Life History theory and social deviance: The mediating role of Executive Function

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A B S T R A C T

The present work examined predicted relations among Life History strategies, Executive Functions, socially antagonistic attitudes, socially antagonistic behaviors, and general intelligence. Life History (LH) theory predicts that Executive Functions and socially antagonistic attitudes and behaviors underpin an interrelated and coherent set of behavioral strategies (LH strategies) designed to enhance reproductive success. Specifically, LH theory predicts a positive relation between Executive Functioning and LH strategies; a negative relation between socially antagonistic attitudes and behaviors and LH strategies; and that Executive Functions mediate relations among LH strategies and socially antagonistic attitudes and behaviors. Results from a Structural Equation Model (SEM), based on self-reported Life History strategies, Executive Functioning, socially antagonistic attitudes and behaviors, and general intelligence support these predictions. The structure of the model suggests that Executive Functions serve a mediating role in the relations between LH strategy and social deviance.

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1. Introduction

The purpose of this paper is to present the results of a Structural Equations Model (SEM) examining predictions from Life History (LH) theory with a focus on a pivotal role of Executive Functioning (EF) in the onset and perpetuation of social deviance. Specifically, LH theory predicts that EF mediates relations between socially antagonistic attitudes and behaviors and social deviance (as a LH strategy). We tested this prediction using data from a sample of undergraduate students from a University in the Southwestern United States; and a second sample from a community-based employment-training program, which we assumed constitutes a higher-risk population.

In general, traditional theories specify difficulties in impulse control and differences in cognitive abilities, such as intelligence, as predominant risk factors in the etiology and maintenance of social deviance. These theories have stimulated a large body of research, the bulk of which has made significant contributions to our current understanding of proximate factors involved in social deviance. Despite this, several aspects of socially deviant behavior remain unexplained. We propose that integrating existing knowledge with findings from more recent research investigating LH and Neuropsychological theory, as applied to human behavioral development, will enhance our understanding of the sources of social deviance.

2. Control-based and cognitive perspectives on social deviance

Lower IQ predicts a higher likelihood of engaging in self-reported delinquent behavior, regardless of socioeconomic status (Denowski & Denowski, 1985; Herrnstein & Murray, 1994; Kandel et al., 1988; Moffitt, Gabriellie, Mednick, & Schulsinger, 1981).[1] Traditional cognitive theories of social

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[1] Although one might argue that intelligence is a factor in the likelihood of being caught in a socially deviant act rather than a causal factor.

deviance specify that differences in cognitive abilities, like intelligence, are a major predictor of a tendency toward social deviance. These theories do not account for facts such as the finding that the mean IQ of individuals endorsing and engaging in psychopathic, aggressive, and antagonistic attitudes and behaviors and those who do not are statistically equivalent (e.g., Gladden, Figueredo, & Jacobs, 2008). Nor do they account for the fact that the difference in average IQ between the general population and incarcerated individuals is not large enough to account fully for the occurrence of these criminal behaviors.

Although the estimated average IQ in the USA is 99.4 (SD = 14.9), the average estimated IQ of incarcerated criminal offenders falls about 8 points (a bit more than half a standard deviation) below this national average (Herrnstein & Murray, 1994). Based upon this, it seems unlikely that differences in IQ alone are capable of fully differentiating individuals who are likely to engage in socially antagonistic attitudes and behaviors from those who are not.

In light of theoretical and empirical concerns such as these, some researchers have proposed that it is not just deficits in general intelligence that influences the risk of criminality, but rather a deficit in a more specific and identifiable mental ability on which individuals of otherwise similar IQ vary. It is to these theories that we now turn. We begin with proximate-level influences on social deviance and then segue into ultimate-level influences. Proximate explanations address "how?" and implicate immediate factors and mechanisms in the cause of a certain behavior. Ultimate explanations address "why?" and seek to capture the functional significance of a behavior, thus implicating the evolutionary history of the organism. To fully describe a phenomenon, both proximate and ultimate explanations complement one another and are thereby both necessary.

3. Proximate-level influences on social deviance

Etiological theories of crime focus primarily on proximate experiential factors associated with deviant, delinquent, and criminal behaviors. Control-based theories are the most well known. Gottfredson and Hirschi (1990) 'Self Control Theory of Crime', for example, predicts that failures to self-regulate and control one's *immediate* impulses ultimately lead to deviant and criminal acts. Overall, control-based theories have led to the discovery of a number of proximate factors that contribute to the onset and perpetuation of deviant, delinquent, and criminal behavior.

It is but a short step to augment these etiological accounts with data from contemporary cognitive neuroscience. So doing permits us to point toward specific neurological mechanisms underpinning observed failures to self-regulate. Self-regulation and the inhibition of impulsive behavior appear dependent upon a 'properly' functioning frontal cortex (Banfield, Wyland, Macrae, Munte, & Heatherton, 2004). A well-formed frontal cortex appears essential for abstract reasoning, the organization of behaviors across time and space, and decision-making. Patients with frontal lobe damage exhibit a variety of disorganization, including failures to plan, adhere to rules, to self-regulate emotions, and to self-regulate overt behavior properly (Lezak, Howieson, & Loring, 2004).

Executive Functions such as planning, attending, and inhibiting behavior, all of which depend on the frontal cortex, act as 'switches' that effectively inhibit impulsive stimulus-bound behavior (Fuster, 2008). Accordingly, an immature or underdeveloped frontal cortex may contribute to poorer Executive Functioning, which in turn may influence the onset and perpetuation of socially deviant behavior. The fact that risk-taking and deviant behaviors increase remarkably during adolescence and equally remarkably decline following adolescence (especially in human males), a time during which the pre-frontal cortex undergoes continuous and substantial change and modification is consistent with this notion (Patton, Stanford, & Barratt, 1995; Steinberg, 2007). Furthermore, the behavioral 'disorganization', associated with frontal lobe damage, resembles traits associated with deviant behavior, criminal behavior, and several psychopathologies. For example, hallmark DSM-IV TR criteria for anti-social personality disorder (ASPD) includes failures to plan (i.e. impulsivity) and to comply with social rules.

