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Criminal Behavior and Self-Control: Using the Dual Component Theory of Inhibition Regulation to Advance Self-Control and Crime Research

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Abstract Predicting crime remains a central issue for social science research. Perspectives that consider the role of self-control have added greatly to our ability to explain and predict criminal behavior. However, this approach has been narrowly focused on the role of individual differences in trait self-control, limiting the potential of this approach to integrate a range of findings in the literature. To realize the full potential of the self-control construct to explain criminal behavior, we use the Dual Component Theory of Inhibition Regulation (DCTIR). We discuss how the model can account for a number of findings, including patterns of recidivism, age differences, and the role of socioeconomic factors in crime. The DCTIR provides a framework for integrating these findings, generating new predictions, and ultimately better predicting criminal behavior.

Keywords Self-control · Inhibition regulation · Crime · Criminal behavior · DCTIR

Criminal behavior is behavior that is deviant, unacceptable, and has been codified as unlawful. It is important to understand and predict criminal behavior for scientists and lay persons alike. Indeed, Anderson (1999) found that the net annual cost burden of crime, across the United States, exceeded one trillion dollars. Therefore, research that helps to understand and ultimately reduce criminal behavior is of great importance. An important approach to the understanding of crime has involved examining the role of self-control (Pratt and Cullen 2000). This perspective has largely taken an individual difference approach, viewing self-control as a trait that is lacking in individuals prone to committing crime. Additionally, this research has proceeded without a theory of the mechanism of self-control. As a result, self-control approaches to understanding crime have been rather limited in scope. In this paper, we discuss the Dual Component Theory of Inhibition Regulation (DCTIR), which proposes a specific mechanism of self-control. We then discuss how individual differences as well as situational and societal factors can affect the operation of self-control, accounting for a wide-range of criminal behavior. Thus, the DCTIR provides a framework for advancing research and understanding of criminal behavior.

Self-Control

Psychologists have long been interested in self-control, including the possibility that it plays a role in criminal behavior. However, it was Gottfredson and Hirschi's (1990) general theory of crime that highlighted the importance of self-control for understanding crime. The general theory of crime argues that self-control can explain a wide range of behavior, including all types of crime (Gottfredson and Hirschi 1990). According to the theory, engaging in crime is a form of immediate gratification. Self-control is required to prevent succumbing to these short-term desires. Thus, individuals who have an impulsive personality and lack strong social bonds are more likely to exhibit criminal behavior when the opportunity arises.

Although there is a large literature on self-control, there is still a lack of consensus on the definition of this construct. Hirschi and Gottfredson (1994) defined self-control as the "tendency to avoid acts whose long-term costs exceed their momentary advantages" (p. 3). They argued that self-control

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involves six elements: impulsivity, preference for simple tasks, risk-seeking, preference for physical activities, self-centeredness, and a volatile temper. This definition of self-control has been criticized for being tautological (Arneklev et al. 2006). In other words, it should not be surprising that a volatile temper and risk-taking predict criminal behavior, as those features tend to define many crimes. Additionally, this definition also includes constructs (e.g., self-centeredness) that most researchers would argue are separate from self-control. Thus, the definition of self-control in the general theory of crime is problematic.

Although Gottfredson and Hirschi's definition can be criticized, it is not as if there is an agreed upon definition of self-control or a consensus on the best way to measure self-control. Baumeister et al. (2007) argue that self-control is the mental process that allows people to override their thoughts, emotions, and behaviors in order to keep in line with overarching goals, but these researchers usually focus on inhibition of impulses as the means to do so. Fujita (2011) argues that self-control is not just inhibition of impulses but may be the process of advancing distal, rather than proximal, motivations when there is competition between the two. Miyake et al. (2000) show that inhibition is related to other "executive functions" like task switching and working memory, but is a distinct construct. Self-control is clearly a complex construct. Although self-control may be multifaceted, most researchers do agree that the *heart* of self-control is inhibitory cognitive control (Inzlicht et al. 2014). That is, the heart of self-control is inhibiting responses motivated by short-term rewards. In addition to this view of self-control being more conceptually sound and more easily tested, it also is preferable because it avoids any tautology when predicting crime.

