields similar results. In the present study, one inmate was unable to complete the colour-word interference task due to colour blindness. As such, sample means were used to fill the missing data points.

Outliers. Prior to analyses, data were screened for multivariate outliers. This was accomplished by examining Cook's *D* statistics, a summary index of the influence that an observation exerts on the coefficients (Tabachnick & Fidell, 2001). Cook's *D* was calculated from a regression containing rates of offending (i.e., rate of nonviolent, reactive violent, and instrumental violent offending), *z*-scores from the BRIEF-A and KBIT, and component scores from the D-KEFS as predictors and the Participant Identification number as the independent variable. Values greater than 1 were used as a cut-off to identify outliers (Tabachnick & Fidell, 2001), but no such outliers were identified.

Invalid responders. All participants' scores on the validity scales from the BRIEF-A were examined to determine whether participants had provided invalid

responses to the self-report measure. Using the cut-off scores identified in the BRIEF-A manual, seven participants were identified as being elevated on the Infrequency scale, one participant was identified as being elevated on the Inconsistency scale, and no participants were elevated on the Negativity scale. Analyses were run with and without these potentially invalid cases, and it was found that the magnitude of the effects did not change whether these individuals were included or excluded. As a result, these cases were retained in all analyses in order to avoid bias by excluding individuals with a particular response style.

Descriptive statistics. Of the 240 violent offences reviewed in the files of the 151 participants who met the study's inclusion criteria, four offences (2%) were described in insufficient detail to allow type of violence to be coded. Of the 236 violent offences that could be coded for type of violence, 126 were coded as reactive and 110 were coded as instrumental. In addition, 116 of these violent offences were committed while intoxicated. The average severity of a violent offence was 2.46 (*SD* = 1.34). Descriptive statistics for the frequencies of each type of offence are presented in Table 6.

Table 6

Means, Standard Deviations, and Ranges of Outcome Variable

Type of Offence	*M* (*SD*)	Minimum	Maximum	Skewness	Kurtosis
Total	9.40 (9.23)	1	49	9.19	10.71
Nonviolent	7.81 (9.01)	0	47	9.61	11.35
Violent	1.59 (1.70)	0	12	12.17	24.64
Reactive	0.83 (1.43)	0	12	20.09	63.05
Instrumental	0.73 (1.01)	0	6	10.96	17.35

Note. $N = 151$. Skewness and kurtosis are reported in *z*-scores (i.e., statistic/ standard error).

The means, ranges, and standard deviations for the predictor variables, including scores from the KBIT, D-KEFS, and BRIEF-A, are presented in Table 7. For this study, raw scores from each of the D-KEFS subtests were transformed into standard scores (which ranged from 1 to 20; $M = 10$, $SD = 3$), based on available norms. It should be noted that although *z*-scores are used in subsequent analyses, the standard scores for the KBIT and D-KEFS and the *T*-scores for the BRIEF-A are presented in table 7 to facilitate interpretation. As can be seen, on average, inmates performed slightly lower than the general population on the KBIT (i.e., < 100) and on several scores from the D-KEFS (i.e., < 10), but for the BRIEF-A, where higher scores indicate more deficits, participants scored somewhat higher than the normative sample (i.e., > 50). Therefore, as a group, inmates tended to be characterized by subtle deficits in IQ and EF.

Construction of D-KEFS component scores. Given that there were a number of scores from the D-KEFS that were posited to measure each of the three executive functions of interest in this study, and given also that these scores were correlated with one another (see Table 8), Principle Components Analyses (PCA) were used to eliminate multicollinearity and reduce the number of scores being used. Moderate correlations between EF scores have been demonstrated in previous research (Muscara et al., 2008), and Tabachnick and Fidell (2007) suggest that PCA is the solution of choice when researchers are primarily interested in reducing a large number of variables down to a small number of components.

Table 7

Means, Standard Deviations, and Ranges of the Predictor Variables

Variable	Mean	SD	Range
$KBIT_{VER}$	88.60	11.65	49-130
$KBIT_{NONV}$	95.22	13.59	40-125
$KBIT_{TOT}$	91.03	11.89	52-120
$DKEFS_{INH}$			
$CWIT_{C3}$	8.92	3.30	1-14
$CWIT_{C4}$	9.29	2.74	1-12
$DKEFS_{SHIF}$			
TMT_{C4}	9.59	2.85	1-14
VF_{SA}	9.09	3.42	1-18
$CWIT_{C4TE}$	9.33	3.42	1-16
$DKEFS_{WM}$			
VF_{RE}	9.36	2.83	1-13
VF_{SLE}	10.43	2.72	1-13
$BRIEF_{INH}$	56.75	9.92	39-87
$BRIEF_{SHIF}$	52.59	8.78	39-73
$BRIEF_{WM}$	55.05	10.73	39-82

Note. $N = 151$. See Table 5 for list of abbreviations. KBIT scores are scaled scores which have a mean of 100 and a standard deviation of 15. All D-KEFS scores are scaled scores which have a mean of 10, a standard deviation of 3, and a maximum of 20. Finally, BRIEF-A scores are t-scores which have a mean of 50 and a standard deviation of 15. Higher scores on the KBIT and D-KEFS indicate better performance while and higher scores on the BRIEF-A indicate more dysfunction.

Table 8

Correlation coefficients between relevant D-KEFS scores.

	1	2	3	4	5	6	7
1. $CWIT_{C3}$	–						
2. $CWIT_{C4}$	.61**	–					
3. TMT_{C4}	.14*	.25*	–				
4. VF_{SA}	.27*	.24*	.38**	–			
5. $CWIT_{C4TE}$	.30**	.29**	.33**	.31**	–		
6. VF_{RE}	.07	.00	-.05	.02	-.03	–	
7. VF_{SE}	.18*	.21*	.18*	.21*	.17*	.28**	–

Note. $N = 151$. See Table 5 for list of abbreviations.

To combine the two scores that measured inhibition into a single composite index, a PCA was conducted, where a one-factor solution was imposed that retained both of the scores (eigenvalue = 1.61, 80% of variance explained). Next, standardized regression component scores were calculated for each inmate. In a similar fashion, PCAs were also used to create composite index scores for shifting (eigenvalue = 1.68, 56% of variance explained) and working memory (eigenvalue = 1.30, 64% of variance explained; see Table 9 for results). The component scores that were created for each executive function were used in subsequent analyses. Selection of scores was theoretically driven and criteria used for selection were the same as those used by Miyake et al. (2000). Other researchers have used similar means to reduce their number of variables measuring a single construct (see Lerner & Keltner, 2001).[3] Further, a composite performance-based

[3] In order to demonstrate that relationships between variables were not merely a function of the present data set, but in fact generalizable to federal offenders, similar correlations were run with a separate data set collected at Fenbrook Institution and at Bath Institution using similar measures (see Appendix E). Two of the three subtests from the D-KEFS had been used (the colour word interference test and the verbal fluency test) as well as the BRIEF and the KBIT-2 and so correlations between the predictor variables were run,

EF score was created for each inmate composed of the sum of these three component scores in order to answer the question of whether it is important to examine separate executive abilities or if a composite score provides the same amount of information. A composite score was also created from the three BRIEF-A scales for the same reason. These composite scores were re-standardized so they had means of 1 and standard deviations of 0.

Table 9

Summary of Principal Component Analyses Results for D-KEFS Scores.

Components and D-KEFS Scores	Factor Loadings
Inhibition Component	
$CWIT_{C3}$	.90
$CWIT_{C4}$	.90
Shifting Component	
TMT_{C4}	.77
VF_{SA}	.76
$CWIT_{C4TE}$	.72
Working Memory Component	
VF_{RE}	.80
VF_{SE}	.80

Note. $N = 151$. See Table 5 for list of abbreviations

Confirmation of the BRIEF-A factor structure. Next, the factor structure of the BRIEF-A was examined in order to determine whether the factor structure that was proposed in the manual remained a good fit in an offender sample, where the BRIEF-A

similar components for the D-KEFS scores were created, and a confirmatory factor analysis was run on the relevant BRIEF subscales.

had yet to be used. Liseral version 8.80 was used to conduct maximum likelihood estimation confirmatory factor analyses (CFA), using only the items from the three subscales of interest (Inhibit, Shift, and Working Memory). Multiple goodness of fit statistics (Standardized RMR, Non-Normed Fit Index [NNFI], Comparative Fit Index [CFI], and Root Mean Square Error of Approximation [RMSEA] with 90% confidence intervals) were examined, so as to reduce the likelihood of both Type I and Type II errors (Hu & Bentler, 1999). Cut off values of $\leq .09$ indicate acceptable fit on the Standardized RMR. Cut off values $\geq .90$ on the NNFI and CFI and $\leq .08$ on the RMSEA indicate an acceptable fit (Hu & Bentler, 1999; Kline, 2005).

The CFA indicated an acceptable fit to the data (Standardized RMR = .07; NNFI = .93; CFI = .94; RMSEA = .07 [90% C.I. = .06; .087]) and so the Inhibit, Shift, and Working Memory scales were used in subsequent analyses. Item factor loadings for the BRIEF-A Items are presented in Table 10 and are all significant at $p < .05$.

Correlations. Preliminary analyses of the correlations between demographic variables and the rates of each type of offending were conducted to identify potential confounding variables (see Table 11). Age, Education, and Total Years Incarcerated were each related to the rates of different types of offending, indicating that they should be considered as covariates for subsequent analyses. However, in addition to being correlated to rates of reactive violent offending, Education was related to a number of predictor variables (see Table 12) and so it was not entered as a covariate in subsequent analyses. Field (2009) explained that covariates must be independent from the predictor variables, otherwise, the effect of the predictor is confounded by

Table 10

Unstandardized Loadings (Standard Errors) and Standardized Loadings for 3-Factor Confirmatory Model of the Behavior Rating Inventory of Executive Function–Adult Version (BRIEF-A) Indices

Index	Unstandardized Factor Loading	Standardized Factor Loading
Inhibit		
Item 5	.58 (.17)	.32
Item 16	.71 (.16)	.42
Item 29	.83 (.15)	.56
Item 36	.18 (.08)	.21
Item 43	.97 (.16)	.62
Item 55	1.08 (.17)	.65
Item 58	.83 (.14)	.61
Item 73	1.00 (--)	.60
Shift		
Item 8	1.00 (--)	.53
Item 22	1.10 (.21)	.58
Item 32	1.24 (.25)	.55
Item 44	1.51 (.27)	.65
Item 61	1.18 (.24)	.53
Item 67	1.30 (.26)	.54
Working Memory		
Item 4	1.00 (--)	.45
Item 11	1.03 (.23)	.55
Item 17	1.16 (.26)	.55
Item 26	1.43 (.30)	.59
Item 35	1.77 (.36)	.66
Item 46	1.63 (.31)	.76
Item 56	1.57 (.32)	.62
Item 68	1.29 (.27)	.61

the covariate and the covariate will reduce the predictor effect. The reason for this is because it explains some of the variance that would otherwise be attributable to the predictor (Field, 2009). Age and Total Years Incarcerated were controlled in negative binomial regressions contained in Appendix F. Age and Years Incarcerated were also entered as grand mean centered covariates at Level 2 in the HLM analyses contained in Appendix F. The reason that the covariates were only included in an appendix is because, while important to identify, including covariates can decrease power and can make the interpretation of results difficult (Lees & Neufeld, 1994). Moreover, as will be seen, the pattern of results remained very similar with and without the inclusion of covariates.

Correlations between Age, Education, Total Years Incarcerated, and the predictor variables are presented in Table 12. Many of the predictor variables were strongly correlated with one another, indicating multicolinearity, and so predictor variables were entered separately into subsequent analyses.