The neuropsychological literature posits three distinguishable Executive Functions that play a substantial role in self-regulation: *shifting, updating, and inhibition* (e.g., Miyake et al., 2000). *Shifting* involves alternating behaviors between various tasks, operations, or mental sets. Hence, shifting involves recognizing contexts and exhibiting behavior appropriate to those contexts (i.e., context discrimination). *Updating* requires an individual to monitor, manipulate, and update stored information with newer incoming information in working memory (e.g., planning). *Inhibition* involves "preventing" unnecessary or inappropriate responses and is central to organizing goal-directed behavior (Miyake et al., 2000). These high-level Executive Functions operate top–down, controlling lower level automatic processes which some suggest underpin impulsive behavior (e.g., Metcalfe & Jacobs, 2009a,b; Metcalfe & Mischel, 1999).

4. Ultimate-level influences on social deviance

LH theory is a mid-level theory from evolutionary biology that describes a variety of life cycles among different species with a range of reproductive strategies (Hamilton, 1966; McArthur & Wilson, 1967; Wilson & Willis, 1975). LH theory has provided a major organizing principle and integrative framework within evolutionary science for most of the past half-century since it was proposed. LH theory provides an explanatory foundation for a number of observations that demonstrated a consistent pattern of relations among rates of maturation, lifespan, reproductive effort, degrees of social behavior, and brain size across species (Wilson & Willis, 1975; Eisenberg, 1981; Barash, 1982). While earlier work focused mainly on between-species differences in LH, later researchers began to draw upon LH theory to describe variation in within-species differences in the developmental timing and appearance of traits, including those of humans (e.g. McNamara, 1997; Rushton, 2000).

Using LH theory, it became possible to examine the behavioral strategies of *r*-selected species, who invest more of their limited bioenergetic and material resources in reproduction, and *K*-selected species, who invest more in longevity (Pianka, 1970). For example, rabbits are known for rapid sexual development, high fertility rates, high offspring production, and high infant mortality due to low parental investment; in contrast, elephants mature sexually at a slower rate, produce fewer offspring, invest highly in those offspring, and experience much longer life spans. LH theory considers these extremes to lie within a continuous spectrum of LH strategy, where two main

components of fitness, individual survival (i.e., somatic effort) and reproduction (i.e., reproductive effort), anchor opposing ends of a single dimension. Additionally, LH theory identifies two main components within the category of reproductive effort, a) mating effort (i.e., devoting resources towards obtaining and keeping mating partners) and b) parental effort (i.e., devoting resources towards improving the survival of offspring) as opposite ends of the same dimension. Finally, by apportioning an individual's limited resources (bioenergetic and material) between the competing interests of individual survival and reproduction (Shennan, 2002), a zero-sum dynamic emerges among the different tactics of survival and reproduction that individuals may deploy.

Furthermore, a large body of subsequent research has elucidated the selective pressures under which these different resource allocations are favored or disfavored: individuals living in unstable and unpredictable environments tend to evolve strategies such as high reproductive output and low parental investment, r-typical traits; in contrast, individuals living in stable and predictable environments tend to evolve strategies such as low reproductive output and high levels of parental investment and offspring care, K-typical traits (Ellis, Figueredo, Brumbach, & Schlomer, 2009; Geary, 2005; Pianka, 1970). In short, r-selected LH strategies apportion an individual's resources more heavily to immediate (short-term) reproductive effort, mating effort, and short-term gains (i.e., quantity) whereas K-selected LH strategies apportion an individual's resources more heavily to long-term reproductive effort, increased levels of parental investment, and long-term gains (i.e., quality). A considerable body of empirical research has accumulated over the years substantiating and elaborating upon these early predictions of LH theory in a broad spectrum on phylogenetically diverse species, including both population-genetic and individual-level developmental effects upon human and nonhuman animals as well as plants (for an extensive review of this literature, see Ellis et al., 2009).

Even though modern humans are generally highly K-selected, measurable and systematic individual differences in human LH strategies exist (McNamara, 1997; Rushton, 1985). There exists a lively debate regarding the extent to which genetic and environmental influences contribute to these individual differences (Belsky, Steinberg, & Draper, 1991; Chisholm, 1996; Rowe, 2000), but most would agree that genetic and environmental influences are both at work. Heritabilities of human LH strategy have been reported ranging from about 60 to 70% (Figueredo, Vasquez, Brumbach, & Schneider, 2004; Figueredo & Rushton, 2009), but the emergence of new knowledge in molecular biology detailing the biochemical mechanisms mediating the epigenetic processes which modify gene expression (the quantitative regulation of gene products by environmental triggers) make it hard to apportion these influences into two discrete and non-overlapping sources of developmental influence.

Research has demonstrated that variation in LH strategies is associated with events and experiences that occur during development. For example, father-absent females tend to reach menarche more quickly than do father-present females (Ellis, 2004). Moreover, both father-absent men and women tend to adopt low romantic attachment and manipulative interpersonal styles with others (Figueredo et al., 2006). Findings such as these support the notion that developing in

unstable environments fosters the evolution and development of an array of r-selected traits (i.e., fast LH strategies), although the degree to which this phenomenon might instead reflect a gene-environment correlation (as by the possible genetic predispositions of the absent fathers presumably causing the family instability being directly inherited by their offspring) continues to present a methodological confound in this line of research.

Conversely, individuals who develop in predictable and stable environments tend to display an array of slow LH or K-selected traits. These individuals tend to prefer long-term relationships (Olderbak & Figueredo, 2009, 2010) and cooperative interpersonal relations with others (Figueredo, Gladden, & Hohman, 2011; Figueredo & Jacobs, 2010). Intuitively, if one lives in an unpredictable and unstable environment, it pays to take small but certain short-term gains at the expense of larger but uncertain long-term gains because, in such an environment, the individual may not survive to reap long-term gains, whereas an individual living in a stable and predictable environment may benefit from foregoing small but reasonably certain short-term benefits for large but equally certain long-term benefits.

Many behaviors categorized as "socially deviant" in modern Western societies do not occur in isolation, but tend to cluster. For example, Rowe and colleagues documented close associations among deception, rebellion, aggression, lying, and a variety of delinquent behaviors including speeding, theft, vandalism, and trespass. Each of these behaviors loaded onto a common factor suggesting they belong to a larger and perhaps coherent system. In the spirit of Spearman's "g" for general intelligence, Rowe and Rodgers (1989) proposed a "d" factor for social deviance.