A second issue in this approach has been that researchers have not proposed a mechanism that produces self-control related criminal behavior. Self-control is simply described as a tendency or trait. As a result, the applicability of the self-control approach is somewhat limited. To truly understand self-control, as well as its relationship to criminal behavior, we must have an explicit theory of the mechanism that produces self-control behavior. There are at least three benefits to this approach. First, it allows for more specific predictions concerning the role of self-control in criminal behavior. Second, it is allows for a more broad integration of findings from different literatures. Third, it can generate new ways to think about the role of self-control in criminal behavior.

A final issue is that Gottfredson and Hirschi's (1990) general theory of crime has argued that socialization, familial socialization particularly, is the main contributor to the development of differences in self-control. Indeed, evidence does suggest that social factors play a role in the development of self-control (Pratt et al. 2004). However, empirically, social factors are only one part of the story. Biological factors, including neuropsychological deficits, have shown to contribute to the etiology of self-control and criminal behavior (Wright and Beaver 2005; Ratchford and Beaver 2009; Jorgensen et al. 2016). Thus, self-control perspectives such as the general theory of crime are ill suited in integrating biological and neuroscientific findings. For example, recent research has linked the heritability of self-control with antisocial outcomes and the P300 brain response (Yancey et al. 2013). The P300 is a positive deflection brain response that is typically elicited through infrequent, task-relevant stimuli. A reduction in amplitude of the P300 response has been linked with substance use problems and antisocial behaviors (Porjesz et al. 1980; Iacono et al. 2002). Yancey et al. (2013) found that higher trait disinhibition scores mediated the relationship between antisocial behavior/substance use scores and P300 response. They also found a genetic link to trait disinhibition and antisocial/addictive problems. Furthermore, the observed association between disinhibition scores and antisocial behaviors/substance use scores could be attributed to common genetic effects and these effects were able to account for the P300 relationships. In other words, there was a strong genetic relationship to the observed findings. Such evidence is difficult to integrate with the view on the etiology of self-control from a general theory of crime approach, where familial socialization effects are primarily considered.

We have elsewhere proposed a mechanistic account of the operation of self-control, called the dual component theory of inhibition regulation, which addresses these shortcomings (DCTIR; Reynolds and McCrea 2016). We first summarize the theory, and then consider how this theory can contribute to our understanding of criminal behavior.

The DCTIR

The DCTIR is a domain specific, modular theory (Reynolds and McCrea 2016). A module is a mechanism designed to carry out a specific function (Ermer et al. 2007; Kurzban 2010; Pinker 1997). Although there are some domain general mechanisms, the assumption of the DCTIR is that there are numerous domain-specific, functionally specialized mechanisms that make up the mind. This view is consistent with the evolutionary psychology approach (Ermer et al. 2007; Kurzban 2010; Pinker 1997).

The DCTIR argues that self-control is accomplished using one of these modules. The DCTIR defines self-control as inhibition regulation, "the process by which computational mechanisms produce and adjust inhibition effort" (Reynolds and McCrea 2016, p. 20). The function of this mechanism is to inhibit other modules that motivate immediate, prepotent, or impulsive behavior in search of short-term rewards. The inhibition module likely evolved to regulate these impulsive modules that may have conflicting outcomes with other, more

long-term systems. For example, impulsive modules promoting aggressive behavior may conflict with systems designed for maintaining long-term interpersonal relationships.

There are two primary components of the inhibition module: a monitor and a threshold (see Fig. 1). The monitor component determines when and how much to inhibit. The threshold component determines when inhibition of the impulsive modules should stop. The entire module is conceptualized as an algorithm or a set of decision rules.

The monitor component includes two subroutines. The detection subroutines detect the activation of a specific impulsive module, which allows the system to inhibit it. Thus the detection subroutines essentially ask "does module 'A' need to be inhibited?" (see Fig. 2). The detection subroutines thus solve the problem of identifying situations requiring self-control. A detection subroutine is created whenever there is a conflict between an impulsive module and a long-term module. If a detection subroutine is not activated, then no signal is sent, and inhibition will not be applied. If a detection subroutine is activated, a signal is then sent to the next subroutine, the measurement subroutine.