Table 11

Correlations among Age, Education, Total Years Incarcerated, and Rates of Offending

	1	2	3	4	5	6	7	8
1. Age	–							
2. Education	-.04	–						
3. Total Yrs Inc.	.50**	.14	–					
4. Total Offending	-.08	-.11	.32**	–				
5. Violent Offending	-.28**	-.14	.06	.16	–			
6. Nonviolent Offending	-.03	-.09	.31**	.98**	-.04	–		
7. Reactive Violent Offending	-.14	-.26**	-.12	.12	.54**	.01	–	
8. Instrumental Violent Offending	-.22**	-.05	.15	.09	.75**	-.06	-.14	–

Note. $N = 151$
$^{*}p < .05$, $^{**}p < .01$

Table 12

Correlations among Age, Education, Total Years Incarcerated, and Predictor Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	–													
2. Education	-.04	–												
3. Total Yrs Incarcerated	.50**	.14	–											
4. $KBIT_{VER}$	.13	.25**	.10	–										
5. $KBIT_{NONV}$	-.05	.19*	.01	.47**	–									
6. $KBIT_{TOT}$	.06	.24**	.07	.83**	.88**	–								
7. $DKEFS_{INH}$	.10	.19*	.09	.48**	.38**	.49**	–							
8. $DKEFS_{SHI}$	.06	.24**	.01	.54**	.50**	.60**	.63**	–						
9. $DKEFS_{WM}$	.02	.02	.05	.07	.11	.11	.16*	.21**	–					
10. $DKEFS_{COMP}$	.08	.20*	.07	.49**	.44**	.54**	.80**	.82**	.61**	–				
11. $BRIEF_{INH}$	-.01	.16*	-.01	-.05	-.11	-.10	-.14	-.11	.00	-.17	–			
12. $BRIEF_{SHI}$	-.12	.18*	.01	-.11	-.08	-.10	-.02	-.04	-.06	-.05	.63**	–		
13. $BRIEF_{WM}$	-.11	.26**	.02	-.06	-.04	-.05	-.04	.04	-.01	.03	.62**	.63**	–	
14. $BRIEF_{COMP}$	-.09	.23*	-.01	-.05	.00	-.02	-.04	-.04	-.03	-.05	.87**	.87**	.87**	–

Note. $N = 151$
$^{*}p < .05$, $^{**}p < .01$

Poisson-Class Regressions

In order to answer the question of whether intelligence and executive abilities were related to rates of offending, negative binomial regressions were conducted. An explanation of how regression coefficients were interpreted needs to be provided before presenting the results. Briefly, because Poisson-class regression is "linear in the logarithm" (Coxe et al., 2009), when all other variables are held constant, a 1-unit increase in a predictor results in an increase of the natural logarithm of the predicted count that is equal to the value of the unstandardized regression coefficient (*b*). This explanation has the disadvantage of interpreting the change in the unit of a transformation of the outcome (i.e., the natural logarithm of the predicted count). In order to interpret a Poisson-class regression coefficient in terms of the predictors' effects on the actual count, the unstandardized coefficients, *b*, must be exponentiated. The exponentiated coefficients (i.e., e^b), which are presented in Table 13, are interpreted as incidence rate ratios. That is, for a 1-unit change in the predictor, the predicted rate is multiplied by e^b.

Poisson class regression assumes that the period of risk, also known as exposure, is the same for all observations. This assumption was violated in the present study considering that inmates were of different ages and had been in the community for varying lengths of time, meaning that they had been at risk of committing adult offences for different periods of time. To control for non-uniform exposure times, the natural logorithm of years at risk of committing an adult offence while living in the community was entered as an offset variable in each of the regression analyses with its parameter fixed at 1.00. As a result of the inclusion of this variable, the outcome variable predicted

in each analysis was the rate of log-offences per unit of exposure (i.e., per year of adult life living in the community) instead of simply the frequency of offences.

As mentioned above, the inclusion of covariates decreases power and can make it difficult to interpret results (Lees & Neufeld, 1994). Therefore, negative binomial regressions are presented below without covariates. Negative binomial regressions covarying age and total years incarcerated can be found in Appendix F. Moreover, all analyses in Appendix F containing EF scores also covaried $KBIT_{TOT.}$ This was done in order to evaluate whether the association between executive functions and subtypes of crime remained even after controlling for intelligence.

Negative binomial regressions were performed to observe the influence of intelligence and EF on the overall rates of total, nonviolent, violent, reactive violent, and instrumental violent offending. Table 13 shows the *z* values, the incident rate ratios, and the significance level for each predictor variable. Due to the correlations between some of the predictor variables and the exploratory nature of the research, each score was run in a separate regression analysis in order to see whether that particular variable was related to offending. As mentioned previously, time at risk was entered as an offset variable in all analyses.

Three of the eleven predictors were statistically significant in the prediction of rate of total offending. The exponentiation of the regression coefficient for $BRIEF_{INH}$, $e^{-.29} = .75$, was the predicted multiplicative effect of a 1-unit change in $BRIEF_{INH}$ on the number of offences committed in one year. In other words, an inmate with a $BRIEF_{INH}$ *z*-score of 1 was expected to have a rate of offending that was .75 times the rate of offending of an inmate with a *z*-score of 0. Similarly, weaker self-reported shifting and a

Table 13

Negative Binomial Models for the Prediction of Rates of Offending from Intelligence and EF Measures without Covariates

	Total Offending		Nonviolent Offending		Violent Offending		Reactive Offending		Instrumental Offending	
Predictor	IRR (95% CI)	*z*	IRR (95% CI)	*z*	IRR (95% CI)	*z*	IRR (95% CI)	*z*	IRR (95% CI)	*z*
KBIT Scores										
Verbal	0.90 (0.77-1.06)	-1.26	0.92 (0.74-1.15)	-0.70	0.79 (0.66-0.94)	-2.67**	0.89 (0.69-1.16)	-0.86	0.70 (0.55-0.90)	-2.80**
Nonverbal	1.04 (0.90-1.21)	0.54	1.07 (0.89-1.28)	0.68	0.88 (0.72-1.06)	-1.36	0.89 (0.70-1.14)	-0.89	0.85 (0.63-1.14)	-1.08
Total	0.97 (0.83-1.13)	-0.42	1.00 (0.82-1.23)	0.04	0.80 (0.67-0.96)	-2.42*	0.88 (0.68-1.13)	-1.03	0.72 (0.56-0.95)	-2.37*
D-KEFS Component Scores										
Inhibition	1.01 (0.86-1.18)	0.14	1.05 (0.86-1.29)	0.49	0.81 (0.68-0.98)	-2.23*	0.68 (0.54-0.86)	-3.19**	1.00 (0.75-1.32)	-0.03
Shifting	0.96 (0.82-1.12)	-0.58	0.99 (0.81-1.22)	-0.06	0.79 (0.67-0.94)	-2.74**	0.78 (0.63-0.98)	-2.18*	0.80 (0.62-1.03)	-1.70
Working Memory	0.89 (0.79-1.02)	-1.66	0.86 (0.73-1.02)	-1.72	1.15 (0.94-1.40)	1.33	1.13 (0.86-1.48)	0.89	1.13 (0.84-1.51)	0.78
D-KEFS Composite Score	0.93 (0.80-1.08)	-1.03	0.93 (0.77-1.13)	-0.73	0.85 (0.71-1.02)	-1.73	0.78 (0.61-0.98)	-2.08*	0.93 (0.70-1.24)	-0.50
BRIEF-A Scales										
Inhibition	0.75 (0.65-0.84)	-4.03**	0.67 (0.56-0.81)	-4.21**	1.14 (0.95-1.36)	1.45	1.11 (0.87-1.40)	0.84	1.21 (0.92-1.59)	1.38
Shifting	0.78 (0.67-0.90)	-3.42**	0.72 (0.60-0.86)	-3.51**	1.01 (0.99-1.03)	0.97	0.97 (0.75-1.26)	-0.22	1.30 (0.98-1.71)	1.84
Working Memory	0.90 (0.77-1.04)	-1.40	0.87 (0.72-1.05)	-1.40	1.07 (0.87-1.30)	0.71	0.89 (0.69-1.15)	-0.90	1.35 (1.02-1.80)	2.06*
BRIEF-A Composite Score	0.77 (0.67-0.89)	-3.47**	0.71 (0.59-0.85)	-3.59**	1.12 (0.93-1.35)	1.22	0.99 (0.77-1.27)	-0.08	1.33 (1.01-1.76)	2.04*

Note. See Table 5 for list of abbreviations. IRR = incidence rate ratio (i.e., the exponentiated unstandardized regression coefficient, e^b). Years at risk of offending was included as the offset variable in all models, transforming the predicted outcomes from frequencies of offending to rates of offending. $z = b/SE$. For all significant effects, the likelihood ratio chi-square ($LR\ \chi^2$) for the corresponding model was also significant ($p < .05$). $N = 151$. All intelligence and executive functioning scores are *z*-scores with a mean of 0, a standard deviation of 1.
*$p < .05$. **$p < .01$.

lower score on the BRIEF composite score were associated with higher rates of total offending.

Three of the eleven predictors were statistically significant in the prediction of rate of nonviolent offending. Weaker self-reported inhibition and shifting and a lower composite score on the BRIEF were associated with higher rates of nonviolent offending.

Four of the eleven predictors were statistically significant in the prediction of rate of violent offending. Weaker performance on the verbal and total scores from the KBIT and on the inhibition and shifting scores from the D-KEFS were associated with higher rates of violent offending.

Three of the eleven predictors were statistically significant in the prediction of rate of reactive violent offending. Weaker performance on the inhibition, shifting, and composite scores from the D-KEFS were associated with higher rates of reactive violent offending.

Finally, four of the eleven predictors were statistically significant in the prediction of rate of instrumental violent offending. Weaker performance on the verbal and total scores from the KBIT was associated with higher rates of instrumental violent offending. In contrast, better self-reported working memory and a higher score on the composite from the BRIEF were associated with lower rates of instrumental violent offending.

Hierarchical Linear Modeling (HLM)

A series of models were conducted using HLM to determine whether intelligence and executive abilities were related to differences in the inmate's likelihood of having engaged in reactive violence, instrumental violence, or nonviolent forms of offending. Multilevel Bernoulli regression (see Raudenbush, Bryk, Cheong, & Congdon,

2001; Raudenbush & Bryk, 2002) was used to estimate the effects of intelligence and EF on the likelihood of having committed a nonviolent offence versus a violent offence and a reactive violent offence versus an instrumental violent offence. Effects were modelled as fixed and the estimates from the unit specific model with robust standard errors were examined. Level-1 explanatory variables included offence characteristics, such as the severity of violence. Level-2 explanatory variables included inmate characteristics such as intelligence, scores from the performance-based measures of executive functioning, as well as indices from the self-report measure.

Once again, results are presented without covariates. However, analyses covarying intoxication at the time of the offence (if the offence was violent) and the severity of violence at Level 1, and age and total years incarcerated at Level 2 are included in Appendix F. In the analyses containing EF scores as predictors, the $KBIT_{TOT}$ was also covaried. Again, this was done in order to evaluate whether the association between executive functions and subtypes of crime remained even after controlling for intelligence.

The probability of an event occurrence (e.g., reactive violence) is estimated by calculation of odds ratios, which compare reactive violence to other forms of offending (e.g., instrumental violent offending). Table 14 presents the results of the multilevel Bernoulli analyses, estimating the probability that an inmate commits specific offences. Odds ratios can show not only the direction of the association, but also the extent of the association. An odds ratio can be defined as the ratio of the odds of an event occurring at a specific level of the predictor variable (e.g., z score of 0) to the odds of it occurring at a level of the predictor variable that is 1-unit away (Obsorne, 2006). An odds ratio of 1

indicates that the event (e.g., reactive violent offence) is equally likely to happen in both categories. An odds ratio above 1 indicates that the event is more likely to happen at a particular level of the predictor variable compared to the reference category (e.g., instrumental violent offence). An odds ratio of less than 1 indicates that the event is less likely to happen at a particular level of the predictor variable compared to the reference category.

The estimates from the models of the Level-2 predictors are presented in Table 14. All predictors were entered into the models grand-mean centered. Five of the eleven predictors were statistically significant in predicting the odds of committing a violent offence versus a nonviolent offence. The results indicate the odds of an inmate having committed a violent offence versus a nonviolent offence were 1.39 times greater when the inmate scored 1 standard deviation higher on the working memory component score from the D-KEFS than an inmate who scored at the mean. Similarly, the odds of an inmate having committed a violent offence versus a nonviolent offence increased as self-reported inhibition (OR = 1.73), shifting (OR = 1.49), working memory (OR = 1.37), or the composite score from the BRIEF-A (OR = 1.64) increased.

The odds of an inmate having committed a reactive violent offence versus an instrumental violent offence increased as performance on the Verbal Subtest from the KBIT increased (OR = 1.41), performance on the inhibit component score from the D-KEFS decreased (OR = .69), self-reported working memory from the BRIEF-A decreased (OR = .57), and as the composite score from the BRIEF-A decreased (OR = .69). See Appendix F for HLM results containing covariates.

Table 14

Hierarchical Linear Models for the Prediction of the Odds of Committing Violent versus Nonviolent and Reactive Violent versus Instrumental Violent offences from Intelligence and Executive Functioning Measures without Covariates.