Deviant behaviors also often cluster in response to situations and environments characterized as challenging and stressful (Donovan & Jessor, 1985). For example, development in a father-absent and stressful home environment correlates with an array of socially deviant behaviors including poor academic performance, teen-pregnancy, alcohol and substance abuse, and violent offending (Ellis, 2004; Figueredo et al., 2006). Strong correlations between a cluster of socially deviant behaviors and the contexts in which they occur have been replicated across a variety of literatures (Cochran, 1997; Bulow & Meller, 1999; Robbins & Bryan, 2004), suggesting that these behaviors reflect survival and reproductive strategies that occur under stressful and unpredictable conditions (Rowe, 1996; Rowe, Vazsonyi, & Figueredo, 1997).

Thus, we see that "proximate-level" cannot be simplistically equated with "environmental" influences and "ultimate-level" cannot be confounded with exclusively "genetic" influences. Selection instead acts upon the *epigenetic rules of development* that shape an organism's adaptive responses to varying environmental conditions by means of molecular mechanisms regulating gene expression in those different contexts (Figueredo et al., 2006; West-Eberhard, 2003). Furthermore, these gene-environment interactions are generally *pleiotropic*, meaning that they influence an entire assemblage of correlated biological and behavioral traits rather specifying isolated characteristics, as was originally claimed by Gregor Mendel based on early results with a few selected traits in peas.

To summarize, socially deviant behaviors often co-occur or cluster, are more likely to occur in contexts perceived as stressful and unpredictable, and together, may function as a

coordinated strategy allowing an individual to navigate the environment more successfully than those without a coordinated strategy. The strengths of this hypothesis become clearer when considered in light of Life History (LH) theory which provides an integrative framework for examining these issues. In the following sections, we develop an integrated perspective that synthesizes new ideas with the old by linking the evolution and development of LH strategies to those of both general intelligence and Executive Functions. We then describe several novel perspectives suggested by an evolutionary approach.

5. Life History theory and general intelligence

Large brains are a hallmark of species that exhibit slow LH strategies. Large brains, like that of humans, require a large amount of energy to construct and maintain (e.g., nutrients, high-energy foods) and a lengthy developmental period to mature and develop fully (Morgan & Gibson, 2010). An extended developmental period necessarily increases an infant's reliance on caregivers such as parents for strong parental (or caregiver) pair–bond relationships, provisioning, and commitment.

This fact encouraged many to predict, and demonstrate empirically, strong relations among intelligence and a constellation of traits that some characterize as socially deviant or socially undesirable. For example, IQ correlates negatively and significantly with criminality, promiscuous sexual behavior, illegitimate birth, and divorce (Herrnstein & Murray, 1994; Rushton, 2000). In contrast, others theorize that cognitive abilities other than or more specific than general intelligence play a central role in the etiology of socially deviant attitudes and behaviors.

6. Life History theory and Executive Functions

From an evolutionary perspective, Executive Functions direct and organize behavioral tactics (actions) designed to solve adaptive problems. Hence, individual differences in the organization of Executive Functions play a pivotal role determining fast and slow LH strategists. In unpredictable and unstable environments, biases toward short-term gains (impulsivity) and away from long-term benefits are adaptively advantageous. Conversely, in more predictable and stable environments, biases away from immediate gains and toward more long-term benefits (self-regulation) are adaptively advantageous.

By this view, neither fast nor slow LH strategies are inherently superior. The "superiority" of a strategy depends on the environment, the environmental demands and context, and the environmental 'payoffs' within which the individual is situated. In unstable and unpredictable environments, fast LH strategies generally confer more adaptive advantages (in terms of survival and reproduction) than slow LH strategies. In stable and predictable environments, slow LH strategies generally confer more adaptive advantages than fast LH strategies. In both cases, the nature of the environment plays a critical role in determining the most advantageous set of strategies. Executive Functions, then, participate in the proximate implementation of these strategies.

7. Executive Functions and IQ

Recent neuropsychological research demonstrates that relations between IQ and Executive Functions fluctuate. In the latter case, this depends upon the specific Executive Function under analysis. More specifically, *Updating* is highly correlated with IQ, whereas *Shifting* and *Inhibiting* are not (Friedman et al., 2006), suggesting that, although IQ captures *some* Executive functions, IQ is not an adequate proxy for assessing the full range of Executive Functions.

8. An evolutionary understanding of social deviance and its adaptive functions

The incorporation of an evolutionary perspective into current models of social deviance may increase our ability to predict which individuals are more apt to engage in socially deviant behaviors. Although traditional self-control theory takes biological factors such as age and hormonal regulation into account, it does not extend beyond these proximate mechanisms and does not consider the possibility that individual differences in these abilities reflect an underlying adaptive strategy (Figueredo, Cuthbertson, Kauffman, Weil, & Gladden, 2012; Figueredo et al., 2011). That is to say, conventional control-based theories do not entertain ultimate-level questions such as, "Why do individual differences in self-regulation exist in the first place?" and "What, if any, function do these differences serve?"

From an evolutionary framework, social deviance does not reflect an underlying dysfunction in the individual per se, but rather is an adaptive strategy that, under some circumstances, confers benefits upon the individual while simultaneously harming others (Figueredo & Jacobs, 2010). A large body of research supports this notion. Ellis and collaborators (2011) have more recently taken this view to the evolution and development of risk-taking behavior in adolescents, as a more specific implication of this general perspective of substantial social relevance.

9. Summary and study predictions

LH theory predicts that a root cause of social deviance lies in the predictability of environment relationships within which an individual is situated. Harsh and unpredictable environments foster fast LH strategies where short-term gains are biased over long-term benefits. In contrast, stable and predictable environments foster slow LH strategies where larger long-term benefits are biased over smaller short-term gains. We propose that Executive Functions proximately mediate the enactment of these LH strategies, in a way not fully captured by measures of IQ. Hence, the present study empirically investigates theoretically specified relations among LH strategies, Executive Functioning, and socially antagonistic attitudes and behaviors. The study also assesses the relation of LH strategy and IQ to Executive Functioning, Socially Antagonistic Attitudes, and Socially Antagonistic Behaviors to examine the discriminant validity between IQ and Executive Functioning.

Based on the combination of contemporary cognitive neuroscience and LH theory, we can therefore predict that:

1. Higher general intelligence (IQ) and slower LH strategies are *not* significantly associated with each other;
2. Both higher IQ and slower LH make independent and *positive* contributions to the development of enhanced Executive Functioning;

3. Enhanced Executive Functioning serves to inhibit the development of socially antagonistic attitudes;
4. Socially antagonistic attitudes serve to promote the expression of socially antagonistic behaviors;
5. Nevertheless, enhanced Executive Functioning also serves to inhibit the expression of socially antagonistic behaviors directly;
6. Furthermore, higher IQ, but not slower LH, also serves to inhibit the expression of socially antagonistic behaviors directly.