In the measurement subroutine, a measure of the signal (i.e., the output) from the detected module is taken. These computations are represented as costs, motivation, or temptation. The measurement subroutine determines how tempting the situation is. Thus a more tempting situation will register a greater signal in the measurement subroutine compared to a less tempting situation. As the measurement subroutine is measuring temptation, it activates the next step, the inhibit subroutine. The inhibit subroutine produces inhibition effort. The level of inhibition effort is determined by the level of measured temptation. In other words, a greater temptation registered in the measurement subroutine means that greater inhibition effort will be produced by the inhibit subroutine. The output that is produced by the inhibit subroutine is the final output from the monitor component. The next component is the threshold.

Threshold is the individual's tolerance for applying inhibitory effort. As such, there are likely to be large individual differences in threshold (see Figs. 3 and 4). That is, some individuals will have a low tolerance for applying inhibitory effort and others will have a high tolerance. As threshold is processing the inhibitory effort signal sent from the monitor, one of two outcomes is possible. As long as the threshold is not met, a signal is sent from the threshold component inhibiting the impulsive module. If there is greater or more sustained inhibition effort, threshold is more likely to be met. If the threshold is met then the inhibition module stops inhibiting, and the impulsive module carries through with its output (thus an inhibition termination effect). That is, if threshold is met, the person will engage in the impulsive behavior. Theoretically, threshold is measured through an assessment of an individual's self-control behavior for a variety of goals, their level of temptation applied to those goals, and the inhibitory effort used to stop those impulsive behaviors, as well as a person's behavioral enactment. A more simple measure of chronic inhibitory level may be attained through trait measures in self-control or, from a neuropsychological perspective, trait measures in inhibitory executive functioning, as well as strength of activity in prefrontal brain regions (e.g., ventrolateral prefrontal cortex). In sum, the likelihood that an individual will stop inhibiting and engage in the impulsive behavior is a function of the amount and duration of temptation, and their tolerance of inhibition. By describing the mechanism that produces self-controlled behavior, the DCTIR can provide a more nuanced understanding of the self-control crime relationship.

The DCTIR and Criminal Behavior

Using the DCTIR as the primary theory of self-control with which to examine the relationship with crime allows for improved predictions, improved integration of findings, and creates new avenues of research. According to the DCTIR, there are at least three ways in which the inhibition module can affect criminal behavior: no detection subroutine for the criminal behavior exists, the modules involved with the criminal behavior register high costs or temptation, or individuals have a low threshold for inhibition.

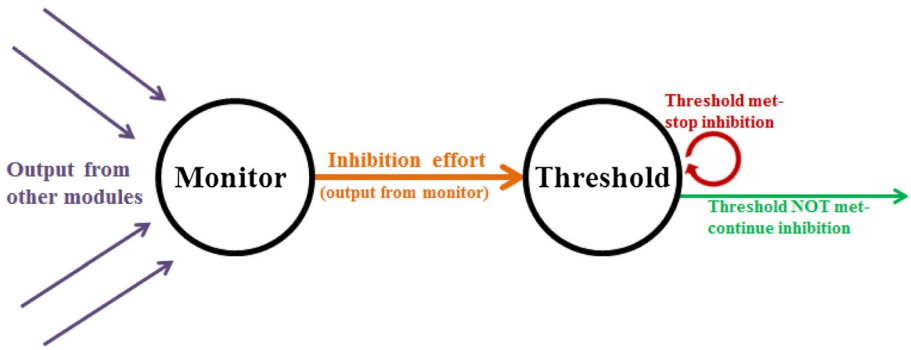

Fig. 1 A model of the mechanism proposed by the dual component theory of inhibition regulation (Reynolds and McCrea 2016, p. 10)