	Violent[a] vs. Nonviolent Offending[b]			Reactive[a] vs. Instrumental Offending[b]		
Predictor	OR (95% CI)	β	Robust Std. Error	OR (95% CI)	B	Robust Std. Error
KBIT Scores						
Verbal	0.85 (0.60-1.20)	-0.16	.17	1.41 (1.02-1.96)	0.34*	.17
Nonverbal	0.84 (0.63-1.13)	-0.18	.15	0.99 (0.71-1.40)	-0.00	.17
Total	0.82 (0.61-1.11)	-0.19	.15	1.21 (0.85-1.71)	0.19	.18
D-KEFS Component Scores						
Inhibition	0.83 (0.61-1.13)	-0.18	.16	0.69 (0.50-0.95)	-0.37*	.16
Shifting	0.77 (0.59-1.01)	-0.26	.14	0.94 (0.68-1.30)	-0.07	.16
Working Memory	1.39 (1.07-1.81)	0.33*	.13	1.02 (0.68-1.53)	0.02	.20
D-KEFS Composite Score	0.95 (0.76-1.20)	-0.05	.12	0.81 (0.58-1.14)	-0.21	.17
BRIEF-A Scales						
Inhibition	1.73 (1.37-2.20)	0.55**	.12	0.86 (0.63-1.18)	-0.15	.16
Shifting	1.49 (1.12-1.99)	0.40*	.15	0.88 (0.51-1.01)	-0.33	.17
Working Memory	1.37 (1.02-1.86)	0.32*	.15	0.57 (0.39-0.85)	-0.56*	.20
BRIEF-A Composite Score	1.64 (1.25-2.14)	0.49*	.14	0.69 (0.49-0.96)	-0.38*	.17

Note. See Table 5 for list of abbreviations. OR = odds ratio.
[a] indicates the estimated offence type and [b] indicates the reference category. All intelligence and executive functioning scores are *z*-scores with a mean of 0, a standard deviation of 1.
*$p < .05$, **$p < .01$
Violent vs. Nonviolent – Level 1 N = 1415, Level 2 N = 151; Reactive vs. Instrumental – Level 1 N = 240, Level 2 N = 113

Discussion

The purpose of this study was to investigate whether there are unique relationships between subtypes of offending and executive functions in a sample of incarcerated adult offenders. This study had several methodological advantages over previous research, including that inmates' complete, rather than partial, criminal histories were reviewed, as well as that the reactive-instrumental distinction was recognized, rather than examining a general index of violence. This research also attempted to clarify the convergent and divergent validity of different indicators of EF within the context of crime. This was accomplished by examining similarities and differences between self-report and performance-based measures of EF; by examining whether separate components of EF had unique associations with subtypes of offending; and by including measures of general intelligence to determine whether the relationships between EF and crime could be accounted for by intelligence. The results as they pertain to each of these objectives are discussed in turn.

Clarifying the Relationship between Executive Functioning and Criminal Offending

The first goal of the study was to determine whether EF was a useful construct in predicting specific subtypes of criminal offending, or whether EF was related to criminal offending more generally. Only the results of the analyses involving the composite EF scores will be discussed here, as the component-specific relationships will be reviewed in the relevant section below. Overall, performance-based EF deficits were related to higher rates of reactive violent offending. In comparison, self-reported EF deficits were related to higher rates of nonviolent offending and lower rates of instrumental violent offending,

which translated into higher odds of nonviolent versus violent offending and of reactive versus instrumental offending.

Regardless of whether the focus was on performance-based or self-report measures of EF, results were consistent with a crime-specific approach. Neither of the EF composite scores were equally related to all subtypes of offending, and results were therefore inconsistent with a generalist approach. Results from the performance-based measures of EF were largely consistent with the results of previous studies that have demonstrated that deficits in EF are characteristic of reactive violence rather than instrumental violence or nonviolent offending (e.g., Broomhall, 2005; Ellis et al., 2009; Jones, 2007; White et al., 2012). However, existing work has largely focused on the behaviour of children and adolescents or on the behaviour of individuals in the community, so the present study extends the evidence-base to a large forensic sample. Moreover, in the majority of research to date, EF was assessed using only performance-based measures. This single-method approach may have oversimplified the EF-crime relationship, given that the current results differed depending on the type of assessment measures used. Reasons for these differences, as well as differences between self-report and performance-based indicators more generally, will be discussed in the next section.

It is also easy to see from the above results how examining violent offending in general, rather than differentiating between reactive violent and instrumental subtypes, can result in misleading findings. Reactive and instrumental violence were differentially associated with executive functions and combining these subtypes often masked these effects. For example, if a researcher only examined rates of violent offending they would have concluded that there was no relationship with performance-based EF. However, this

would be misleading because results actually indicate that rates of reactive violent, but not instrumental violent offending, are associated with deficits in performance-based EF. These kinds of findings suggest that researchers need to be distinguishing between different subtypes of aggression and violence when examining possible predictors. Researchers examining differences between violent and nonviolent forms of antisocial behaviour are at risk of drawing potentially inaccurate conclusions depending on the proportion of violent offences that are reactive versus instrumental in their violent sample.

Clarifying the Convergent and Divergent Validity of Different Indicators of Executive Functioning within the Context of Crime

The second major goal of this dissertation was to better understand EF within the context of crime. First, I examined the convergence among different methods of measuring EF. Second, I explored how these different methods of assessment were differentially associated with subtypes of offending. Third, I looked at whether the examination of separate components of EF was important or whether the use of a composite score was sufficient. Finally, I examined the role of intelligence in the relationship between EF and criminal subtypes as well as the unique relationship between intelligence and criminal subtypes. These will now be discussed in turn.

Divergence between methods of assessment of executive functioning.

Consistent with hypotheses, there was no relationship between composite scores from the self-report and performance-based tasks (r = -.05). As mentioned previously, this is similar to what other researchers have reported when examining the relationship between behaviour ratings/self-reports and performance-based measures of EF in children and

adolescents (McAuley et al, 2010) and in adults (Biederman et al., 2008; Rabin et al., 2006). Moreover, the discrepancy between these two modes of assessment is not unique to EF. Research has similarly shown that performance-based measures of impulsivity (Dolan & Fullam, 2004) and intelligence (Paulhus, Lysy, & Yik, 1998) have weak, if any, associations with behaviour-ratings of the same construct.

At present, self- and other reports of EF and performance based tasks are known to have weak or no convergence, but reasons for this are not well understood. One hypothesis is that these measures assess different aspects of the same underlying construct. For example, it has been suggested that the construct of EF consists of both a behavioural component that is assessed by behavior rating scales such as the BRIEF-A and a cognitive component that is assessed by performance-based tasks such as the D-KEFS (Anderson, Anderson, Northam, Jacobs, & Mikiewicz, 2002). This argument is supported when comparing items from the BRIEF-A scales to Miyake et al.'s (2000) definitions of performance-based executive functions. For example, an item from the Inhibit scale from the BRIEF-A reads "People say that I am easily distracted." Contrast this with the criteria that Miyake et al. proposed for selecting performance-based measures of inhibition, which required tasks to involve deliberate stopping of a response that was relatively automatic. Items from the Shift and Working Memory scales from the BRIEF-A are similarly focused on behaviour and in contrast to the more cognitively focused performance-based tasks (e.g., "I have trouble changing from one activity to another" or "I forget what I am doing in the middle of things"). Alternatively, McAuley et al. (2010) proposed that performance-based tasks assess underlying executive functions whereas the BRIEF-A assesses the application of those abilities at home and in

other environments. If McAuley et al. are correct, perhaps personal or environmental variables moderate how effectively an individual is able to apply or make use of their executive abilities, which would explain why inmates' scores on performance-based tasks did not correspond to ratings on the BRIEF-A. Although such relationships have not yet been empirically examined, possible moderators could include personality traits, the amount of support or structure in the environment, or the social demands of the setting.

The clinical utility of behaviour ratings of EF, and of the BRIEF-A more specifically, has been well demonstrated. For example, the BRIEF has been useful in detecting the presence of ADHD in children and adolescents (Mahone et al., 2002; Toplack, 2009). The adult version of the BRIEF has been shown to differentiate between healthy older adults, those with mild cognitive impairment, and those with significant cognitive complaints (Rabin et al., 2006) as well as between individuals who are characterized by hypersexuality and those who are not (Reid, Karim, McCrory, & Carpenter, 2010). However, McAuley et al. (2010) demonstrated that the BRIEF may be more indicative of general behavioural disruption and impairment than to particular executive functions. Specifically, they compared how a sample of youths' parent- and teacher-rated BRIEF scores related to the youths' inattentive and hyperactive-impulsive symptoms, their level of functioning in their everyday environment, their reading and math skills, and their scores on performance-based measures of EF. Although BRIEF ratings were strongly related to ratings of inattention, hyperactivity, and daily functioning, they were weakly related to academic tasks and not at all related to any of the three performance-based measures of EF. McAuley et al. purported that "although

the BRIEF is sensitive to behavioural disruption and impairment, it is unclear whether the questionnaire is a measure of executive dysfunction per se" (p.496).

While there is little doubt that the BRIEF has clinical utility and that it is sensitive to some level of impairment, whether individuals are able to validly rate themselves on specific components of EF is less understood. In a review of research on the accuracy of self-assessment, Dunning, Heath, and Suls (2004) concluded that people's ability to rate themselves on skill and character is quite poor. For example, self-reports of intelligence correlated .2 to .3 with performance on intelligence tests and other academic tasks (Hansford & Hattie, 1982), ratings of academic skills by first year college students correlated .35 with evaluations given by instructors (Chemers, Hu, & Garcia, 2001), and in the workplace, the correlation between how people expected to perform and how they actually performed was .2 (Stajkovic & Luchins, 1998). It may be that individuals have a sense that something is not functioning as it should, but they are not able to accurately report on specific abilities that are impaired.

Performance-based tasks have also faced criticisms quite different than self-report measures. Some have argued that performance-based tasks of executive function lack ecological validity due to the way in which they are administered (e.g., Chan et al., 2008; Jurado & Rosselli, 2007). Testing usually occurs in an environment that is free from distraction, that maximizes support, and that provides individuals with a great deal of structure (e.g., clear instructions, well-specified goals). Because these environmental conditions are so unlike those in which people typically function, it has been suggested that performance-based tasks engage a different skill set or they fail to detect subtle deficits due to the support imposed (Burgess, 1997). That said, strengths of performance-

based tasks include that they were developed to assess specific components of EF, were validated with brain lesioned patients (e.g., Drewe, 1974; Shallice, 1982), and have well-established neurological correlates (e.g., Newman, Carpenter, Varma, & Just, 2003; Smith, Taylor, Brammer, & Rubia, 2004). Some researchers have interpreted the failure of previous studies to find an association between performance-based measures and ratings on the BRIEF-A as evidence that behaviour ratings do not assess EF to the extent that some believe (McAuley et al., 2010).

Regardless of the exact reason, self-report and performance-based measures of EF are not associated with one another, at least when looking at correlational data. The question then arises of whether these two methods of assessment are similarly related to subtypes of criminal offending.

Methods of assessing executive functioning and relationships with criminal offending. In addition to finding that self-ratings and performance-based measures were unrelated to one another, results from this dissertation also suggest that these methods of assessment are differentially associated with subtypes of offending. As mentioned previously, weaker performance on a global score from the performance-based tasks of EF was associated with higher rates of reactive violent offending, but was not associated with rates of instrumental violent or nonviolent offending. These results are consistent with the previously reviewed research finding a link between executive dysfunction and reactive aggression in both children (Ellis et al., 2009; Giancola et al., 1996) and adults (Broomhall, 2005; Levi et al., 2010; Stanford et al., 1997; Stanford et al., 2003), but this was the first study to use a large forensic sample and to consider each individual's complete adult criminal history. That said, given the retrospective methodology

employed herein, it would be premature to conclude that deficits in EF cause reactive violence. Rather, the current results could reflect a common causal risk factor for both executive dysfunction and reactive violence. Such third factors could include variables such as low socioeconomic status and/or childhood maltreatment. Previous research has found associations between low socioeconomic status and both deficits in EF (Heimer, 1997) and aggression (Noble, Normal, & Farah, 2005), and between childhood maltreatment and both deficits in EF (Chugani et al., 2001) and aggression (Turner, Finkelhor, & Ormrod, R. K., 2006). Unfortunately, there is virtually no research yet available that examines childhood maltreatment, socioeconomic status, and executive functioning longitudinally to see which has a more direct influence on aggression and violence. However, this line of future research will be discussed further when reviewing suggestions for future directions.

In contrast to results with the performance-based measures, weaker self-reported EF was associated with higher rates of nonviolent offending and with lower rates of instrumental violent offending. Moreover, individuals who self-reported weaker EF were more likely to commit a nonviolent relative to a violent offence and a reactive violent offence relative to an instrumental violent offence. These findings were, in part, contrary to hypotheses and to the findings from analyses using performance-based measures of EF. They are also contrary to the findings of two studies that examined behaviour ratings of EF and aggression. In her doctoral dissertation, Broder (2004) found that teacher ratings of EF from the BRIEF were associated with teacher ratings of both reactive and instrumental aggression. Alternatively, White et al. (2012) found that parent ratings from the BRIEF were associated with parent ratings of reactive aggression but not instrumental

aggression. Neither study examined non-aggressive delinquent behaviour. The findings from both studies may have been influenced by shared method variance; however, this alone cannot account for White et al.'s findings given the differences in associations between reactive and instrumental aggression. Contrary to the present study, these two studies examined the behaviour of young children, used informant reports of EF rather than self-reports, and used informant reports of aggression rather than behavioural data. These differences in methodology may explain why there was a discrepancy between the current findings and previous research. For example, the reference group for parents and teachers completing these behaviour ratings was presumably typically developing children. The reference group for the offender population completing the behaviour ratings were other, perhaps in some cases more impaired, offenders. This may also explain why individuals who engage in an increasingly large number of instrumental offences report stronger EF. It is not to say that these individuals in fact have stronger executive abilities when compared to the general population, but rather, when asked about functioning while living in a prison environment and when comparing themselves to other inmates, they report that they are functioning better.

