Youth and their Artificial Social Environmental Risk and Protective Scores (Ya-TASERPS) Model, version 1.1

Below is a detailed description of the model based on the standard Overview, Design concepts, and Details plus Decision (ODD + D) protocol by Müller et al. (2013). We provide this documentation in order to provide more details about the model and aid others in replicating and extending the model if so desired. The model itself is available at: https://www.comses.net/codebase-release/d425e9c1-04b2-402a-a651-ce98beaf909f/ while Figure 1 shows the graphical user interface of the model. On the left-hand side we have user-specified inputs along with model outputs. NetLogo 6.1 (Wilensky, 1999) was used to implement the model.
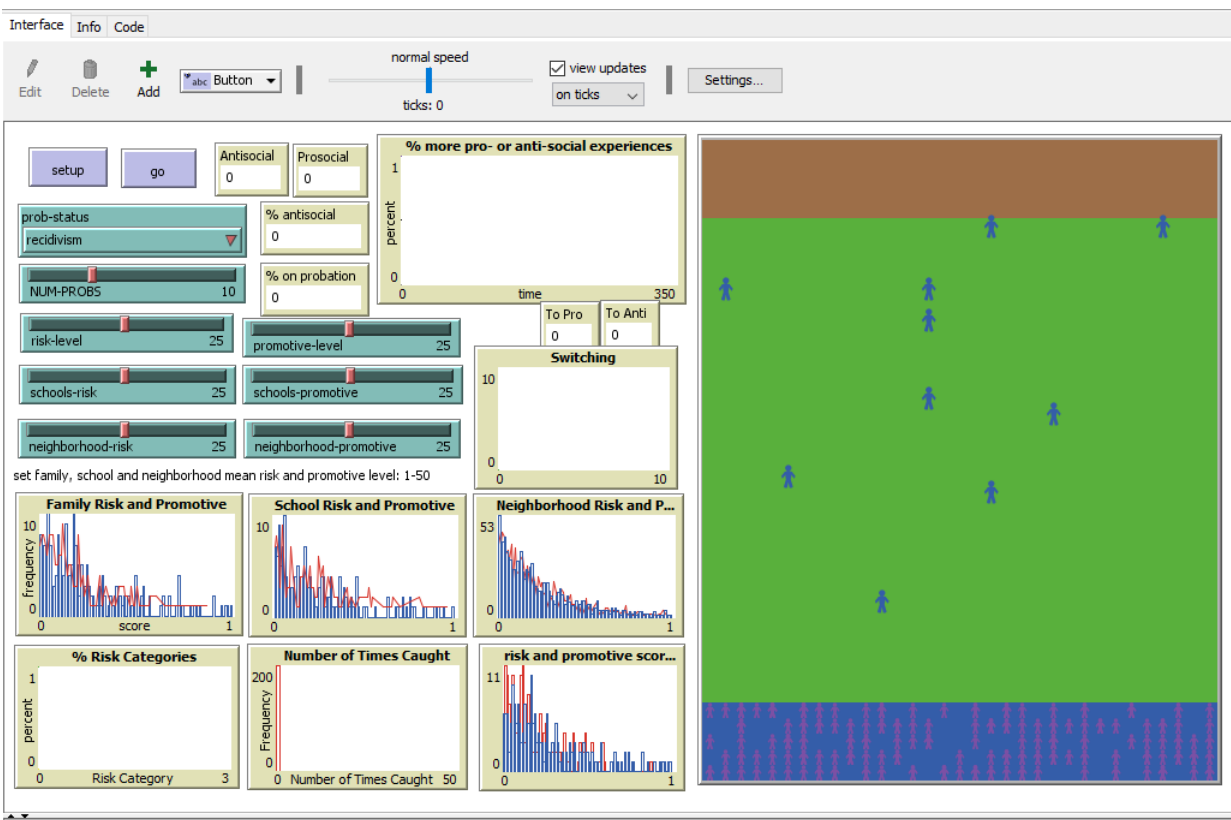

Figure 1. Model Graphical User interface at Initialization.

1. Overview.

1.1: Purpose

This model is for systematically exploring how attempts to intervene in the acquisition of risk and promotive factors may impact a youth's engagement in prosocial and antisocial activities. The original model was developed for exploring a) the premises of interactional theory of delinquency (Thornberry, 1987); and b) how risk and promotive factors accumulate, taking into

account risk in the youth's social environment (see Section 2.1). Interactional theory of delinquency is a developmental theory of process that is based on the premise that individual outcomes are the result of the individual's interaction with their social environment (which will be discussed more throughout Section 2). Additionally, we build on principles of risk and risk assessment approaches in order to simulate the accumulation of risk while also actively exploring the mechanisms proposed by interactional theory of delinquency. This is an abstract, theory-driven model that can be used by scholars and researchers in order to further theory development, specifically in unpacking the specific mechanisms that explain the developmental processes that shape youth engagement in delinquent behaviors.