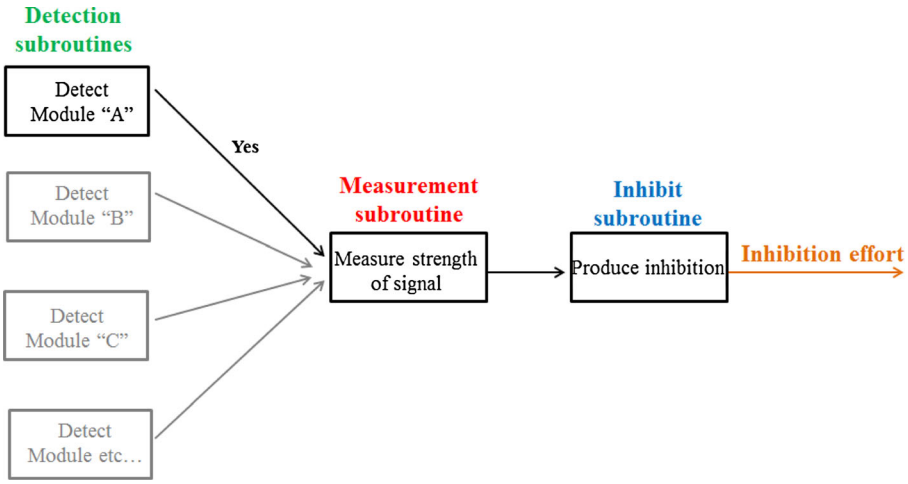

Fig. 2 A model of the monitor where specifically module "A" has been detected (Reynolds and McCrea 2016, p. 11)

Role of the Detection Subroutine

According to the DCTIR, the first explanation for criminal behavior would be cases in which the individual does not view the behavior as requiring self-control. In the language of the DCTIR, the individual has no detection subroutine for inhibiting the modules that produce the criminal behavior. There are likely modules whose function it is to produce behaviors directly or indirectly related to crime. These could include aggression modules, deception modules, and sexual coercion modules. If an individual has a corresponding detection subroutine, it will become activated when it detects the output of the module. Thus, a detection subroutine for aggression will be activated when it detects the output of the aggression module. Once detected, these behaviors can be inhibited. However, not all individuals are likely to have a detection subroutine for a given behavior. For example, some individuals do not attempt to regulate their diet, and thus do not have a detection subroutine for eating high calorie food. Likewise, some individuals may not attempt to regulate their aggressive or sexual behavior, and thus do not have a detection subroutine for these behaviors. As a result, they will not engage the inhibitory module, and will instead carry through with the behavior. The DCTIR would therefore predict that only individuals who are tempted to commit crime and believe they should not commit crime will attempt to resist that impulse. There are several patterns of criminal behavior that can be explained in this manner. For example, individuals with Machiavellian, sadistic, or psychopathic traits have little empathy for victims and thus would not attempt to restrain aggressive behavior (Salekin 2008). Psychopathic traits are consistent predictors of recidivism, even controlling for demographic variables and criminal history (Hemphill et al. 1998). Beyond personality differences, individuals may learn that criminal behaviors are normative or even rewarded. For example, gang members may be rewarded for engaging in crimes (Alleyne et al. 2014; Hughes 2013; Densley 2014). Even in the broader society, some acts are considered acceptable despite being prohibited. Subjective norms influence a range of behaviors including jaywalking, littering, speeding, and downloading copyrighted material (Keizer et al. 2008; Keuschnigg and Wolbring 2015; Neri 2005; Parker et al. 1992; Cox et al. 2010; Depoorter et al. 2005)

Role of the Measurement Subroutine

Assuming individuals do have a corresponding detection subroutine, they will attempt to inhibit the potential criminal behavior. The DCTIR holds that the measurement subroutine will register the degree of temptation to engage in the behavior so that the system can produce a corresponding level of inhibitory effort. Thus, the likelihood that an individual will engage in the behavior is determined in part by how tempting or costly modules are perceived to be. Just as there are individual differences in the detection subroutines, there are likely to be individual differences in the temptation to engage in the

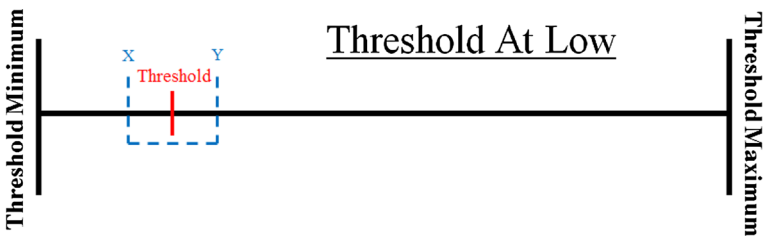

Fig. 3 Model of the threshold component from someone with a low threshold (Reynolds and McCrea 2016, p. 12)