The observation that self-reported executive dysfunction was most strongly associated with nonviolent offending was unexpected; however, this finding can be interpreted within the context of Burt's (2012) review of the relationship between crime and *trait impulsivity*. Specifically, Burt reviewed findings suggesting that trait impulsivity, or a stable propensity to act rashly, is more strongly associated with nonaggressive criminal behaviour than aggressive criminal behaviour. For example, Burt, Donnellan, and Tackett (2012) and Burt and Donnellan (2008) found that

personality traits of impulsivity were robustly associated with nonaggressive antisocial behaviour but not with aggressive behaviour in adults. Similarly, in a meta-analytic review of the associations between the domains and facets from the Five Factor Model of personality and antisocial and aggressive behaviour, Jones, Miller, and Lynam (2011) found that facets related to trait impulsivity were more associated with antisocial behaviour than aggressive behaviour. For example, the impulsivity-related facets had larger effect sizes for antisocial behaviour than for aggressive behaviour. These results are relevant because impulsivity is a construct often used synonymously or at least thought to be associated with EF (Lau & Pihl, 1996). Sample items from the impulsivity-related domains from a questionnaire assessing the Five Factor Model of personality read "I sometimes do things on impulse that I later regret" or "over the years I have done some pretty stupid things" (NEO-PI-R; Costa & McCrae, 1992). These are very similar to items from the BRIEF inhibit scale including "I make decisions that get me in trouble (legally, financially, socially)" and "I am impulsive". Perhaps, consistent with the argument in the previous section, the BRIEF measures trait impulsivity, rather than executive functioning, making the current findings consistent with previous research that has found trait impulsivity to be more strongly or exclusively related to nonviolent criminal behaviour rather than violent behaviour.

Previous research has not informed why trait impulsivity would be associated with nonviolent offending but not violent forms of offending. It is possible that trait impulsivity makes it difficult for individuals to deny themselves anything desirable, and increases their likelihood of attempting to reach their desired end goal, even if this goal achievement requires them to engage in criminal acts. Perhaps this trait is not enough to

predispose an individual to pass the threshold into violence. Individuals may need additional characteristics, such as aggressive attitudes, a hostile attribution bias, or an enjoyment of violence, before violence is used to obtain something desirable or solve a problem.

Utility of examining separate components of executive functioning. So far I have discussed only those findings involving the EF composite scores, as though EF were a unitary construct. However, as I alluded to earlier, this view of EF is likely overly simplistic. Many researchers have found that EF is composed of separate but related components. Despite this, researchers in the forensic field have often failed to acknowledge these separate abilities. In contrast, in this dissertation, I explored whether examining separate components of EF is necessary, or whether it is equally informative to examine composite scores when exploring the relationship with offending. Three separate abilities were studied and it was hypothesized that examining separate executive functions would have incremental predictive power over and above a single composite score.

It was hypothesized that all three components of EF would be uniquely associated with reactive violence. When looking at the performance-based measures of EF, negative binomial regression results suggested weaker inhibition and shifting (but not working memory) were associated with rates of violent offending, and of reactive violent offending more specifically. HLM results similarly suggested that inhibition was able to differentiate between reactive and instrumental violence, whereas working memory was able to differentiate between nonviolent and violent behaviour.

Results from the performance-based measures were, in part, consistent with hypotheses and with earlier research comparing EF in reactive and instrumental aggressors. As mentioned previously, forensic researchers do not often discuss separate executive abilities and their associations with subtypes of violence. However, in examining the EF measures used in their research, measures can often be mapped onto one of the three Miyake components. The current results indicate that inhibition and shifting, but not working memory, may be particularly important for differentiating subtypes of violence which is similar to what Jones (20007) found using the Stroop test. Jones (2007) found that children who engaged in reactive aggression were more impaired in inhibition than children who engaged in instrumental aggression. Using the Stroop test and the Wisconsin Card Sorting Task (WCST), Ellis and colleagues (2009) found that children who engaged in reactive aggression were characterized by deficits in inhibition but not shifting, and that children who engaged in instrumental aggression remained intact on both. In adults, both Haberle (2011) and Broomhall (2005) found that, relative to instrumental aggressors, reactive aggressors were characterized by deficits in shifting and inhibition as measured by the Stroop test, the Tower of Hanoi, and subtests from the D-KEFS. Levi and colleagues (2010) found that a group of inmates, similar to a reactive aggressor (referred to as irritable aggressors), were characterized by deficits in inhibition as measured by a continuous performance test and the Iowa Gambling Task (IGT). None of these researchers included measures of working memory. Previous research has found that working memory is impaired in offender samples when compared to non-offender sample (e.g., Cauffman, Steinberg, & Piquero, 2005), but there is no previous research examining working memory and specific subtypes of criminal offending.

The results from the current dissertation suggest that examining a composite score of performance-based tasks of EF can be misleading given that separate components of EF are differentially related to subtypes of criminal offending. Individuals who have trouble altering their behaviour in response to environmental changes (shifting) and who have difficulty inhibiting their prepotent responses are at a higher risk of reacting inappropriately to environmental change, instigating or exacerbating a confrontation, and being provoked into reactive violence. Individuals who struggle to update and work with information temporarily stored in their working memory may struggle to use past experiences (such as punishment) as a means to control their current desires, and as a result, engage in an increasingly large number of nonviolent offences in order to obtain those desires. Working memory may also reduce an individual's problem solving skills by interfering with their ability to generate or evaluate alternative solutions to a problem which could further contribute to their likelihood of engaging in criminal behaviour.

When examining specific executive functions, there was once again no relationship between self-report and performance-based measures. For example, the inhibit scale from the BRIEF-A was not correlated with the inhibition score from the performance-based tasks. When looking at self-reported executive functioning and criminality, the results were quite different relative to those involving the performance-based tasks. Results suggested that weaker self-reported working memory was associated with lower rates of instrumental violence, whereas weaker self-reported inhibition and shifting were associated with increased rates of nonviolent offending. Similarly, HLM results suggested that self-reported working memory could differentiate between an individual having committed a reactive violent versus an instrumental violent offence.

Weaker self-reported inhibition, shifting, and working memory predicted an individual having committed a nonviolent offence over a violent offence. Given the earlier discussion calling into question the BRIEF's ability to assess EF specifically, these results will not be interpreted. More research is needed looking at self-reported executive functions in adults and relationships with subtypes of crime.

It should be noted that the magnitude of the predicted changes in rates of offending by each executive function was not large; however, given the importance of predicting violent offending in society, these findings are still meaningful. It is also important to stress that these findings are preliminary, warranting further replication before any definitive conclusions can be drawn. Furthermore, it would be of interest to follow-up with this group of inmates in a number of years in order to see whether their scores from the D-KEFS or the BRIEF-A predict future rates of offending.

Taken together, results from the present dissertation highlight the importance of examining components of EF separately, rather than as a composite score. A composite can mask information about the specific abilities impaired, and as discussed above, it appears that certain abilities are more relevant to specific subtypes of offending (e.g., performance-based inhibition and shifting are able to distinguish between reactive and instrumental violence whereas working memory cannot). This study did not examine all abilities subsumed under the umbrella of executive functioning, and so future researchers should consider including additional abilities, such as verbal fluency, initiation, planning, and concept formation, when examining relationships between EF and subtypes of crime.

Executive functioning, criminality, and intellectual functioning. Intelligence is often discussed as being a separate construct from EF (Milner & Petrides, 1984;

Shallice & Burgess, 1991). However, EF is correlated with intelligence (Miyake et al., 2001; Salthouse et al., 2003), and both constructs depend on at least some shared neural circuitry (Barbey et al., 2012). Furthermore, the capacity for understanding and remembering the rules involved in some of the performance-based EF tasks could presumably be affected by intelligence. Because of the positive relationship between intelligence and EF and because offenders are known to have lower intelligence (Hirschi & Hinderlang, 1977), it is possible that previous research supporting a relationship between EF and subtypes of violence may have simply been a consequence of the inmates' lower intelligence, rather than their executive dysfunction. It is more appropriate to acknowledge that an overlap between intelligence and executive abilities exists than to ignore it. Therefore, intelligence was included in all analyses in order to determine whether the relationships between executive functions and criminality remained. Moreover, the relationships between intelligence and criminal subtypes were also directly examined. Three intelligence scores were examined, including verbal IQ, nonverbal IQ, and a total IQ score.

Consistent with previous research, intelligence scores were correlated with scores from the performance-based measures of EF. As a result, all analyses containing EF scores were rerun, controlling for the total IQ score (see tables in Appendix F). The pattern of results remained largely the same, whether intelligence was included as a covariate or not. This is consistent with hypotheses and suggests that the relationship between executive functions and subtypes of crime cannot simply be explained by differences in intellectual functioning. When looking at the relationship between intelligence and criminality directly, negative binomial regression results revealed that

weaker verbal IQ and total IQ scores were associated with rates of violent offending, and of instrumental violent offending more specifically. HLM results similarly suggested that verbal IQ was able to differentiate between reactive and instrumental violence.

These results are consistent with previous findings, but extend researchers in the field's understanding of the relationship between intelligence and criminality to more specific criminal subtypes. The relationship between intelligence and criminality has been well documented. Moreover, violent criminals have been shown to perform worse on intelligence measures than their nonviolent counterparts (Holland & Holt, 1975; Holland, Beckett, & Levi, 1981). Some investigations have led to researchers to conclude that verbal IQ is more strongly associated to delinquency than nonverbal IQ (Moffit et al., 1981; Reichel & Magnusson, 1988; West & Farrington, 1973). Using a prospective longitudinal design, Stattin & Klackenberg-Larsson (1993) found intelligence measured at ages 3, 11, 14, and 17 was associated with criminality at age 17, and that early language ability (language maturity and language comprehension) was related to later criminality. Lewis and colleagues (1980) reported that verbal intelligence distinguishes between nonviolent and violent offenders more effectively than does nonverbal intelligence. The current study adds to this literature by suggesting that weak verbal intelligence is associated with instrumental violence but not reactive violence.

Different explanations have been put forth in an attempt to elucidate the mechanism through which low intelligence exerts its effect on criminal behaviour. Some have posited a connection between intelligence and moral reasoning, or they have simply assumed that less intelligent individuals are more often apprehended by the police (Stattin & Klackenberg-Larsson, 1993). Researchers have proposed that deficits in verbal IQ

may prevent an individual from using verbal mediation for self-control or may result in poor communication skills which could evoke negative interactions (Moffit & Lynam, 1994). However, it seems as though these latter explanations would put an individual at risk of engaging in reactive violence, and the present study found that weak verbal intelligence was associated more strongly with instrumental violence. One possibility, that would be consistent with the findings of the present study, is that poor verbal reasoning leaves an individual less able to problem solve nonviolent ways of achieving their goals, and as a result, the only strategy they have when trying to obtain some sort of goal is instrumental violence.

Strengths and Limitations

As with all empirical research, this study is not without its strengths and limitations. These will be briefly discussed as to identify directions for future research and to provide a context within which the implications of this study can be presented. The approach to managing offence data and the analytic strategy were both strengths of this study. Each individual's complete adult criminal history was considered and offender classification was avoided. This provided a more reliable estimate of propensities towards violence subtypes, relative to previous work that has determined offender subtypes based on a single most recent (e.g., Broomhall, 2005) or the most severe offence (e.g., Woodworth & Porter, 2002). Moreover, the complementary analytic approach allowed entire criminal histories to be considered and assisted in integrating discrepant findings from past research that has conceptualized subtypes of violence either as two discreet categories (e.g., Tapscott, Hancock, & Hoaken, 2013) or as opposite ends of a single continuum (e.g., Woodworth & Porter, 2002), but not both.