We build upon this original model to explore how three philosophical approaches to youth justice may impact the acquisition of both risk and protective factors. The original model allows us to frame the youth's development as a complex adaptive system, allowing us to observe how the youth's development is inextricably linked to their environments and cumulative experiences. The youth's interactions with their environments reflect ongoing feedback loops between the youth and their environments, which can create path dependency. It is within this developmental system that we can explore the potential effects of various types of interventions. This is an abstract, prototype model that can be useful for scholars and researchers in order to observe how interventions may impact youth development, with implications for policy.

1.2: Entities, State Variables and Scales

The main entity in this model are the youth agents. Additionally, there are authority agents and three types of spatial units. Details about the agent and spatial parameters are presented in Table 1. Youth agents are assigned family risk and promotive scores and individual risk and promotive scores, which are a cumulative measure of risk and promotive factors. Risk and promotive factors have been extensively identified as predictors of engagement in delinquent behaviors (as will be discussed in Section 2.1). These risk and promotive scores represent the scores these youth would receive if they completed a standardized risk assessment (Baglivio, 2009). Additionally, youth agents will carry an ongoing tally of their prosocial and antisocial experiences, since research suggests that the processes that contribute to prosocial and antisocial outcomes are not the same – for example, the predictors of social connectedness are not the same as the predictors of social exclusion (Lee & Ballew, 2018). These two ongoing tallies capture the youth's behavioral trajectory (Thornberry, 1987).

In addition to the youth agents, the user can select one of three potential authority agents. Within juvenile justice and community supervision, there has been a debate about whether deterrence, punishment, or rehabilitation should be the objective of intervention (Feld, 1999; Hazel, 2008). Thus, the three types of authority agents are abstractions that represent each of these philosophical approaches to youth justice. Additionally, each of the agents are assigned a personal philosophy, as individual workers may not share the same philosophy as the justice system within which they work (as will be discussed in Section 2.2). The agents follow a separate procedure depending on the philosophy driving the intervention. The user can select

None (the original model), **Deterrent** (passive surveillance), **Recidivism** (a punitive approach focused on recidivism reduction), and **Prosocial** (a rehabilitative approach which seeks to foster the youth's prosocial development while reducing the likelihood of recidivism).

In addition to the agents, there are three types of spatial units within the model: *home*, *school*, and *neighborhood*. These spatial units do not represent any real landscapes, but rather, are abstractions that encompass the range of prosocial and antisocial influences a youth may encounter in their homes, schools and neighborhoods. Each of these spatial units is characterized by a probability that a youth in that space will encounter a prosocial opportunity and a probability a youth in that space will encounter an antisocial opportunity to simulate the availability and accessibility of institutional resources in the neighborhood which contribute to developmental outcomes (Leventhal & Brooks-Gunn, 2000). Youth agents are not assigned to specific home spaces, so those spatial units do not have any distinct characteristics. They merely signify that a youth is at home, during which time the youth may interact with their family. The family characteristics (i.e., risk and promotive scores) are assigned to the youth agent rather than the home unit. In contrast to risk and promotive factors in the school and neighborhood environment, which can be location dependent, the transmission of risk and promotive factors from the family occurs through interactions with family members rather than being specific to the location of the home.

Each model step represents a day in the life of a youth, during which they go to school, have free time in the neighborhood, and spend time at home with their families. The model runs for 1800 days, approximately 5 years. Our rationale for this is by doing so, the model starts in early adolescence as the youth are beginning to formulate delinquent values (Thornberry et al., 1991), and extends through the teen years and high school graduation when most of them have reached the age of majority, and thus would be legally recognized as adults (~13 – 18 years old).

Table 1: Parameters and initialization values within the model.