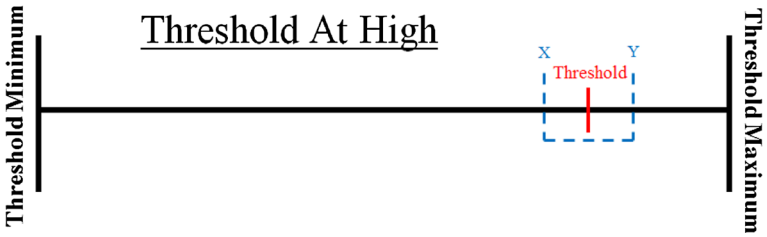

Fig. 4 Model of the threshold component from someone with a high threshold (Reynolds and McCrea 2016, p. 12)

behavior. Thus, two individuals may have a detection subroutine for a crime-related module (s), but the individuals could differ in how costly or tempting that module is perceived. For example, Jeff and Brian both have detection subroutines for crime-related modules, but Brian is highly tempted by high-end electronics. Jeff is only mildly tempted by such crime-related stimuli. If both individuals have the opportunity to steal high-end electronics, Brian will register a greater signal in the measurement subroutine indicating greater temptation. He will thus be more likely to eventually stop inhibiting and steal the electronics. According to the DCTIR, variations in the level of crime-related temptation predict the likelihood of eventually committing crime. In other words, an increase in the temptation to engage in crime should predict criminal behavior.

A number of findings in the literature support this view. For example, individual differences in trait impulsivity predict likelihood of engaging in criminal behavior (Vazsonyi et al. 2006; Zimmerman 2010). However, this perspective suggests that the level of temptation experienced will be specific to that domain. That is, a given individual may be more tempted to engage in certain types of crimes than others. Indeed, past offenses are predictive of future offenses of the same type (Hanson et al. 2010).

Relatedly, the DCTIR predicts that there will be variation in the temptation of the situation. More tempting situations are more likely to cause the individual to stop inhibiting, as the individual is more likely to meet threshold. A straightforward prediction of the model is that individuals will be more tempted to steal highly valuable goods. Criminal behavior should also be more likely for highly salient temptations. For example, individuals may steal goods that are more accessible or from locations that are more familiar. Similarly, many violent crimes are not planned but involve a "heat of the moment" response to a provocation (Wolfgang and Ferracuti 1969; Solway et al. 1981; Fox et al. 2012; Navis et al. 2008).

A common feature of crime is the presence of alcohol. For example, McClelland and Teplin (2001) examined 2365 police citizen encounters and found that 43.3% of violent crime and sexual assaults and 46.1% of public order crimes involved alcohol. Results also indicated that suspects were more likely to be intoxicated than victims. Thus, it is important to understand the relationship between alcohol and criminal behavior. An early explanation for such behavior was disinhibition theory, which argued that intoxicated individuals were not able to control themselves. However, this view did not receive empirical support (MacAndrew and Edgerton 1969). A theory with better support is alcohol myopia, which argues that intoxicated individuals respond to a restricted set of immediate cues while also ignoring remote cues indicating potential consequences (Griffin et al. 2010). Using the DCTIR, alcohol myopia and the relationship between crime and alcohol can be explained. According to the DCTIR, responding to a restricted set of immediate cues causes the modules that are being inhibited to be more responsive and reward-sensitive. In other words, the immediate cues are more powerful when individuals are intoxicated. A greater signal is therefore registered in the measurement subroutine, and a quicker inhibition termination effect is likely. To give an example, suppose George is intoxicated and gets into an altercation. George need not be an aggressive person to act aggressively in this situation. Alcohol may cause George to respond more strongly to the immediate "fight" cues, resulting in a larger temptation to aggress. George is likely to meet threshold quicker, and to subsequently commit a violent crime.

Role of Threshold Component

When individuals reach threshold, they will stop inhibiting potentially criminal behavior. Thus, the DCTIR posits that individual differences in the "chronic" level of inhibitory tolerance, or threshold, will also influence the likelihood of committing a crime. Individuals with a lower threshold will not inhibit for as long a period of time as those with a higher threshold. Similarly, those with a lower threshold will be more likely to carry-out very tempting behaviors because they will meet threshold more quickly. In either case, people with a lower threshold will be more likely to carry through with the criminal act. Effects of trait self-control on criminal behavior can be conceptualized as reflecting differences in threshold.