10. Method

10.1. Participants

10.1.1. Sample 1

One hundred fifty five individuals, enrolled at a federally funded agency, ranging age from 18 to 25 years, (M = 19.58, SD = 1.60 were recruited via agency invitations and flyers about the study). Individuals in this sample are self-identified as Hispanic (43%), Native American (19.3%), Caucasian (19.3%), Black (8.8%), Pacific Islander (3.5%), Asian (.9%), and Other (5.3%).

All participants (P) in this sample read at or above the 8th grade level. Furthermore, among the Ps who reported educational achievement (n = 108), nearly two thirds graduated from high school, received a General Educational Development certificate, or had some college experience (n = 62.9%). The remaining 37% of Ps completed the 7th grade (1.9%), 8th grade (2.8%), 9th grade (8.3%), 10th grade (13%), or 11th grade (11.1%).

The agency provides educational and employment training for older adolescents and younger adults, serving individuals for whom traditional educational programs such as high school and college are not suitable and/or a good fit. These individuals typically use the program to gain employment.

10.1.2. Sample 2

One hundred twenty one undergraduate students (79 males, 43 females) enrolled at the University of Arizona, ranging from 18 to 25 years (M = 18.89, SD = 1.60) were recruited from introductory level psychology courses. Individuals in this sample are self-identified as Caucasian (45.7%), Hispanic (17.5%), Native American (10.7%), Asian (5%), and Black (4.2%). All Ps completed grade 12 and read at or above the eighth-grade level.

10.2. Common measures

The common measures fall into five conceptual categories: (1) Assessments of Life History Strategy; (2) Assessments of Cognitive Abilities; Executive Functioning, and Self-Regulation; (3) Assessments of Socially Antagonistic Attitudes; (4) Assessments of Socially Antagonistic Behaviors; and (5) Assessments of Socially Desirable Response Biases. Although the Ps in this study completed the measures as described below, administration procedures sometimes differed

Category 1 Assessments of Life History Strategy (SLH)
- *Arizona Life History Battery* (ALHB; Figueredo, 2007). The ALHB is a 199-item battery of cognitive and behavioral indicators of LH strategies. The ALHB includes the *Mini-K* short-form version of LH strategies (20 items), *Insight Planning and Control* (20 items), *Parental Investment* (26 items), *Family Support* (15 items), *Friends Support* (15 items), *Altruism toward Own Children and Kin* (15 items), *Altruism toward Friends* (14 items), *Altruism toward Community* (21 items), *Religiosity* (17 items), and *Partner Attachment* (36 items). Because of the high correlations among the altruism scales, the 50 altruism items are typically collapsed into a lower-order factor "*General Altruism*" (Figueredo et al., 2005). The battery has strong convergent and discriminant validity and within-scale internal consistency (Figueredo et al., 2005).

Category 2 Assessments of General Cognitive Abilities (CGA), Executive Functioning (EF), and Behavioral Self-Regulation (BSR)
- *Shipley Institute of Living Scale* (The Shipley; Zachary, 1986). The Shipley is a 60-item paper and pencil test that assesses general cognitive ability. The Shipley consists of two subtests: Shipley Vocabulary (40 items) and Shipley Abstraction (20 items). The Shipley has been validated and normed on 322 Army recruits and is recommended for use with English speaking individuals over fourteen years of age.
- *Dysexecutive Questionnaire* (DEX; Wilson, Alderman, Burgess, Emslie, & Evans, 1996). The DEX assesses a variety of behaviors presumed to result from strong Executive Functions. Ps indicate how often they experience a variety of scenarios. For example, "I act without thinking, doing the first thing that comes to mind." The response scale ranges from 0 (never) to 4 (very often).
- *Behavioral Rating Inventory of Executive Functioning — Adult Version* (BRIEF-A; Gioia & Isquith, 2002). The BRIEF-A is a 75-item measure of global Executive Functioning. Ps are asked "…if you have had problems with the (list of) behaviors over the past month." The response scale ranges from 1 (never) to 3 (often). Sample items include "I have trouble prioritizing activities" and "I don't plan ahead for tasks."
- *Executive Functions Questionnaire* (EFQ; Wenner, Jacobs, & Nagaran, 2007). The EFQ is a 36-item measure that assesses *Shifting* (11 items), *Updating* (12 items), and *Inhibition* (13 items). Miyake's (Miyake et al., 2000) three self-regulatory factors motivated this scale. Ps indicate "…how strongly you agree/disagree with the following statements." The response scale ranges from −3 (strongly disagree) to +3 (strongly agree). An example of a Shifting item is "I find it easy to do two things at once"; an example of an Updating item is "it is easy for me to find new and useful information in most situations"; and an example of an Inhibition item is "I consider myself careful and cautious."

Category 3 Assessments of Socially Antagonistic Attitudes (SAA)
- *Impulsive Behaviors Questionnaire* (IBQ; Figueredo et al., 2006). The 15-item IBQ assesses a propensity to engage in impulsive behaviors. Respondents are asked, "How strongly do you agree or disagree with the following statements" with a scale that ranges from −3 (Strongly disagree) to +3 (Strongly Agree). Sample items include "I act on impulse" and "I say inappropriate things."

- *Psychopathic Personality Inventory — Short Form* (PPI-SF; Lilienfeld & Andrews, 1996). The 56 item Psychopathic Personality Inventory — Short Form assesses socially antagonistic attitudes.
- *Risk Taking Questionnaire* (RTQ; (adapted from Eadington, 1976; Kidd & Holton, 1993). The 20-item RTQ is a general measure of risk taking and attitudes towards risk taking. Ps indicate how strong they agree or disagree with a number of statements. For example, "A little recklessness is good for people". The response scale ranges from −3 (strongly disagree) to +3 (strongly agree). The original scale includes 20 items but our group included an additional two items: "I would not date someone too attractive for fear of losing them" and "I would approach someone very attractive even if it were a long shot" (Cronbach's alpha = 0.84).