Object	Variable	Theoretical Construct	Value	Reference
Global	1. Promotive-level 2. Risk-level 3. Schools-promotive 4. Schools-risk 5. Neighborhood-promotive 6. Neighborhood-risk 7. Prob-status 8. Num-probs	User-controlled, allows for systematic testing.	Between 1-50.	N/A: This is being tested
School and Neighborhood Patches	Pro-opp	Score based on opportunities assigned to place.	Random-exponential (schools-promotive	Thornberry (1987); Harris et al. (2011); Rodriguez (2013).

			or neighborhood-promotive). Between 0-1.	
	Risk-opp	Score based on risks assigned to place.	Random-exponential (schools-risk or neighborhood-risk). Between 0-1.	Thornberry (1987); Harris et al. (2011); Rodriguez (2013).
Youth	Family-risk	Score based on user-defined risk level.	Random-exponential (risk-level). Between 0-1.	Empirical data
	Family-pro	Score based on user-defined promotive level.	Random-exponential (promotive-level). Between 0-1.	Empirical data
	Individual-risk	Individual risk score derived from family risk.	Random-normal (family-risk). Between 0-1.	Lee (2014); Sampson & Laub (1997); Thornberry (1987).
	Individual-pro	Individual protective score derived from family promotive level.	Random-normal (family-pro). Between 0-1.	Lee (2014); Sampson & Laub (1997); Thornberry (1987).
	Prosocial	Running tally of prosocial experiences.	0	Lee & Ballew (2017)
	Antisocial	Running tally of antisocial experiences.	0	Lee & Ballew (2017)
	Caught	Tracks the number of times a youth is "arrested." This provides a measure of the youth's legal history.	0	Lee & Taxman (n.d.)
	Risk-cat	This represents the risk category the youth would be assigned to based on a risk assessment. These risk categories are important factors in justice work.	0	Baird et al (2013)
	on-prob	This is an indicator of whether the youth is on probation.	False	N/A: This is for administrative record keeping purposes.

|	visits	This tracks the number of times a youth visits an authority figure.	0	N/A: This is for administrative record keeping purposes.
Authority Figure	pun-tx	This represents the individual authority figure's personal philosophy on punishment versus rehabilitation.	Random. Between 1 (punitive)-5 (rehabilitative).	Mackey et al. (2023)

1.3: Process Overview and Scheduling

The model sequence consists of three main routines that occur within each day. The flow of these three routines are presented in Figure 2, and are explained in more detail in Section 3.4. These three routines were selected to reflect the major social contexts, and thus influences, in the lives of adolescents – parents (families), schools, and neighborhoods (Sampson & Laub, 1997; Thornberry & Krohn, 2005). Peer influences are embedded within the school and neighborhoods, and any work, religious, or other activities are embedded within the neighborhoods.

Once the agents wake up, they enter the *school routine*, during which a youth makes choices to stay in school or leave school – this is explained further in Section 2.1. If the youth leaves school early, their antisocial score increases – they are at risk of falling behind in their classes, getting arrested for truancy, and/or otherwise getting in trouble. If they stay in school, their prosocial score increases periodically (which is stochastic dependent on the school's promotive score), since they have stayed within an educational environment and are closer to high school graduation. Similarly, if they have left school early, their antisocial score increases periodically, which is also stochastic and dependent on the school's risk score – this is discussed further in Section 2.9.

Second is the *after-school routine*, during which a youth may be presented with prosocial or antisocial opportunities, and makes choices about whether to engage in an opportunity – this is also explained further in Section 2.1. If the youth engages in a prosocial opportunity, such as playing on a sports team or working a job at the mall, their prosocial score increases periodically, which is stochastic dependent on the individual's promotive score. If the youth engages in an antisocial opportunity, such as smoking marijuana with their friends, their antisocial score increases periodically, which is stochastic dependent on the individual's risk score – this is discussed further in Section 2.9.

In addition, the *after-school routine* also introduces an authority figure who will intervene in antisocial opportunities and activities. The authority figure's routine depends on the scenario selected by the user, but there are three types of activities. First, the authority figure simply