Mead et al. (2009) used the resource, or strength, model to understand self-control and cheating behavior. This model holds that initial acts of self-control deplete a limited resource. Subsequent attempts at self-control are undermined. The term "ego depletion" has been used to describe this effect. The DCITR instead uses the term "inhibition termination effect" to describe this phenomenon, as inhibitory control stops when threshold is met rather than when a resource is exhausted.

Mead et al. (2009) assigned participants to engage in either a self-control task or a control task. Subsequently, participants were given a set of math problems to solve. Performance on the task determined how much money they could earn in the experiment. Using self-scored versus experiment scored conditions (making cheating possible in the self-scored condition), Mead et al. (2009) found that self-control was not associated with performance or mood. However, in the self-control condition, participants claimed 25% more correct answers than did those in the control condition. Gino et al. (2011) replicated these findings, showing increased cheating after participants completed a task requiring self-control. Importantly, an advantage of Gino et al. (2011) was that the actual number of correct responses for each participant was attained, thus not requiring self-scored versus experimenter-scored conditions. This was accomplished by recording on a computer how many math problems they actually solved, but paying participants based on how many the participants claimed on a collection slip. Finally, Muraven et al. (2006) found that self-control increased cheating and that trait self-control was negatively related to the level of cheating. Although cheating is not always a criminal behavior, cheating as measured on these tasks is correlated with delinquency and deviant behavior (Reynolds and McCrea 2015). Thus, these studies suggest that not only is trait self-control related to criminal and deviant behavior, but that variations in state self-control could influence the tendency to engage in such behavior.

Trait self-control is predicted in the DCTIR to be partly a manifestation of threshold. This explains the relative stability in self-control and the moderating effects of trait self-control. Thus, the typical criminological study which involves trait measures of criminal behavior and self-control can be explained mechanistically, in terms of level of threshold. Ego depletion effects are also integrated using threshold. In studies such as Mead et al. (2009), state (as opposed to trait) variations predict cheating behavior. This line of research demonstrates that prior attempts at self-control can affect future attempts at self-control (see also Gino et al. 2011; Muraven et al. 2006). The DCTIR provides a mechanistic explanation that individuals who stop inhibiting because of the prior use of self-control have met threshold.

These effects are not limited to stealing money, however. Studies similar to Gino et al. (2011) have been conducted on self-control and aggression and may be applicable to certain types of homicides. DeWall et al. (2007) investigated ego depletion effects and aggression, as well as the role of trait self-control. In multiple experiments, participants engaged in a self-control task or control, and completed measures of aggression. For example, participants had to imagine a hypothetical bar scenario, in which a person of the opposite sex flirts with their spouse and then violently shoves the participant. Participants rated how likely they would be to smash a bottle over the individual's head. Results indicated that participants who had just engaged in a self-control task responded more aggressively in the hypothetical scenario. However, this effect was moderated by individuals' level of trait self-control. Importantly, only among participants who scored relatively low on trait self-control and engaged in the prior self-control task demonstrated an increase in level of intention to aggress. Of course, intention to aggress is not the same as actual aggression or criminal behavior. However, these laboratory results may extend to situations of actual violent criminal behavior, trivial altercation homicides.

Although there are many different contexts in which homicide occurs, the most common is a male killing another male, usually after an altercation (Wolfgang 1958; Wilson and Daly 1985). These homicides are usually classified under the label, "trivial altercation", because the conflict appears to result from a minor offense including an insult or even perceived slight. Although the conflicts appear trivial on the surface, the underlying motivation to maintain status and face is not trivial (Wilson and Daly 1985; Daly and Wilson 1988). There are many explanations, both distal and proximal, for this type of homicide, but self-control may also play a role. For example, some of these homicides may be the result of an inhibition termination effect due to the individual meeting threshold. As in DeWall et al. (2007), we would expect a moderating effect of trait self-control in the commission of these types of homicides. In this manner, the DCITR can be used to mechanistically explain why some individuals may commit acts of violence and homicide in trivial altercation situations, while others do not. Specifically, the DCTIR predicts that individuals who have lower thresholds, as compared to higher thresholds, are more prone to engage in criminal behavior in these situations as they are more likely to reach threshold. This might also help explain the effects of some traumatic brain injury in relation to self-control and crime. For example, perpetrators of domestic violence tend to have higher rates of severe traumatic brain injury and score lower on measures of executive function (Marsh and Martinovich 2006).