However, despite these strengths, the generalizability of the results of this study is limited by characteristics of the sample. First, although this study solicited a random selection of inmates, rather than selecting participants on a volunteer basis, it remains that only 155 of the 303 inmates (51%) who were invited to participate actually ended up following through with the study. Although many did not consent because of schedule conflicts, others did not agree because they did not trust the testing process or for an undisclosed reason. It is possible that inmates who volunteered or who followed through with the research were different in some way (e.g., more motivated or organized) than those who did not. If this sampling bias resulted in a restricted range in EF scores, then the reported effects may be an underestimate of the true effect in the population. Second, because this sample consisted only of men, it is difficult to determine whether the results of the current investigation would generalize to women as well. Very little research has examined EF in female offenders; however, the little that has been done has presented conflicting results. For example, some research has found that aggressive females are characterized by executive dysfunction (Daoust, Loper, Magaletta, & Diamond, 2006; Giancola, Mezzich, & Tarter, 1998), while others have found that they are not (Komarovskaya, Loper, & Wamen, 2007). There is no known research examining EF and aggressive subtypes in women. Although nothing in the literature on the development of executive dysfunction suggests that women are any different than men with regards to these abilities, the extent to which the current results generalize to female offenders is unknown. Women are equally aggressive as men; however, they tend to cause more psychological harm rather than physical (Bjorkvist & Niemela, 1992; Hines & Saudino, 2003). Perhaps because they fight less, they incur fewer traumatic brain

injuries and suffer from less executive dysfunction, meaning that EF may not be a factor that contributes to their likelihood of engaging in violence. Research examining EF and criminality in women is needed before conclusions can be made. Future studies could examine gender as a moderator to determine whether women display the same associations between EF and criminality.

Beyond characteristics of the sample, the generalizability of the results is also limited to the three executive functions of interest in this study. It is unknown whether results would generalize to other components of EF such as initiation or planning. Further, while the approach to EF measurement was a definite strength of this dissertation, as a function of examining both performance-based and self-report measures of EF which diverged in their relations to the outcomes of interest, general conclusions about the EF-crime relationship cannot be provided. Several limitations inherent in self-reported EF were highlighted, and future research should further examine the validity of the BRIEF in assessing specific components of EF. Before definite conclusions can be drawn about the relationship between EF and subtypes of crime, it will be important to understand why performance-based tasks are unrelated to self-report measures of EF. Beyond the EF measures used, the assessment of these abilities occurred in prison, not at the time that the offences took place. It is unknown how EF measured in prison compares to EF on the street or, for example, whether anything may have happened since the participants committed their prior offences that may have influenced the integrity of their EF abilities. Although EF remains stable throughout adulthood (Ettenhofer, Hambrick, & Abeles, 2006), there are a number of variables that could disrupt EF such as a brain injury (Marsh & Martinovich, 2006) or use of certain medications (see Brooks &

Hoblyn, 2007 for a review). Therefore, it is possible that for some individuals, their assessed EF at the time of testing was different than their EF while committing offences. If such events were random, then they would introduce error and make it more difficult to detect effects. A longitudinal design with repeated measurement of EF would help to avoid this source of error.

Future Directions

Beyond addressing the aforementioned limitations, researchers should consider future directions in terms of the broader context of the forensic literature. What will follow is a discussion of future directions for the study of EF and violence subtypes, with an emphasis on determining whether the relationship is causal and on further theory development. A more integrative approach to studying the risk factors associated with violence, including EF as well as other variables, will be reviewed. Finally, the possibilities of incorporating EF in violence risk assessment and of targeting EF in offender rehabilitation programs will be discussed.

The current dissertation does not address the question of whether deficits in EF cause an individual to engage in subtypes of violence. Rather, its results suggest that there are associations between EF and criminal subtypes. As mentioned previously, it is possible that there are common causal risk factor for both executive dysfunction and reactive violence, meaning that EF may not necessarily play a role in causing one to engage in reactive violence. It is difficult to test a causal model given that the variable of interest is violence. Future research would benefit from using a longitudinal design in an attempt to predict whether EF in childhood or adolescence predicts violent behaviour in adulthood or to examine whether EF in adulthood predicts recidivism after release from

prison. If a more casual link between executive dysfunction and violence subtypes is established, then researchers can focus on building theories that better explain mechanisms through which EF might influence an individual's propensity towards violence.

Future researchers should also consider examining whether there are indirect influences of EF on violent behaviour. There could be variables that mediate and/or moderate the relationship between EF and subtypes of crime. The present study examined neuropsychological dysfunction in isolation, purposely ignoring psychosocial factors. This approach was justified given the preliminary nature of the research; however, there are likely a number of factors that contribute to subtypes of criminality, with EF being only one of these factors. Social skills, personality traits, attitudes, assumptions, other cognitive abilities such as attention, early childhood experiences, and a number of additional factors likely interact and contribute to criminal subtypes. A potential interaction between EF and other variables may have made predictors of violent subtypes go undetected. Although little is known about how risk factors interact in predisposing one to subtypes of violent behaviour, Scarpa and Raine (2007) reviewed the evidence of biosocial interaction effects in the prediction of antisocial and violent behaviour more generally. One interaction of particular interest to the present study was the interaction between neurocognitive deficits and social variables. For example, Lewis, Lovely, Yeager, and Femina (1989) followed 15-year-old juvenile delinquents and found that the combination of neurocognitive deficits and child abuse was associated with higher rates of violent offending than was having only neurocognitive deficits or only experiencing child abuse. Similarly, Moffit (1990) found that boys with low

neuropsychological functioning and family adversity scored four times higher on measures of aggression than did boys with either family adversity or neuropsychological deficits. It may be that executive deficits result in individuals being more vulnerable to psychosocial risk factors and, consequently, more likely to be violent.

Another variable, discussed earlier, that has been associated with subtypes of aggression and violence is social cognition, or social problem solving. Although both EF and SIP have been examined in isolation and have been shown to be independently associated with instrumental and reactive forms of violence, the relationship between EF and SIP remains largely unknown. It was suggested in the introduction of this dissertation that social problem solving may be one intuitively appealing way to understand the association between executive functioning and reactive violence. Some evidence suggests that biases in processing social information may interact with deficits in EF in predisposing individuals to reactive violence. For example, Ellis et al. (2009) examined how deficits in EF and distortions in processing social information have both main and interactive effects on subtypes of aggressive behaviour. Ellis et al. found that a tendency to attribute hostility to another's intention (known as a hostile attribution bias) moderated the relationship between specific executive functions and reactive aggression in children, such that the effect of EF on reactive aggression was larger in children with hostile attribution biases. In addition to interactive influences, there is some preliminary evidence to suggest that executive abilities may indirectly influence an individual's propensity for using different subtypes of violence through their influence on other aspects of social problem solving. As mentioned earlier, Tate and colleagues (1991) showed that deficits in shifting lead to problems in social communication and social

interactions, while McGann and colleagues (1997) demonstrated that deficits in EF impaired an individual's ability to solve problems in social contexts. There appears to be preliminary research evidence suggesting that through its influence on social problem solving, perhaps decreasing an individual's ability to generate solutions to resolve social conflicts, EF may influence social outcomes which could include aggression or violence (Muscara et al., 2008). In light of the aforementioned research findings and proposed models, it follows that researchers need to better understand the indirect and interactive effects of EF and social problem solving on propensity towards subtypes of violent behaviour. A combination of insufficient social problem solving capacities and difficulties in inhibition, cognitive flexibility, et cetera may predispose individuals to engage in violent behaviour, specifically in reactive violence. Therefore, to determine whether these abilities account for unique or shared variance in violent offending, an integrative approach to the study of the cognitive correlates of reactive and instrumental violent behaviour should be taken in future research.

A final variable that will be discussed here with regards to its effect on the relationship between EF and criminality is alcohol intoxication. The consumption of alcohol has been associated with an increased likelihood of aggression and of reacting aggressively when faced with provocation (Chermack & Giancola, 1997; Fishbein, 2003). Using both correlational and experimental designs, researchers have found that alcohol is present in a large proportion of violent crimes (Murdoch, Pihl, & Ross, 1990; Pernanen, 1991) and that it is the acute effects of alcohol that increase an individual's likelihood of engaging in aggressive behaviour (Chermack & Blow, 2002; Chermack &

Giancola, 1997; Hoaken & Pihl, 2000). That said, alcohol intoxication does not increase the likelihood of aggression in everyone (Ito et al., 1996).

Giancola (2000) contended that alcohol's pharmacological properties facilitate aggression by disrupting executive functions. Giancola's model implicated EF as both a mediator and a moderator in the alcohol-aggression relationship. A review of other research findings suggested that acute alcohol intoxication reduced EF, which Giancola theorized increased an individual's likelihood of reacting to provocation with aggression. Further, the consumption of alcohol was more likely to increase aggressive tendencies in individuals who had weaker EF to begin with, compared to those who had stronger EF (Giancola, 2000; Giancola, 2004). Although this research did not examine subtypes of aggression, the interpretation of results focused on aggressive responses to provocation, which is characteristic of reactive but not instrumental aggression. Given this complex relationship, future research examining the relationship between EF and violence subtypes should also consider the influence of alcohol intoxication. Although the current dissertation attempted to control for the effects of general substance intoxication (not specifically alcohol) at the time of each violent offence, this attempt was limited by the details available in the files. Official crime data is not the ideal means through which to gather information about alcohol intoxication during violent offences. It is likely that individuals are not always forthcoming to the authorities about their use of substances during offending, and those involved in the criminal investigation are, at times, unable to determine whether alcohol was involved. As such, other ways of gathering this information, such as through an experimental alcohol and aggression paradigm, should be

investigated and the relationship between EF and subtypes of crime should be examined with and without the effects of alcohol intoxication.

What one would think of as a "biopsychosocial" model of violence is very much underdeveloped. It is time for a more integrative approach to examining the contributors to instrumental and reactive violence. Future researchers should consider including variables such familial abuse, social-information processing, and alcohol intoxication in order to better understand how these variables influence the relationship between EF and subtypes of criminality. Joint assessment of both psychosocial and cognitive factors will likely yield innovative insights into the development of theories about reactive and instrumental violent behavior.

Implications of the Current Research

From a practical standpoint, understanding how executive functions are differentially associated with subtypes of crime provides potential targets for violence risk assessment and for offender rehabilitation. If additional research replicates the findings from the current dissertation, and extends this research in a way that confirms a causal model, then researchers may wish to examine how EF could be incorporated into risk assessment measures and rehabilitation programs for violent offenders.

Violence risk assessment. The value of being able to estimate the likelihood that someone may be violent in the future cannot be overstated. Currently, executive functions (or any cognitive abilities for that matter) are not considered in the most widely used and validated violence risk assessment tools (e.g., Level of Service Inventory - Revised: Andrews & Bonta, 2003; the Violence Risk Appraisal Guide: Quinsey, Harris, Rice, & Cormier, 2006; Historical, Clinical, Risk Management-20: Webster, Douglas,

Eaves, & Hart, 1997). Given that violence risk assessment is far from perfect, and given that the current review provides preliminary support for specific EF's being related to reactive violent offending, EF may be a construct that merits further exploration in the field of violence risk assessment. Measures of EF are objective and relatively easy to administer, and executive functions are thought to be relatively stable across adulthood (Ettenhofer et al., 2006). Given these features, EF is a good candidate for evaluation for potential inclusion in risk assessment. Future research should examine the incremental validity of adding measures of EF to violence risk assessments.

Potential for rehabilitation. Beyond simply assessing an individuals' risk for future violence, researchers need to develop interventions to manage or reduce this risk. Given the findings of the current review, EF may be a construct that warrants further exploration as a potential target for improvement during the rehabilitation of reactive violent offenders. Executive dysfunction is not specific to incarcerated offenders, but rather characteristic of a number of clinical populations such as individuals with schizophrenia (Velligan & Bow-Thomas, 1999), attention-deficit disorders (Pliszka, 2007), Tourette's disorder (Bornstein, 1990), and some traumatic brain injury (Cicerone, Levin, Malec, Stuss, & Whyte, 2006; Krpan, Levine, Stuss, & Dawson, 2007). Research in cognitive rehabilitation suggests that using a skills re-training approach, executive dysfunction can be improved in these populations (Cicerone et al., 2006; Rath, Simon, Langenbahn, Sherr, & Diller, 2003; Worthington, 2005). Such approaches hold that practicing specific cognitive functions through specially designed tasks and exercises will allow the functions to improve (Evans, 2005). For example, impairments in EF are considered to be a core deficit in schizophrenia, and researchers have found that through

Cognitive Remediation Therapy, which focuses on working memory, cognitive flexibility, and planning, individuals with schizophrenia can improve their performance on EF measures (Evans, 2005). In a systematic review of randomized control trials examining cognitive remediation programs targeting EF in individuals with schizophrenia, Kluwer-Schiavon, Sanvicente-Vieria, Kristensen, and Grasssi-Oliveira (2013) concluded that these programs could be a promising therapeutic option for cognitive deficits in schizophrenia. Indeed, Wykes et al. (2002) were able to show that such training was associated with increased activation levels in frontal areas of the cortex while completing EF tasks. Despite these encouraging results in the laboratory, it remains unclear whether such training brings about generalized and sustained improvement in everyday functioning.