Category 4 Assessments of Socially Antagonistic Behaviors (SAB)

- *Life Experiences Questionnaire Revised* (LEQ-R; Zuckerman & Kuhlman, 2000). The LEQ-R assesses a broad range of risky behaviors including risky sexual activity, drinking, smoking, drug-use, reckless driving, and gambling. The LEQ-R uses a variety of categorical response options. Example items include "If you are driving on a straight-uncrowded highway with a 55 mph speed limit, how fast do you drive?" with answer choices ranging from "I never drive" to "75 miles faster."
- *Delinquency Short Form* (D20; Charles & Egan, 2005). As a pure measure of mild to moderate antagonistic behaviors, we included the D20. Respondents are asked, "How many of these things have you ever done?" on a scale that ranges from 0 (never) to 3 (very often) Example items include "fighting in the street or another place" and "purposely damaging property that belongs to someone else."
- *Drug Abuse Screening Test* (DAST; Skinner, 1982). The DAST is a 10-item measure that assesses drug abuse. Example items include, "Do you abuse more than one drug at a time?" and "Have you engaged in illegal activities in order to obtain drugs?" Ps must choose between yes/no response options.

Category 5 Assessments of Socially Desirable Response Biases

- *Marlowe Crowne Social Desirability Scale* (Crowne & Marlowe, 1960). We used the Marlowe Crowne Social Desirability Scale, because it is the most widely used measure of social desirability response bias (van de Mortel, 2008).

10.3. Testing procedures

10.3.1. Sample 1

After providing informed consent, Ps in Sample1 took part in five assessment sessions, three group sessions and two individual sessions. During the first three sessions, Ps completed three packets of questionnaires requiring up to 65 min per packet to complete. Each group contained up to twenty-one Ps. The Ps were monitored to ensure they did not discuss the material or view each other's responses.

The last two sessions involved individual neuropsychological testing in a private room. To avoid missed appointments, neuropsychological testing occurred only when Ps were on campus and available to be tested. Each neuropsychological testing session required up to 65 min to complete. In all, each P underwent about 5 h of testing.

Ps received fifty ($50) US Dollar gift cards to WalMart for participation in the study. They received one five-dollar gift card after completing each of the first four sessions and a thirty-dollar gift card or completing the fifth and final session.

Graduate and undergraduate-level university students, each trained and supervised by one doctoral-level clinician trained in neuropsychological assessment and one master-level clinician recruited Ps and administered questionnaire. Training focused on neuropsychological testing, professional conduct, ethics, and data and testing documentation.

10.3.2. Sample 2

The Ps completed the majority of the questionnaires via a web-based rather than a paper and pencil format. Each P provided on-line consent before completing questionnaires *and* following an in-person description of the study. The web-based consenting process and questionnaire completion took about 90-min. Each P in Sample 2 completed The Arizona Life History Battery (ALHB), Impulsive Behaviors Questionnaire (IBQ), The Psychopathic Personality Inventory — Short Form (PPI-SF), Risk-Taking Questionnaire (RTQ), Life Experiences Questionnaire- Revised (LEQ-R), Delinquency-Short Form (D20), Drug Abuse Screening Test (DAST), Dysexecutive Questionnaire (DEX), and the Marlowe Crowne Social Desirability Scale online.

Ps also engaged in an in-person group-testing session where they complete tests of intelligence and neuropsychological functioning. This session, which occurred in a private room within the university, required up to 30 min to complete. Each P completed The Shipley Institute of Living Scale, Behavioral Rating Inventory of Executive Function (BRIEF-A), and the Executive Functions Questionnaire (EFQ) during this session.

Graduate and undergraduate-level university students conducted the assessments. Research personnel characteristics, training, and supervision were similar to that in Sample 1. The Ps in each sample had the opportunity to speak with a researcher during the debriefing process.

10.4. Unique measures

The Ps in Sample 1 initially received a more extensive battery of neuropsychological assessments of mental abilities, Executive Functioning and, self-regulation during the first three sessions. The extra items included the Rey–Osterrieth Complex Figure Test (Rey-O; Osterrieth, 1944), the Trail-Making Test B (Trail-B; Army Individual Test Battery, 1944), the Five-Point Test (Five-Point; Regard, Strauss, & Knapp, 1982), and the Modified Stroop Task (Stroop, 1935). We will describe results from those tests in a separate publication.

10.5. Statistical analyses

All statistical analyses were performed using SAS version 9.1.3. Subscale scores were estimated using SAS PROC STANDARD and DATA by simple unit-weighting (Gorsuch, 1983) as the means of the standardized scores for all non-missing items on each subscale. All scale scores were estimated as the means of the standardized scores for all non-missing

subscales on each scale (Figueredo, McKnight, McKnight, & Sidani, 2000; McKnight, McKnight, Sidani, & Figueredo, 2007). Cronbach's alphas and covariance matrices of the scales were also both computed using SAS PROC CORR.

10.6. Statistical control of social desirability

We used a series of general linear models to statistically control for social desirable response biases (via Marlowe-Crowne Social Desirability Scale) for each of the indicator variables before common factor modeling. The preliminary results indicated that many Ps responded in a socially desirable manner, enough to influence their responses on over two-thirds of the measures. Thus, all remaining multivariate analyses were conducted on residualized scales.

10.7. Data aggregation strategy

Because of the limitations imposed by our sample size, we could not analyze all of the individual indicator scales within a single multivariate model simultaneously. Hence, we used a hierarchical analytical strategy of psychometric aggregation. Unit-weighted common factor scores (Gorsuch, 1983) were estimated, using SAS PROC STANDARD and DATA, as the means of the standardized scores for all non-missing sub-scales on each factor (Figueredo et al., 2000), as had been done with the scales themselves and the subscales within them. We assessed the adequacy of these unit-weighted factors by computing the part-whole correlation of each indicator to each common factor to which the factor was theoretically assigned. We then tested the statistical significance and relative magnitude of that correlation. All of the resultant unit-weighted factor scales were entered as manifest variables for multivariate causal analysis within a single structural equation model. Structural equation modeling (SEM) between these constructs then provided a multivariate causal analysis of the structural relations between them.