Multiple Components

Finally, there are variables that could affect multiple components in the DCTIR model. The effects of age and socioeconomic factors on crime are examples of such variables.

Age and Crime Perhaps one of the best known effects in criminology is the age effect. Research has demonstrated that age is a strong predictor of criminal offending. Adolescents and young adults are more likely to commit crime than are other age groups (Farrington 1986; Hirschi and Gottfredson 1983; Piquero et al. 2003; Shulman et al. 2014; Sweeten et al. 2013). This relationship cannot be explained solely with self-control.

However, the DCTIR can add to the explanation. Not all parts of the multi-component module proposed by the DCTIR have the same developmental trajectory. For example, only the threshold component is proposed to be relatively (not absolutely) stable. Indeed, developmental evidence supports the relative stability of self-control (see Vazsonyi and Huang 2010). In other words, self-control may increase over the course of development, but individuals who had lower self-control in childhood will tend to have lower self-control than do those who had higher self-control as children (i.e., rank differences remain). However, the modules that are being regulated by the inhibition module change greatly over development. One way the behavior associated with these systems changes is with regard to how motivating they are to pursue. For example, prior to puberty, mating behaviors are largely silent. Once individuals can reproduce, these behaviors become more central. Over the lifespan, these eventually decrease, and reproductive concerns are less relevant. Thus, puberty is a time when sexual behaviors are particularly motivating. As a result, when adolescents are in a self-control situation involving these behaviors, the measurement subroutine is measuring a high cost. This makes it more likely that the adolescent individual will eventually stop inhibiting. However, threshold is predicted to increase linearly over the course of development. Thus, adolescents have thresholds that are lower than they will be when they are in their late 20's. Therefore, there is a mismatch between these powerfully motivating behaviors, which include criminal behavior, and the tolerance for applying inhibitory effort. This makes adolescence a unique period of time and one ripe for producing criminal behavior.

The mismatch in impulsive motivating systems and components of self-control is supported by neurodevelopmental evidence. For example, brain maturation in reward centers, such as the striatum, occurs early in adolescence. Maturation for neural areas implicated in self-control, such as the lateral prefrontal cortex, occurs later (Luna et al. 2010; Steinberg 2010). In addition to a difference in maturation times for different neural areas to consider, there is also an increase over time in connectivity between subcortical regions like the striatum and prefrontal regions (e.g., Bos et al. 2012). Just as there is an increase in connectivity in these neural systems, the DCTIR would predict that an increase in the connectivity between impulsive systems and the monitoring system would affect self-control behavior. Thus, not only are differential maturation rates implicated, but the connectivity in these systems as well.

Construing the strength of temptations is also a critical aspect of self-control, as proposed by the DCTIR, and there may also be a developmental mismatch in this type of processing. For example, the anterior insular cortex, is a neural area responsible for interpreting signals of arousal and coordinating context relevant brain networks (Menon and Uddin 2010). The anterior insular cortex also appears to be maturationally imbalanced (i.e., relatively immature) in adolescence in comparison to cognitive control areas. As a result, affectively driven behavior, such as criminal behavior, is more likely (Smith et al. 2014).

Duckworth and Steinberg (2015) also make a distinction between the different developmental trajectories of impulsive sensation-seeking processes and the ability to control them. However, only the DCTIR mechanistically explains these trajectories and does so with a more fully developed theory of self-control. This shows that the DCTIR can help explain the age and crime relationship, one of the most fundamental effects in criminology.