Rather than aiming to restore normal executive functioning through over-practicing certain skills, some rehabilitation programs have focused on teaching compensatory strategies to promote behavioural change in patients with EF impairments (Evans, 2005). Examples of such compensatory strategies include making use of external reminders and manipulating the social environment. This kind of training may also be possible in a correctional facility as the environment is greatly controlled and there would be ample opportunity for practice.

The two aforementioned approaches to improving EF should be considered when developing rehabilitation programs for offenders identified as have deficits in EF, with the intention that such treatment programs may teach offenders an alternative to reactive violence. The importance of executive control is discussed in much of the literature regarding correctional-based programming (Mullin & Simpson, 2007; Paschall &

Fishbein, 2002). However, current conceptualizations of offender remediation do not yet reflect the accumulating research (Bonta & Cormier, 1999; Ross & Hoaken, 2010).

Conclusion

This study advances the literature, first by extending the knowledge base on the relationship between executive functions and subtypes of criminal offending. Importantly, the connection between EF and subtypes of criminal offending has never been investigated in a large forensic sample, and its exploration offers a more comprehensive understanding of which specific executive functions are associated with subtypes of offending. Furthermore, by including self-report and performance-based measures of EF, composite as well as separate executive function scores, and an intelligence measure, this study was able to clarify the convergent and divergent validity of different indicators of EF within the context of better understanding crime. Previous studies examining the relationship between EF and antisocial behaviour have been limited by the inadequate assessment of EF. This dissertation was designed, in part, to increase understanding of the conceptualization and operationalization of the elusive construct of EF, so as to better test the link between EF and criminal behaviour.

Overall results from this dissertation suggested that the relationship between EF and criminal subtypes was best understood from a crime-specific approach to criminality. Reactive violence, instrumental violence, and nonviolent offending were each characterized by a unique constellation of strengths and weaknesses in EF. Moreover, results suggested that these relationships changed depending on whether EF was assessed using performance-based or self-report measures. Results supported not only the examination of specific executive functions over a composite score, but also the

divergence between executive functioning and intelligence. In fact, results suggested that different facets of intelligence were also uniquely associated with reactive and instrumental forms of violence.

It is acknowledged that it is unlikely that EF is the only important variable when considering subtypes of violence. Rather, there are likely a number of factors that contribute to criminality and violence subtypes, with executive functioning being one of these variables. Social skills, personality traits, cognitive abilities, early childhood experiences, and a number of other factors likely interact and contribute to a propensity for violence subtypes. Regardless, even if executive abilities play a relatively minor role in predisposing an individual to violence, this role needs to be better understood. An understanding of the complex and interacting variables underlying violence and criminality is a prerequisite for the early identification of at-risk youth and for the development of interventions for offenders.

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Appendix A

Letter of Information Provided to the Inmates

Letter of Information

Project Title: An investigation of the cognitive, personality, and social risk factors associated with instrumental and reactive violence

Principal Investigator: Peter N.S. Hoaken, Ph.D., Associate Professor, Department of Psychology,

Invitation to Participate in Research: You are being invited to participate in a research study conducted by researchers from the University of Western Ontario with the co-operation of the Correctional Service of Canada. The purpose of this letter is to provide you with the information you require to make an informed decision on participating in this research. We are asking you to take part because we are interested in learning more about the characteristics of individuals who have committed different types of offenses.

Purpose of Research: Some researchers have suggested that there are two main types of violence. Some violence is unplanned and is committed only to harm an individual after being angered by that person. Other violence is planned ahead of time and is committed for a reason other than simply harming someone, for example to obtain money or power. Researchers are now trying to determine whether there is a different group of individuals at risk of committing each of these types of violence, or whether all individuals are just as likely to commit either type of violence. The purpose of this study is to try to better understand the relationship between different types of violence and characteristics of individuals such as their personality, their ability to successfully solve puzzles, and their ability to correctly understand social interactions. It is hoped that this research will help to improve the treatment programs available for violent offenders.

Participant Exclusion Criteria: Any male offender currently incarcerated at Fenbrook Institution may be considered for participation in the study. However, you may only participate if you (a) have normal or corrected-to-normal vision (that is, you may participate if you wear glasses or contact lenses), (b) are fluent in English, (c) can hold and move an object (e.g., pencil, block) with your hand, and (d) can respond (verbally or in writing) to verbal and/or written questions.

Description of Research: Participation in this study will take approximately 2.5 to 3 hours of your time, but you can ask for breaks as needed. First, you will be asked to complete a series of questionnaires that assess your personality, attitudes, functioning in daily life, understanding of social situations, behaviour (including aggressive behaviour), strengths and weaknesses, and negative events that you may have experienced during your childhood (e.g., abuse). It is important for you to know that your answers to some of the questions will help us determine whether you are responding honestly. Second, you will be asked to solve a number of puzzles and problems such as your word knowledge, your ability to identify patterns, your ability to solve riddles, and your decision-making. For some other problem-solving tasks, we will ask you to follow a set of rules while you build towers and connect a series of dots. Third, we would also like to review your file information held by the Correctional Service of Canada. This file review will entail access to your

Case Management and Psychology files only. Your files will be reviewed to (a) determine the characteristics of any prior crimes, and (b) review psychological test results.

Potential Harms: There are no known risks to participating in this study, but you may become tired while completing the tasks. You may also be asked to discuss some sensitive topics that may make you feel uncomfortable. If this occurs please inform the researcher and we will provide you with available resources.

Possible Benefits: There are no direct benefits to you for participating in this study, but knowledge may be gained to help people understand the individual characteristics that are associated with committing specific types of crime.

Voluntary Participation: Participation in this study is voluntary. You should only agree to participate if you feel you have been given enough information about the study. You may refuse to participate, refuse to answer any questions, or withdraw from the study at any time. Participation in this study, refusing to answer questions, or withdrawal at any time will not have any effect on the terms of your incarceration, case management plan, or decisions of release.

Participation in Other Studies: If you are already participating in another study at this time, you should tell the interviewer right away to decide if it is appropriate for you to participate in this study.

Confidentiality: **Any information that you provide us with or that is obtained from your file is valuable, and we will respect your privacy by keeping this information confidential. To protect confidentiality, a participant code will be assigned to all documents and information that you provide to us or that we retrieve from your file. All data will be placed in a locked cabinet, in a securely locked room, in the Psychology Department at the University of Western Ontario, where it can only be viewed by the Principal Investigator and other approved personnel. If the results of the study are published, names will not be used and no information that discloses your identity will be released or published. Five years after the study has been completed and the findings published, we will destroy the data you have provided us. Please note that if you would like to receive a copy of the overall results of the study please bring this to the attention of the interviewer, and this will be provided to you when it becomes available (please be aware this may take several months). Also, please be aware that the Research Ethics Board at The University of Western Ontario may contact you directly to ask about your participation in the study.**

Contact Persons: If you have any further questions about any aspect of this study, you may contact (at no charge, through the office of Dr. Rowntree). If you have questions about the conduct of this study or your rights as a research subject, you may contact (at no charge, through the office of Dr. Rowntree): Office of Research Ethics, The University of Western Ontario, 519-661-3036.

Compensation: Following the rules of the Correctional Service of Canada, no compensation is provided for participation in this study.

Appendix B

Consent Form

Consent Form

Project Title: An investigation of the cognitive, personality, and social risk factors associated with instrumental and reactive violence

Consent: By signing below, you are agreeing that you have read the Letter of Information (or had it read to you), the nature of the study has been explained to you, all questions have been answered to your satisfaction, and you agree to participate. *Please note that you do not waive any legal rights by signing this document.* You will be provided with a copy of this letter once it has been signed.

Participant's Full Name: _____

Participant's Signature: _____

Date: _____

Full Name of Person Obtaining Informed Consent: _____

Signature of Person Obtaining Informed Consent: _____

Date: _____

Appendix C

Ethics Approval from the Research Ethics Board at the University of Western Ontario

Office of Research Ethics
The University of Western Ontario
Room 4180 Support Services Building, London, ON, Canada N6A 5C1
Telephone: (519) 661-3036 Fax: (519) 850-2466 Email: ethics@uwo.ca
Website: www.uwo.ca/research/ethics

Western

Use of Human Subjects - Ethics Approval Notice

Principal Investigator: Dr. P.N.S. Hoaken
Review Number: 17412S **Review Level:** Full Board
Review Date: September 09, 2010 **Approved Local # of Participants:** 170
Protocol Title: An investigation of the cognitive, personality, and social risk factors associated with instrumental reactive violence.
Department and Institution: Psychology, University of Western Ontario
Sponsor: SSHRC-SOCIAL SCIENCE HUMANITIES RESEARCH COUNCIL
Ethics Approval Date: December 03, 2010 **Expiry Date:** March 31, 2012
Documents Reviewed and Approved: UWO Protocol, Letter of Information and Consent (main), Letter of Information and Consent (follow-up).
Documents Received for Information:

This is to notify you that The University of Western Ontario Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the applicable laws and regulations of Ontario has granted approval to the above named research study on the approval date noted above.

This approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the NMREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

During the course of the research, no deviations from, or changes to, the study or consent form may be initiated without prior written approval from the NMREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of monitor, telephone number). Expedited review of minor change(s) in ongoing studies will be considered. Subjects must receive a copy of the signed information/consent documentation.

Investigators must promptly also report to the NMREB:

a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected;
c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to this office for approval.

Members of the NMREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the NMREB.

Chair of NMREB: Dr. Riley Hinson
FDA Ref. #: IRB 00000941

Ethics Officer to Contact for Further Information			
☒ Grace Kelly (grace.kelly@uwo.ca)	☐ Janice Sutherland (jsutherl@uwo.ca)	☐ Elizabeth Wambolt (ewambolt@uwo.ca)	

This is an official document. Please retain the original in your files.

cc: ORE File

Appendix D

Ethics Approval from the Research Board at the Correctional Service of Canada

Correctional Service Canada / Service correctionnel Canada

PROTECTED / PROTÉGÉE A ☒ B ☐ C ☐ ONCE COMPLETED / UNE FOIS REMPLIE

RESEARCH APPLICATION AND UNDERTAKING
Research Branch

FORMULE DE DEMANDE DE RENSEIGNEMENTS À DES FINS DE RECHERCHE ET ENGAGEMENTS CORRÉLATIFS
Direction de la recherche

NOTE - SEE REVERSE FOR TERMS AND CONDITIONS

NOTE – VOIR LES MODALITÉS ET CONDITIONS AU VERSO

Date submitted / Date déposée: 2011 02 18

RESEARCH PROJECT – PROJET DE RECHERCHE

PROJECT TITLE - TITRE DU PROJET

An investigation of the cognitive, personality and social risk factors associated with instrumental and reactive violence.

PROJECT DESCRIPTION - DESCRIPTION DU PROJET

Purpose – But :

To test the generalizability of previous evidence for the divergent validity of instrumental and reactive violence.

Participants – Participants :

170 male offenders, residing at Fenbrook Institution will be divided into three groups and compared on 16 dependent variables.

TYPE/CLASS OF INFORMATION REQUESTED - TYPE/CATÉGORIE DES RENSEIGNEMENTS DEMANDÉS

Voluntary - Informed consent to participate – Consentement volontaire et éclairé pour participer

Criteria - Critères:

a. conformity with the principles of CCRA - conformité aux principes de la *LSCMLSC*
b. contribution to the achievement of the Mission and the priorities of CSC - contribution à la réalisation de la Mission et aux priorités du Service correctionnel du Canada;
c. compliance with the Tri-council's Policy Statement on Ethical Conduct for Research Involving Humans - conformité à l'énoncé de politique des trois Conseils intitulé Éthique de la recherche avec des êtres humains
d. level of disruption to the implementation of correctional objectives from an operational perspective - mesure dans laquelle le projet nuirait à la mise en œuvre des objectifs correctionnels sur le plan opérationnel
e. quality of the methodology - qualité de la méthode
f. qualifications of the researchers – compétences des chercheurs
g. anticipated benefit to corrections – avantages éventuels pour les services correctionnels
h. value for money - rapport valeur-coût

PRIMARY RESEARCHER – CHERCHEUR PRINCIPAL

a) Name and title - Nom et titre	Operational unit – Unité opér.	Sector - Secteur	Region - Région
Peter Hoaken, Ph.D.	Psychology dept University of Western Ontario		
b) Address - Adresse			c) Telephone number – N° de téléphone

OTHER RESEARCHERS – AUTRES CHERCHEURS

a) Name and affiliation – Nom et affiliation	e) Telephone number – N° de téléphone
b) Name and affiliation – Nom et affiliation	b) Telephone number – N° de téléphone
c) Name and affiliation – Nom et affiliation	c) Telephone number – N° de téléphone

APPROVAL - APPROBATION

Director General Research – Directeur général de la Recherche

Brian A. Grant

Date: MAR 2 0 2011

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Appendix E

Corroborating Data from an Additional Sample

As mentioned in the Methods section of this dissertation, supplementary analyses were conducted on an independent sample to test the generalizability of several findings. The sample was comprised of 148 offenders, who were recruited from two medium security federal penitentiaries (Fenbrook Institution and Bath Institution) during the previous year for a study on the influences of programming on EF. First, correlations were run between the relevant D-KEFS scores from the Colour-Word Interference Task and the Verbal Fluency task (see Table E1), and principal components analyses were used to reduce these scores into the same three components as was done in the Results (see Table E2). Unfortunately, the Trail-Making-test had not been administered to this sample of inmates, meaning that the score from this test could not be included in these analyses. Furthermore, offence data had not been obtained for this sample and so no information could be provided about these individuals' offence histories.