10.8. Evaluation of model adequacy

Structural equations models were evaluated using chi-square, the Bentler–Bonett Normed Fit Index (NFI), the Bentler–Bonnett Comparative Fit Index (CFI), and the Root Mean Squared Error of Approximation (RMSEA). Index values of the NFI and CFI that exceeded 0.90 are satisfactory levels of practical goodness-of-fit (Bentler & Bonett, 1980; Hu & Bentler, 1995). RMSEA values of 0.05 or less indicate good fit, values between 0.08 and 0.10 indicate a mediocre fit, and values greater than 0.10 indicate a poor fit (Browne & Cudeck, 1993; Steiger & Lind, 1980). The CFI was selected because it is adjusted for model parsimony and performs well with moderate to small sample sizes, especially with Maximum Likelihood estimation (Bentler, 1995; Hu & Bentler, 1995). Other fit indices, such as the Bentler–Bonnett Non-Normed Fit Index (NNFI), provide poor estimates of model fit with smaller samples (Hu & Bentler, 1995). The differences between hierarchically nested models in their statistical and practical indices of fit indicate the relative loss of fit of the model to the data either entailed by the elimination or constraining of specific causal pathways.

10.9. Statistical power

Although the total number of Ps in both samples was $N = 276$, our usable sample was $N = 175$ due to non-recoverable missing data. Generally, a sample size of $N < 250$ is "small" for the purposes of structural equations modeling. Hu and Bentler (1995), however, recommended a ratio of five or more cases for every parameter freely estimated in confir-matory models. By that criterion, a sample of $N = 175$ can support $k = 35$ parameter estimates. The SEM tested here contained 11 freely estimated parameters, or just under one-third of the estimated maximum. We therefore conclud-ed that we have sufficient statistical power to detect any additional 'nontrivial' effects not specified in the restricted structural equation model. Nevertheless, the sample did not afford us the statistical power to us a Multisample Structural Equation Model (MSEM) with Cross-Sample Equality Con-straints; a test to determine if the model parameters were statistically equivalent across the two samples. We therefore pooled the two samples based on the similarities observed in all of the major risk and protective factors of interest, and a single SEM was estimated for the combined sample.

11. Results

11.1. Pooling of samples

Results from separate ANOVAs and effect size estimates revealed that the two samples were more similar on the major risk and protective factors of interest than originally anticipated. In terms of risk factors, there were no significant differences between groups on The Risk Taking Question-naire. In terms of protective factors, there were no significant differences between groups on the Mini-K, Insight-Planning and Control, Family Support, Partner Attachment, and the Executive Functions Questionnaire.

The community sample, however, score significantly higher than the university sample on the following protective factors: General Altruism, Religiosity, the Behavioral Rating of Executive Functioning, and the Dysexecutive Questionnaire. Furthermore, the community sample scored significantly lower than the university sample on the following protective factors: Parental Investment, Shipley Vocabulary, and Shipley Abstraction. Finally, the community sample scored higher than the univer-sity sample on the following risk factors: the Psychopathic Personality Inventory-SF, Life Experiences Questionnaire-R, Delinquency Short-Form, and the Drug Abuse Screening Test. Estimates of Cohen's d for the statistically significant effects, however, were generally in the 'small' category (Cohen, 1988), indicating that none were, for practical purposes, clinically significant. Cohen's guidelines for interpreting small, medium, and large effect sizes are given as points (e.g., d of .2 = small, .5 = medium, .8 = large).

Taken together, these findings suggest that on many key variables of interest, the two groups were quite similar. Although there were significant between-group differences on some risk and protective factors, due to the extremely small effect sizes of these differences, we pooled the samples together for further statistical analyses.

11.2. The measurement model

As described above, we constructed five unit-weighted common factors (SLH-Factor, GCA-Factor, BSR-Factor, SAA-Factor, and SAB-Factor), representing the variables of interest. Table 1 shows the internal consistencies and the unit-weighted factor structure coefficients for each of the indicator variables comprising these latent constructs. These inter-item reliability and convergent validity coefficients demonstrate that each indicator correlated with its theoretically assigned common factor:

- *Slow Life History Strategy* (*SLH*). Multiple dimensions of social cohesion, according to LH theory, constitute important psychosocial SLH characteristics. Eight theoretically specified manifest indicators, representing markers for multiple components of social relationships tied to overall social cohesion, comprised the latent construct "SLH". These indicators include the Mini-K Short Form; Insight, Planning, and Control; Parental Investment and Attachment; Family Contact and Support; Friends Contact and Support; Romantic Partner Attachment; General Altruism, and Religiosity. Factor loadings for each of these manifest indicators were in the moderate to high range.
- *General Cognitive Ability* (*GCA*). The Shipley Institute of Living Scale, comprised of Vocabulary and Abstraction subtest scores, provided manifest indicators of the latent construct "GCA". Factor loadings for these two indicators were in the high range.
- *Behavioral Self-Regulation* (*BSR*). Three manifest indicators comprised the latent construct, "BSR". These indicators included Behavioral Rating Inventory of Executive Functions — Adult Version; the Executive Functions Questionnaire; and the Dys-Executive Questionnaire. Factor loadings for these two indicators were in the high range.

- *Socially Antagonistic Attitudes* (*SAA*). Three manifest indicators comprised the latent construct, "SAA". These indicators included the Lilienfeld Psychopathic Personality Inventory — Short Form; the Risk-taking Questionnaire; and the Impulsive Behaviors Questionnaire. Factor loadings for these two indicators were in the high range.
- *Socially Antagonistic Behaviors* (*SAB*). Three manifest indicators comprised the latent construct, "SAB". These indicators included the Life-Experiences Questionnaire — Revised; the Delinquency Short-Form; and the Drug Abuse Screening Test. Factor loadings for these three indicators were in the high range.

Table 2 provides an exhaustive list of the bivariate correlations among the unit-weighted common factors. As can be seen, significant positive associations emerge between both the SLH-Factor and GCA-Factor with the BSR-Factor (r = .33, p<.001; r = .27, p<.001; respectively). The BSR-Factor and the SAA-Factor correlated negatively (r = −.27, p<.001); and the SAA-Factor and the SAB-Factor correlated positively (r = .30, p<.001). Further the BSR Factor and GCA-Factor both correlated negatively with the SAB-Factor (r = −.26, p<.001; r = −.26, p<.001 respectively). There were no statistically significant relations between the SLH-Factor and the SAB-Factor or the SLH-Factor and the GCA-Factor.

11.3. The structural model

Fig. 1 displays the structural equations model tested. The structural model fit the data well statistically, as indicated by the chi-square fit index (X^2 (3) = 6.063[ns]). The RMSEA fit index of .077 was also good, meeting the criteria suggested by Steiger (1990). In addition, the NFI fit index of .94 and the CFI fit index of .97 suggested a good practical fit by Bentler and Bonnett's standards (Bentler & Bonett, 1980). Last, all of the standardized path coefficients (β-weights) specified as structural pathways in the model were statistically significant (p<.05). In sum, these fit indices supported a good fit of the model to the data.