Socioeconomic Effects In the sociological and criminological literatures, the effects of poverty and inequality on crime are heavily researched and central to many theories. However, the effects of poverty and inequality are not always consistent and there is much debate about which variable is more important. For example, Chamlin and Cochran (2005) found that high levels of inequality lead to higher homicide rates. Similarly, Daly et al. (2001) found that, in both Canada and the United States, greater income inequality was related to homicide rate and could account for the different homicide rates in the two countries. However, Pare and Felson (2014) found that inequality is not related to multiple types of crime (including homicide) when controlling for poverty. Ouimet (2012) examined homicide rates for 165 countries and found that both poverty and inequality were generally significant predictors, although in some countries only inequality predicted homicide rate. Hsieh and Pugh (1993) conducted a meta-analysis and found that both income inequality and poverty moderately predicted violent crime. Collectively, these results suggest that both poverty and income inequality are relevant to at least some types of crime, although they likely depend on many factors. There are numerous explanations as to *why* poverty and inequality affect crime. Part of the explanation may involve self-control.

The DCTIR predicts that self-control interacts with the environment in adaptive ways. For example, when the environment has high morbidity, mortality, and unpredictability (characterizing many poverty stricken areas), it is adaptive to lower threshold. For example, it would be adaptive to indulge cravings for food during a famine or if food schedules were unpredictable. Of course, what is adaptive for the individual may not be socially desirable. Similarly, if individuals are raised in poverty-stricken and unpredictable environments, their criminal behavior will be affected. In situations involving the self-control of crime, these individuals are less likely to resist. In the evolutionary sense, this behavior could be adaptive (i.e., raising fitness), though it may not be socially desirable. There is evidence for such effects in the life history theory literature (see Ellis et al. 2009 for a review).

Income inequality may affect another aspect of self-control. Whereas poverty is hypothesized to cause changes in threshold, income inequality is hypothesized to affect the monitor component of the DCTIR. One consequence of income inequality is that one's relative diminutive income may be made more salient. Thus, income inequality may remind individuals of their lack of resources relative to others. In a crime relevant self-control situation, engaging in the criminal behavior would register a higher temptation in the measurement subroutine. More tempting behaviors should make it more likely that threshold will be reached, thus stopping inhibition. The lack of resources relative to others may additionally create the need to inhibit thoughts about this situation. This added inhibitory effort may result in an ego depletion/inhibition termination effect. Although these questions should be empirically addressed, the DCTIR nonetheless provides several novel hypotheses to explain the relationship between poverty and inequality and crime.

Universal Nature of Self-Control Vazsonyi et al. (2001) investigated the role of self-control in Hungary, the Netherlands, Switzerland, and the United States, in a large ($N = 8417$) representative sample of adolescents. The results showed that self-control reliably predicted deviance in all four countries and accounted for a substantial amount of the variance in total deviance scores (20% on average). Furthermore, Vazsonyi and Huang (2015) found similar results in a cross-cultural sample of eleven countries. These cross-cultural studies are important contributions because they show that the self-control and crime relationship is not simply a peculiarity of the United States, but occurs across several different countries. This suggests the effect is a universal phenomenon, which is more likely to occur for biological and evolutionary reasons, as opposed to sociological reasons. This is an important aspect of self-control that theories of self-control must explain. Indeed, the DCTIR can account for such findings. The inhibition module proposed by the DCTIR is argued to be an evolved computational system. Although culture should play a role, the DCITR predicts that all humans share the same basic computational inhibition mechanism. This means that, although local culture can shape self-control, everyone has the same inhibitory mechanism. Thus, the self-control and crime relationship should hold regardless of culture. Once again the DCTIR can integrate an important criminological finding.

Conclusions

We have argued that self-control is an important construct to understand crime and that self-control as a variable has not been examined to its fullest potential. What is lacking is a theory that directly specifies the mechanism of self-control. Herein, we have offered the DCTIR as a mechanistic theory that has the potential to expand this line of research by making more nuanced predictions, integrating findings, and generating new avenues for research. The module proposed by the DCTIR is not meant to explain every self-control effect. However, the DCTIR is a significant improvement over past models and using the DCTIR can enhance current perspectives on self-control and crime. By the same token, research using the DCTIR to understand crime, may also further our understanding of self-control itself. Thus applying the DCITR to crime is mutually beneficial. The future of self-control and crime research is bright, using the DCITR can contribute to that future in substantial ways.

Compliance with Ethical Standards

Conflict of Interest Joshua Reynolds declares that he has no conflict of interest. Sean McCrea declares that he has no conflict of interest.

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