Table E1

Correlation coefficients between relevant D-KEFS scores from the second data set.

	1	2	3	4	5	6	7
1. $CWIT_{C3}$	–						
2. $CWIT_{C4}$	.57**	–					
3. TMT_{C4}[a]	–	–	–				
4. VF_{SA}	.27**	.31**	–	–			
5. $CWIT_{C4TE}$	.36**	.30**	–	.44**	–		
6. VF_{RE}	.00	-.01	–	.14	.12	–	
7. VF_{SE}	.03	.06	–	.24**	.15	.59**	–

Note. $N = 148$.

[a] this subtest was not administered in this study and so information on this variable could not be provided.

Table E2

Summary of Principal Component Analyses Results for D-KEFS Scores from the second data set.

Components and D-KEFS Scores	Factor Loadings
Inhibition Component	
$CWIT_{C3}$	.89
$CWIT_{C4}$	.89
Shifting Component	
VF_{SA}	.79
$CWIT_{C4TE}$	.79
Working Memory Component	
VF_{RE}	.75
VF_{SE}	.75

Note. $N = 148$.

As can be seen in Tables E1 and E2, the correlations between D-KEFS variables were similar to those presented in the main body of this dissertation, and the same three components (Inhibition, Shifting, and Working Memory) were able to be created. Next, descriptive statistics were generated for the KBIT-2, D-KEFS, and BRIEF-A scores (see table E3), and again these were comparable to the descriptive statistics generated from the sample used in the current study. Participants were once again characterized by subtle impairment on most of the intelligence and EF scores.

Correlations were run between the age of the offender, scores from the BRIEF, the D-KEFS component scores, and the BRIEF-A scales (see Table E4) and the second

data set yielded similar results as the ones obtained using the first data set (refer back to Table 12).

Table E3

Means, Standard Deviations, and Ranges of the KBIT-2, D-KEFS, and BRIEF-A scores from the second data set

Variable	Mean	SD	Range
$KBIT_{VER}$	89.69	11.34	49-128
$KBIT_{NONV}$	91.41	15.36	40-133
$KBIT_{TOT}$	89.84	12.18	54-126
$DKEFS_{INH}$			
$CWIT_{C3}$	10.13	2.30	1-15
$CWIT_{C4}$	8.77	3.24	1-15
$DKEFS_{SHIF}$			
TMT_{C4}	–	–	–
VF_{SA}	8.99	2.93	1-16
$CWIT_{C4TE}$	8.84	2.95	1-12
$DKEFS_{WM}$			
VF_{RE}	9.54	2.64	1-13
VF_{SLE}	10.23	2.16	1-13
$BRIEF_{INH}$	56.47	10.52	36-80
$BRIEF_{SHIF}$	54.08	9.51	39-84
$BRIEF_{WM}$	55.24	10.89	39-90

Note. $N = 148$. See Table 5 for list of abbreviations. KBIT scores are scaled scores which have a mean of 100 and a standard deviation of 15. All D-KEFS scores are scaled scores which have a mean of 10, a standard deviation of 3, and a maximum of 20. Finally, BRIEF-A scores are t-scores which have a mean of 50 and a standard deviation of 15. Higher scores on the KBIT and D-KEFS indicate better performance while and higher scores on the BRIEF indicate more dysfunction.

Table E4

Correlations among Age and Predictor Variables from the second data set

	1	2	3	4	5	6	7	8	9	10
1. Age	–									
2. $KBIT_{VER}$	.04	–								
3. $KBIT_{NONV}$	-.01	.39**	–							
4. $KBIT_{TOT}$	.06	.78**	.87**	–						
5. $DKEFS_{INH}$	-.12	.24**	.26**	.29**	–					
6. $DKEFS_{SHI}$	-.14	.40**	.25**	.37**	.53**	–				
7. $DKEFS_{WM}$	-.26**	-.03	.08	.03	.03*	.26**	–			
8. $BRIEF_{INH}$	.08	-.15	.05	-.03	-.10	-.08	.06	–		
9. $BRIEF_{SHI}$	-.11	-.12	.07	-.02	-.02	-.09	.03	.63**	–	
10. $BRIEF_{WM}$	-.11	-.12	.13	.04	.09	.08	.11	.59**	.63**	–

Note. $N = 148$. See Table 5 for list of abbreviations.

*$p < .05$, **$p < .01$

Finally, the factor structure of the relevant BRIEF-A scales were examined in order to see whether the factor structure remained in this second data set, as it had in the data used in the present study. A Maximum Likelihood Estimation CFA was conducted in order to test the fit of the data to the previously found BRIEF-A factor structure for the three interested scales (Inhibit, Shift, and Working Memory). Again, goodness of fit statistics (Standardized RMR, Non-Normed Fit Fit Index [NNFI], Comparative Fit Index [CFI], and Root Mean Square Error of Approximation [RMSEA] with 90% confidence intervals) were examined. Cut off values of $\leq .09$ indicate acceptable fit on the Standardized RMR. Cut off values $\geq .90$ on the NNFI and CFI and $\leq .08$ on the RMSEA indicate an acceptable fit (Hu & Bentler; Kline, 2005).

The CFA indicated a similarly acceptable fit to the second data set (Standardized RMR = .08; NNFI = .93; CFI = .92; RMSEA = .07 [90% C.I. = .06; .08]). Item factor loadings for the BRIEF Items are presented in Table E5 and are all significant at $p > .05$.

Table E5

Unstandardized Loadings (Standard Errors) and Standardized Loadings for 3-Factor Confirmatory Model of the Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A) Indices from the second data set

Index	Unstandardized Factor Loading	Standardized Factor Loading
Inhibit		
Item 5	.79 (.21)	.59
Item 16	1.45 (.25)	.66
Item 29	.88 (.18)	.51
Item 36	.40 (.12)	.33
Item 43	1.22 (.61)	.61
Item 55	1.62 (.25)	.79
Item 58	1.10 (.20)	.61
Item 73	1.00 (--)	.55
Shift		
Item 8	1.00 (--)	.53
Item 22	.96 (.22)	.58
Item 32	1.18 (.25)	.51
Item 44	1.24 (.26)	.54
Item 61	1.36 (.26)	.62
Item 67	1.43 (.28)	.60
Working Memory		
Item 4	1.00 (--)	.59
Item 11	.70 (.13)	.52
Item 17	.75 (.15)	.50
Item 26	1.07 (.18)	.61
Item 35	1.33 (.21)	.70
Item 46	1.06 (.18)	.61
Item 56	1.02 (.18)	.57
Item 68	.78 (.15)	.52

It appears that similar relationships exist between variables, the same three components can be created from the D-KEFS scores, and the factor structure of the three BRIEF-A scales indicates a ‘good fit’ regardless of the data set that is used.

Appendix F

Negative Binomial Regressions and Hierarchical Linear Models with Covariates

Negative binomial regressions were performed to observe the influence of intelligence and EF on the overall rates of total, nonviolent, violent, reactive violent, and instrumental violent offending. Table F1 shows the *z* values, the incident rate ratios, and the significance level for each predictor variable. As mentioned previously, time at risk was entered as an offset variable in all analyses. Age and total years incarcerated were included as covariates in all analyses and general intelligence (KBIT total) was entered as a covariate in analyses containing EF scores.

Four of the eleven predictors were statistically significant in the prediction of rate of total offending. Weaker performance on self-reported inhibition, shifting, working memory, and a lower score on the BRIEF composite score were associated with higher rates of total offending. Similarly, four of the eleven predictors were statistically significant in the prediction of rate of nonviolent offending. Weaker self-reported inhibition, shifting, working memory, and a lower composite score on the BRIEF were associated with higher rates of nonviolent offending.

Three of the eleven predictors were statistically significant in the prediction of rate of violent offending. Weaker performance on the verbal, nonverbal, and total scores from the KBIT were associated with higher rates of violent offending. One of the eleven predictors was statistically significant in the prediction of rate of reactive violent offending. Weaker performance on the inhibition score from the D-KEFS was associated with higher rates of reactive violent offending. Finally, two of the eleven predictors were statistically significant in the prediction of rate of instrumental violent offending.

Table F1

Negative Binomial Models for the Prediction of Rates of Offending from Intelligence and EF Measures with Covariates

	Total Offending		Nonviolent Offending		Violent Offending		Reactive Offending		Instrumental Offending	
Predictor	IRR (95% CI)	*Z*	IRR (95% CI)	*z*	IRR (95% CI)	*z*	IRR (95% CI)	*z*	IRR (95% CI)	*z*
KBIT Scores										
Verbal	0.89 (0.77-1.02)	-1.74	0.90 (0.75-1.10)	-1.03	0.80 (0.69-0.93)	-2.84*	0.91 (0.71-1.15)	-0.79	0.69 (0.56-0.85)	-3.50**
Nonverbal	0.95 (0.83-1.08)	-0.83	0.95 (0.80-1.14)	-0.53	0.84 (0.72-0.98)	-2.22*	0.87 (0.69-1.09)	-1.23	0.83 (0.67-1.03)	-1.73
Total	0.91 (0.79-1.03)	-1.45	0.92 (0.77-1.10)	-0.89	0.80 (0.69-0.93)	-2.91*	0.88 (0.70-1.10)	-1.12	0.73 (0.59-0.90)	-3.01*
D-KEFS Component Scores										
Inhibition	1.00 (0.85-1.17)	-0.02	1.01 (0.82-1.24)	0.06	0.91 (0.76-1.08)	-1.06	0.69 (0.53-0.89)	-2.79*	1.20 (0.92-1.54)	1.43
Shifting	1.06 (0.90-1.25)	-0.72	1.09 (0.88-1.37)	0.81	0.89 (0.75-1.07)	-1.24	0.79 (0.61-1.02)	-1.78	1.01 (0.78-1.30)	0.09
Working Memory	0.91 (0.81-1.03)	-1.51	0.88 (0.75-1.02)	-1.60	1.16 (0.99-1.37)	1.86	1.15 (0.90-1.47)	1.09	1.12 (0.91-1.39)	1.09
D-KEFS Composite Score	0.96 (0.82-1.11)	-0.59	0.94 (0.77-1.14)	-0.61	0.99 (0.83-1.19)	-0.08	0.80 (0.61-1.06)	-1.56	1.17 (0.91-1.51)	1.25
BRIEF-A Scales										
Inhibition	0.77 (0.68-0.87)	-4.22**	0.71 (0.60-0.83)	-4.16**	1.11 (0.95-1.29)	1.36	1.09 (0.87-1.36)	0.72	1.18 (0.96-1.46)	1.59
Shifting	0.77 (0.68-0.87)	-4.13**	0.73 (0.61-0.86)	-3.69**	1.00 (0.86-1.17)	0.02	0.93 (0.73-1.18)	-0.61	1.13 (0.92-1.40)	1.16
Working Memory	0.82 (0.72-0.93)	-3.00*	0.80 (0.67-0.94)	-2.68*	1.00 (0.87-1.17)	0.00	0.87 (0.68-1.10)	-1.17	1.17 (0.95-1.44)	1.44
BRIEF Composite Score	0.76 (0.67-0.86)	-4.42**	0.71 (0.60-0.84)	-4.10**	1.04 (0.89-1.215)	0.53	0.95 (0.76-1.21)	-0.39	1.19 (0.96-1.46)	1.60

Note. See Table 5 for list of abbreviations. IRR = incidence rate ratio (i.e., the exponentiated unstandardized regression coefficient, e^b). Years at risk of offending was included as the offset variable in all models, transforming the predicted outcomes from frequencies of offending to rates of offending. Age and total years incarcerated were entered as covariates in all analyses. In analyses including EF scores, the KBIT total score was entered as a covariate. $z = b/SE$. For all significant effects, the likelihood ratio chi-square ($LR\ \chi^2$) for the corresponding model was also significant ($p < .05$). $N = 151$. All intelligence and executive functioning scores are *z*-scores with a mean of 0, a standard deviation of 1.
*$p < .05$. **$p < .01$.

Weaker performance on the verbal and total scores from the KBIT was associated with higher rates of instrumental violent offending.