Although these analyses were performed on purely observational, cross-sectional data, we present the results of this structural model as tests of overtly directional hypotheses. Path-analytic models employ a hypothetico-deductive method to test causal theory against correlational data. This puts the theory at risk of falsification because the predictions of the theory and empirical data may be inconsistent. In SEM, this process is operationalized as a statistical rejection of the theoretically specified model. If the predictions of the theory are consistent with the observed data, then the data are said to "support" but not conclusively prove the theory. Thus,

Table 1
Sample sizes (N), Cronbach's Alpha's (α), and unit-weighted factor structure coefficients (r) for combined samples.

	α	r
Measures of Slow Life History Strategy: ALHB SLH-Factor		
Mini-K Short Form	.75	.79
Insight, Planning, and Control	.91	.64
Parental Investment and Attachment	.93	.52
Family Contact and Support	.92	.62
Friends Contact and Support	.89	.54
Romantic Partner Attachment	.90	.42
General Altruism	.92	.61
Religiosity	.97	.34
Measures of Behavioral Self-Regulation: BSR Factor		
Behavioral Rating Inventory of Executive Function	.90	−.88
Dysexecutive Questionnaire	.96	−.85
Executive Function Questionnaire	.85	.72
Measures of Socially Antagonistic Attitudes: SAA Factor		
Psychopathic Personality Inventory-SF	.73	.80
Risk Taking Questionnaire	.84	.80
Life Experiences Questionnaire	.80	.87
Measures of Socially Antagonistic Behavior: SAB Factor		
Delinquency Short Form	.90	.83
Drug Abuse Screening Test	.93	.83
Impulsive Behavior Questionnaire	.84	.75
Measures of General Cognitive Ability: GCA Factor		
Shipley Vocabulary Test	.91	.78
Shipley Abstraction Test	.78	.90

Note. All coefficients are significant at the p<.05 level.

Table 2
Correlations among unit-weighted common factors.

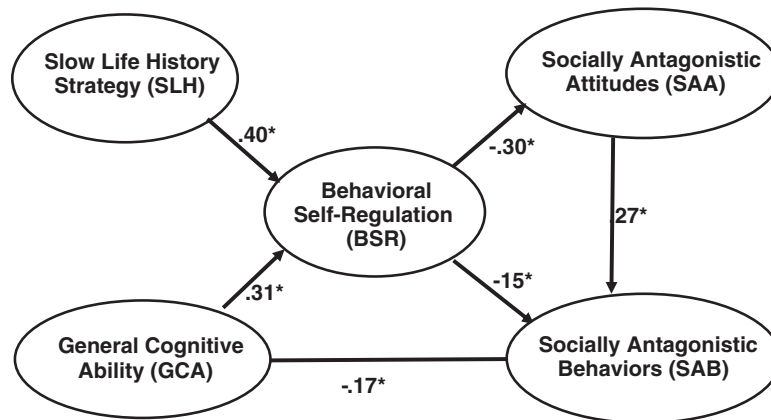|	SLH	SAA	SAB	BSR	GCA
SLH	1.0	−.12	−.07	.33*	−.10
SAA		1.0	.30*	−.28*	−.19*
SAB			1.0	−.26*	−.26*
BSR				1.0	.27*
GCA					1.0

* p<.05.

Fig. 1. Structural equations model predicting Socially Antagonistic Attitudes (SAA) and Behaviors (SAB).

although it is true that "correlation does not imply causation", causation does indeed imply correlation and unless the predicted correlations are obtained, a causal theory can be falsified by the rejection of the specific causal model it implies in relation to the empirical data collected to test it.

The parameter estimates reported in a structural model therefore represent what the pathways of causal influence *would probably have been* (under Maximum Likelihood Estimation) if our theory were correct. This is a long-standing tradition in statistics. For example, all the "p-values" reported in conventional univariate statistics are not "real" or empirically derived probabilities of the occurrence of any particular event at all: they are probabilities of obtaining certain values "under the null hypothesis". Hence, traditional "p-values" are probabilities of certain occurrences that are *conditional* upon a specific hypotheses (the null) being true. The same thing is true of path coefficients: they are estimates of causal influence *conditional* upon a correct specification of the model. They are *not* estimates of the magnitudes of the raw associations, which are succinctly summarized in the correlation matrix already presented. Thus, because SEMs are inherently and explicitly about testing *causal theories*, causal language, however cautious or qualified, can not be entirely avoided.

The following are the findings for each of the major hypotheses tested in this path-analytic model:

• As expected, there was no significant bivariate correlation between the two exogenous factors, Slow Life History (SLH) strategy and General Cognitive Ability (*GCA*).
• Both SLH ($\beta = .40$) and GCA ($\beta = .31$) significantly influenced BSR in a *positive* direction, as expected, indicating two independent contributions to heightened self-regulatory abilities.
• In turn, BSR significantly influenced both Socially Antagonistic Attitudes ($\beta = -.30$) and Socially Antagonistic Behaviors ($\beta = -.15$) in a *negative* direction, also as expected, suggesting that older adolescents with greater shifting, updating, and inhibition abilities are less inclined to possess "socially deviant" beliefs and are less inclined to engage in "socially deviant" acts.
• Furthermore, Socially Antagonistic Attitudes (SAA) significantly influenced ($\beta = .27$) Socially Antagonistic Behaviors (SAB) in a *positive* direction, also as expected.

• Finally, GCA directly influenced ($\beta = -.17$) SAB in a *positive* direction, also as expected.

These results indicate that there were *indirect* effects of SLH and GCA through BSR, but no significant *direct* effects of SLH on either SAA or SAB or GCA on SAA. Moreover, these results also indicate a *direct* effect of GCA on SAB that was not through BSR. This pattern of results implies that: (1) BSR only *partially* mediates the observed association between GMA and SAB; whereas (2) BSR provides *complete* mediation of the observed associations between SLH and SAA, between SLH and SAB, and between GCA and SAA.

As with SEM in general, the idea of "mediation" is also inherently a causal concept. To avoid misunderstanding, we are applying it in this case in that BSR provides *complete* mediation because there were *indirect* effects of SLH and GCA through BSR, but there were no significant *direct* effects of SLH on either SAA or SAB, or of GCA on SAA, whereas BSR functions to provide only *partial* mediation of the observed association between GMA and SAB, in that there was also a significant *direct* effect of GCA on SAB that was not through BSR.