The estimates from the models of the Level 1 predictors are presented in Table F2. Both intoxication and severity of violence were entered grand-mean centered and statistically significant in predicting the odds of committing a reactive violent offence versus an instrumental violent offence. The results indicate that the odds of an inmate having committed a reactive violent offence versus an instrumental violent offence are 2.85 times greater when the inmate was intoxicated during the offence as compared to when they were not intoxicated. The results also indicate that the odds of a violent offence being reactive versus instrumental are 1.33 times (i.e., 1/.75) greater when the severity of the violent offence is one level lower (e.g., a severity of 5 rather than a severity of 6). Given these findings, intoxication and severity of violence were entered as Level-1 covariates in models contained in Tables F3 examining the influence of Level-2 predictors on the odds of committing a reactive versus instrumental violent offence.

Table F2

Individual Hierarchical Linear Models (HLM) with Level 1 Predictors for Reactive vs. Instrumental violence.

Predictor	β	Exp(β) [95% Conf. Interval]	Robust Std. Error
Severity of Violence	-.29*	.75 [.60-.94]	.11
Intoxication During the Violent Offence	1.05**	2.85 [1.51-5.37]	.32

Note. All values are from 'robust standard errors'
*$p < .05$, **$p < .01$

Table F3

Hierarchical Linear Models for the Prediction of the Odds of Committing Violent versus Nonviolent and Reactive violent versus Instrumental violent offences from Intelligence and EF Measures with Covariates.

	Violent[a] vs. Nonviolent Offending[b]			Reactive[a] vs. Instrumental Offending[b]		
Predictor	OR (95% CI)	β	Robust Std. Error	OR (95% CI)	β	Robust Std. Error
KBIT Scores						
Verbal	0.86 (0.61-1.21)	-0.15	.17	1.45 (1.05-1.01)	0.37*	.17
Nonverbal	0.83 (0.62-1.12)	-0.19	.15	1.04 (0.75-1.45)	0.04	.17
Total	0.83 (0.62-1.12)	-0.19	.15	1.25 (0.89-1.75)	0.26	.17
D-KEFS Component Scores						
Inhibition	0.91 (0.64-1.29)	-0.10	.18	0.50 (0.34-0.74)	-0.69**	.20
Shifting	0.80 (0.58-1.10)	-0.23	.16	0.77 (0.51-1.18)	-0.28	.20
Working Memory	1.43 (1.10-1.86)	0.36*	.13	0.99 (0.67-1.46)	-0.01	.19
D-KEFS Composite Score	1.08 (0.76-1.55)	0.08	.18	0.61 (0.40-0.93)	-0.50*	.22
BRIEF-A Scales						
Inhibition	1.71 (1.34-2.11)	0.53**	.12	1.00 (0.66-1.25)	-0.19	.16
Shifting	1.49 (1.13-1.98)	0.40*	.14	0.83 (0.60-1.45)	-0.21	.16
Working Memory	1.36 (1.02-1.86)	0.31*	.16	0.65 (1.03-2.29)	-0.43*	.20
BRIEF Composite Score	1.61 (1.23-2.11)	0.48*	.14	0.77 (0.55-1.09)	-0.26	.17

Note. See Table 5 for list of abbreviations. OR = odds ratio. Age and total years incarcerated were entered as Level 2covariates in all analyses. In analyses including EF scores, the KBIT total score was entered as a covariate as well. In the reactive vs. instrumental analyses, intoxication and severity of violence also served as Level 1 covariates.

[a] indicates the estimated offence type and [b] indicates the reference category. All intelligence and executive functioning scores are z-scores with a mean of 0, a standard deviation of 1.

*$p < .05$, **$p < .01$

Violent vs. Nonviolent – Level 1 N = 1415, Level 2 N = 151; Reactive vs. Instrumental – Level 1 N = 240, Level 2 N = 113

The estimates from the models of the Level-2 predictors are presented in Table F3. All predictors were entered into the models grand-mean centered. Age and total years incarcerated were entered as Level 2 covariates in all analyses. In analyses including EF scores, general intelligence (KBIT total score) was entered as a covariate as well. In the reactive versus instrumental analyses, intoxication and severity of violence also served as Level 1 covariates.

Five of the eleven predictors were statistically significant in predicting the odds of committing a violent offence versus a nonviolent offence. The results indicate the odds of an inmate having committed a violent offence versus a nonviolent offence were 1.43 times greater when the inmate scored 1 standard deviation higher on the working memory component score from the D-KEFS than an inmate who scored at the mean. Similarly, the odds of an inmate having committed a violent offence versus a nonviolent offence increased as self-reported inhibition (OR = 1.71), shifting (OR = 1.49), working memory (OR = 1.36), or the composite score from the BRIEF-A (OR = 1.61) increased.

The odds of an inmate having committed a reactive violent offence versus an instrumental violent offence increased as performance on the Verbal Subtest of the KBIT increased (OR = 1.45), performance on the inhibit component score from the D-KEFS decreased (OR = .50), self-reported working memory from the BRIEF-A decreased (OR = .61), and as the composite score from the BRIEF-A decreased (OR = .65).

MEGAN HANCOCK, M.Sc.

Curriculum Vitae

EDUCATION

In Progress **Doctor of Philosophy, Clinical Psychology**
University of Western Ontario, London, Ontario
Advisor: Peter Hoaken, Ph.D., C.Psych.
Dissertation: The unique influences of executive functioning on reactive and instrumental forms of violent behaviour

2009 **Master of Science, Clinical Psychology**
University of Western Ontario, London, Ontario
Advisor: Peter Hoaken, Ph.D., C.Psych.
Thesis: The ability of executive functioning to predict frequency and severity of violent offending

2007 **Bachelor of Science, Honours Psychology with Distinction**
University of Toronto, Scarborough, Ontario
Advisor: David Nussbaum, Ph.D., C.Psych.
Thesis: The ability of the Nussbaum Fitness Questionnaire (NFQ) to assess fitness to stand trial

TEACHING AND SUPERVISION EXPERIENCE

Teaching Assistantships:

- Introduction to Psychology (2010–2013)
- Human Adjustment (2012)
- The Psychology of People, Work, and Organization (2011)
- Adult Psychopathology (2009–2010)
- Health Psychology (2009)
- Research Methods in Psychology – Lab Instructor (2008–2009)
- Human Sexuality (2007)

Supervision Experience:

Primary Clinical Supervisor, Thames Valley District School Board (2012)

- Roles: supervised a second-year Master's student from the Clinical Psychology Program in her initial assessment practicum; observed and provided guidance during clinical interviewing and cognitive testing; provided feedback regarding test

administration and report writing; assisted in providing feedback to children, their families, and school staff

Honors Thesis Research Advisor, University of Western Ontario (2010–2011)

- Project title: An examination of executive functioning and social information processing: Associations with various forms of aggressive behaviour

Honors Thesis Research Advisor, University of Western Ontario (2009–2010)

- Project title: Executive functioning and violence

PUBLICATIONS AND PRESENTATIONS

Publications:

Tapscott, J. L., **Hancock, M**., & Hoaken, P. N. S. (2012). Severity and rates of reactive and instrumental violent offending: Evidence of divergent validity of subtypes of violence from an adult forensic sample. *Criminal Justice and Behavior*, *39*, 202-219.

Hoaken, P. N. S., Hamill, V. L., Ross, E. H., **Hancock, M.**, Lau, M. J., & Tapscott, J. L. (2012). Drug use and abuse and human aggressive behavior. In J. Verster, K. Brady, E. Strain, M. Galanter, & P. Conrod (Eds.), *Drug Abuse and Addiction in Medical Illness: Causes, Consequences, and Treatment* (pp. 467-477). USA: Springer/Human Press.

[4]**Hancock, M**., Tapscott, J. L., & Hoaken, P. N. S. (2010). Role of executive functioning in predicting frequency and severity of violence. *Aggressive Behavior, 36,* 338-349.

Nussbaum, D., **Hancock, M.**, Turner, I., Arrowood, J., & Melodick, S. (2008). Fitness/competency to stand trial: A conceptual overview, review of existing instruments, and cross-validation of the Nussbaum fitness questionnaire. *Brief Treatment and Crisis Intervention. Special Issue: Forensic Psychiatry & Forensic Mental Health, 8*, 43-72.

Conference Proceedings:

Hancock, M., Tapscott, J. L., & Hoaken, P.N.S. (2012, March). *The influences of executive functioning on reactive and instrumental violence*. Paper session presented at the annual American Psychology Law Society Conference, San Juan, Puerto Rico.

Tapscott, J. L., **Hancock, M**., & Hoaken, P. N. S. (2010, March). *Establishing the validity of the distinction between instrumental and reactive violent offending*. Paper session presented at the annual American Psychology-Law Society Conference, Vancouver, BC.

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[4] This publication was selected for inclusion by *Crime Times*, a quarterly international newsletter covering articles in the scientific literature "linking brain dysfunction to disordered/criminal/psychopathic behaviour."

Hancock, M., Tapscott, J. L., & Hoaken, P. N. S. (2010, March). *The role of executive dysfunction in predicting frequency of violence: A potential avenue for rehabilitation*. Paper session presented at the annual American Psychology-Law Society Conference, Vancouver, BC.

Hancock, M., & Hoaken, P. N. S. (2009, June*). Executive dysfunction in violent offenders: A potential avenue for rehabilitation*. Poster session presented at the annual meeting of the Canadian Psychological Association, Montreal, QC.

Hancock, M. & Nussbaum, D. (2007, April). *The ability of the Nussbaum Fitness Questionnaire to assess fitness to stand trial*. Poster session presented at the annual University of Toronto, Scarborough Campus, Honors Thesis Conference, Scarborough, ON.

Other Professional Presentations:

Hancock, M. (February, 2009 & 2010). *The road to success: How to promote healthy brain development in children*. Talk presented at the public library through the "Finding your Way: Psychology in Everyday Life" lecture series.

Hancock, M. & Tobin, J. (January, 2010). *Advocacy through Action: Students Bringing Psychology to our Community*. Talk presented to the London Regional Psychological Association.

Hancock, M. & Tapscott, J. (October, 2009). *Rolling with the punches: An endeavour to measure psychopathy and executive functioning in a population of violent offenders*. Talk presented to faculty and graduate students of the Western's Psychology Department.

Hancock, M. & Tapscott, J. (November, 2009). *Rolling with the punches: Two students' experiences applying to graduate school and conducting research with violent offenders.* Talk presented to students in Western's Psychology Association.

ACADEMIC AWARDS AND HONOURS

Date	Award	Institution	Value
2012 – 2013	Doctoral Fellowship Award	Social Sciences and Humanities Research Council of Canada (SSHRC)	$20,000
2012 – 2013	Ontario Graduate Scholarship (declined)	Ontario Ministry of Training, Colleges and Universities	$15,000
2011 – 2012	Ontario Graduate Scholarship	Ontario Ministry of Training, Colleges and Universities	$15,000
2011	Graduate Thesis Research Award	University of Western Ontario	$600
2010 – 2011	Ontario Graduate Scholarship	Ontario Ministry of Training, Colleges and Universities	$15,000
2010	Graduate Alumni Scholarship	University of Western Ontario	$2,000
2009	Graduate Alumni Scholarship	University of Western Ontario	$2,000

2008 – 2009	Graduate Student Teaching Award (nominated)	University of Western Ontario	n/a
2008 – 2009	Canada Graduate Scholarship	Social Sciences and Humanities Research Council of Canada (SSHRC)	$17,500
2008	Operating Grant: Internal Competition	Social Sciences and Humanities Research Council of Canada (SSHRC)	$4,650
2008	Ralph S. Devereux Award in Psychology	University of Western Ontario	$1,000
2006	University In-Course Scholarship	University of Toronto	$750

PROFESSIONAL SERVICE

Executive Committee: London Regional Psychological Association (LRPA, 2012–Present)

- Student Representative on LRPA which involves attending LRPA meetings and talks, providing information to the clinical psychology students about events offered through LRPA, and liaising between LRPA and the students

Advocacy Through Action (AtoA, 2008–Present)

- AtoA is a student-run initiative that strives to make research and resources on psychological issues available to the community. Each year our group offers a series of public lectures, ("Finding your Way: Psychology in Everyday Life") on various topics related to mental health and well-being. In addition to being an active member of this group since 2008, I have also held the following leadership positions:
- **Co-chair - Finding Your Way: Psychology in Everyday Life Lecture Series** (2010–2012): Responsible for overseeing the duties of various AtoA committees, coordinating AtoA members and meetings; applying for external funding to purchase materials; liaising with the library regarding the scheduling of the series
- **Co-chair - Marketing Committee** (2009-2011): responsible for distributing information about the series to various community agencies and contacting media outlets, conducting interviews, and writing articles about the series

PROFESSIONAL MEMBERSHIPS

- London Regional Psychological Association (Student Member, 2010–Present)
- American Psychology-Law Society (Student Member, 2009–Present)
- Canadian Psychological Association (Student Affiliate, 2006–Present)