12. Discussion

The current work investigated relations among LH strategies, EF, socially antagonistic attitudes and behaviors, and general intelligence. The final structural equations model supported predictions generated from LH theory and articulated in the introduction. The model demonstrates that both slow LH strategies and intelligence ultimately correlate positively with specific psychological abilities (captured under the category label Executive Functions) and behavioral preferences (socially antagonistic attitudes) that correlate positively with actual behaviors (socially antagonistic behaviors).

The finding that slow LH strategies and EF correlate positively suggests that slow LH strategists in our sample tend to be more 'neurologically mature' in terms of frontal functioning compared with fast LH strategists. Furthermore, the negative correlation between LH strategies and antagonistic attitudes and behaviors suggests that slow LH strategists are less likely to engage in socially antagonistic attitudes and behaviors compared to their fast LH counterparts. In line

with LH based predictions, the results demonstrate that self-regulation via Executive Functioning fully mediates the relations between LH strategies and antagonistic attitudes and behaviors. This suggests that mature Executive Functions buffer against socially antagonistic attitudes and behaviors. Last, and as predicted, there was no detectable relation between general intelligence and LH strategies when taking into account self-regulation via Executive Functioning. This finding is consistent with previous work that did not detect a significant relation between LH strategies and general intelligence (Wenner, Figueredo, Rushton, & Jacobs, 2007).

Earlier work by our research group demonstrated that social relations and individual traits such as insight and planning load onto a single higher-order K factor (Figueredo, Vásquez, Brumbach, & Schneider, 2007; Figueredo et al., 2005). Our group has also shown significant relations among the K Factor and a variety of antagonistic social attitudes and behaviors (Wenner, Figueredo, & Jacobs, 2005), adolescent sexual restrictedness (Brumbach, Walsh, & Figueredo, 2007), romantic relationship satisfaction (Olderbak & Figueredo, 2009, 2010), sexual coercion (Gladden, Sisco, & Figueredo, 2008), morality and religiosity (Gladden, Welch, Figueredo, & Jacobs, 2009) and general health, the Big 5 personality traits, and general cognitive ability (Figueredo et al., 2007; Gladden et al., 2009).

The current research extends these results by demonstrating that self-regulation fully mediates the relations between LH strategies and a suite of antagonistic attitudes and behaviors. In addition, general intelligence, although positively correlated with self-regulation and negatively correlated with antagonistic attitudes and behaviors, did not correlate with LH strategies.

To summarize, the model presented rests on the assumption that partially heritable LH strategies help guide the development of neuroanatomical and neurophysiological mechanisms and that these neurological mechanisms then interact with the environment during ontogeny, which shapes the extant neurological function that we ultimately observe (e.g. self-regulation and related Executive Functions). An individual's Executive Functions appear to fully mediate the relationship between LH strategies and the extent to which that individual exhibits typical or antagonistic attitudes and behaviors. Essentially, evolved LH strategies effectively direct the construction of the brain, and mold it to suit the environment in which the organism is developing; this neurological functioning in turn influences social functioning, which is the behavioral output that provides the potential solutions to the adaptive problems the organism is facing. The current model presented and tested here lends support to these notions.

The current model, if correct, has important implications. Psychologists typically assume risky, deviant, and delinquent acts are inherently pathological and that individuals who engage in those acts suffer from some form of psychopathology. Individuals exhibiting these behaviors are often the target of intervention with little regard to the context that elicited or evoked them. LH theory and the results obtained in this study suggest this developmental context is a crucial factor that one must include in any attempt to understand the ultimate causal factors driving socially deviant behavior fully. In stable and predictable environments (e.g., where mortality rate is low and food is plentiful), risky and deviant

behaviors can be more costly than beneficial: there may be little to gain and more to lose. Conversely, unpredictable and unstable environments *reduce* the costs of engaging in risky and or socially deviant pursuits: an individual in an impoverished environment may have more to gain by stealing resources than does an individual in a more resource-rich environment. This may seem obvious, but traditional approaches to risk-taking and social deviance often underestimate the potential benefits of the behavior while overestimating the costs, leading to the erroneous conclusion that socially deviant acts are always maladaptive and thus pathological.

Attending to potential individual *benefits* of socially deviant behavior as well as the more traditional focus on the *costs* may provide the basis for a more balanced intervention strategy (Ellis et al., 2011). If we hope to design interventions to reduce the occurrence of social deviance, understanding *why* particular individuals engage in socially deviant behavior in terms of benefits as well as cost free clinical researchers and clever therapists to develop more innovative strategies for reducing social deviance, perhaps by working with a client's individual motives as opposed to working against them.

The current research also suggests that interventions may be as, or perhaps more effective than attempts to change the individual if these treatments focus on: (1) altering the context within which the individual is situated; or (2) attempt to match the individual to contexts more compatible with their LH strategies. For example, matching fast LH strategists to contexts that promote quick decision-making and provide short-term gains may be a more successful strategy than attempting to 'mold' the individual into using slow LH strategies. In contrast, it may be useful to direct slow LH strategists towards environments that promote long-term gains and reward long-term planning. It is important to note that we base these ideas on the assumption that LH strategies are less malleable later in development, an assertion that requires further empirical investigation.

The current study is limited in that it relied upon self-report measures of LH strategies, Executive Functions, and social deviance. Although we did include neuropsychological tests in the study upon which the present analysis, those data require their own separate treatment. Future work should seek to incorporate more behavioral and externally valid measures of these constructs in order to further our current knowledge regarding how these relationships unfold.

The current research project extends previous work on LH strategies with the goal of promoting consilience (Wilson, 1998), by helping to synthesize literatures from a wide variety of fields of the behavioral sciences. Specifically, the current work integrates evolutionary, developmental, criminological, and clinical neuropsychological approaches in an attempt to understand the mediating mechanisms by which human LH strategies influence socially deviant attitudes and behaviors. We developed and tested a structural model of the developmental influences of slower LH strategy and higher general intelligence, as mediated by behavioral self-regulation through enhanced Executive Functioning, on the inhibition of socially antagonistic attitudes and behaviors. Future research in this area should not only shed further light upon the onset and maintenance of socially deviant acts, but through approaching greater consilience, will inform future intervention strategies and attempts to reduce socially problematic behaviors.

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