acts as a Deterrent – they provide passive surveillance but does not actively intervene. A youth, if presented with an antisocial opportunity near an authority figure, will decline the opportunity. In the second and third types, the authority figure can intervene and acts to alter the youth's acquisition of risk and promotive factors. We discuss the authority figure's decision making further in Section 3.4.
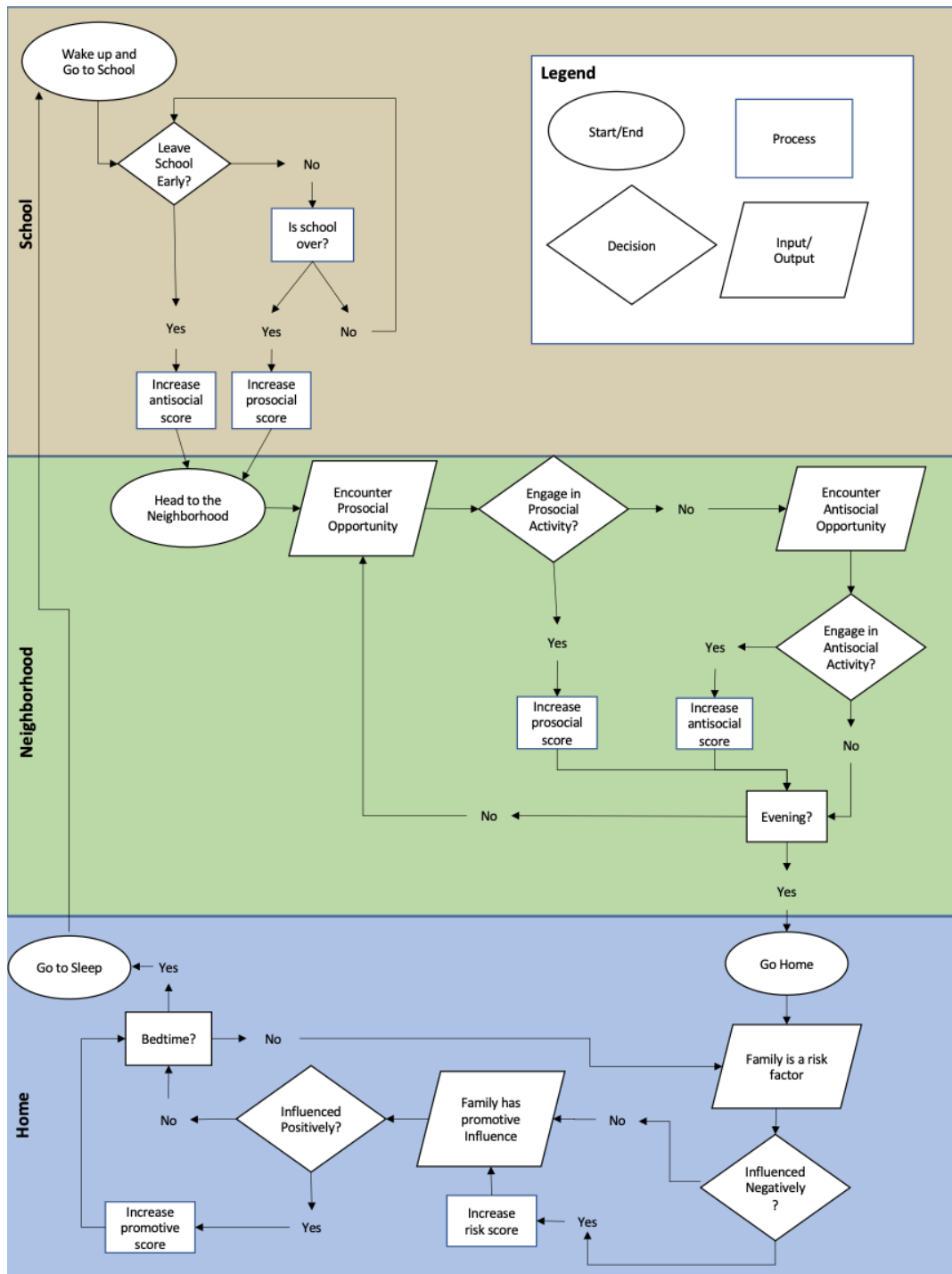
Figure 2: Model flow diagram.

Third is the *home routine*, during which a youth's risk factors or promotive factors may be increased by the socializing influence of their family. For example, messages of the importance of staying in school may be reinforced, which would contribute to their promotive score. On the other hand, there may be family members who smoke marijuana and expose the youth to this behavior, thus increasing the youth's risk score.

2: Design Concepts

2.1: Theoretical and Empirical Background

This model is guided by Thornberry's (1987) interactional theory of delinquency. The theory is based on the key assertion that *"human behavior occurs in social interaction and can therefore best be explained by models that focus on the interactive process"* (Thornberry, 1987, p. 864). Thus, an individual's behavioral outcomes (e.g., delinquency) cannot be understood in isolation from their social environment.

Thornberry and Krohn (2005) identify three fundamental premises to the theory. First, interactional theory of delinquency takes a developmental life-course perspective. A life course perspective acknowledges an individual's agency while recognizing that individuals are embedded within social relationships (Elder, 1994). Within this perspective, factors that contribute to the initiation, maintenance, or desistance of delinquency change during developmental periods. Thus, while in childhood, the family plays a critical role in the youth's development, in adolescence, as the youth is becoming more independent, the family plays a less important role while peers and schools begin to play a more important role (Sampson & Laub, 1997; Thornberry & Krohn, 2005). Additionally, delinquent values do not begin to form until early adolescence (Thornberry et al., 1991). Moreover, an individual's success in one developmental stage has implications for success in later stages (Thornberry & Krohn, 2005). Success in adolescence will situate the youth for a successful adulthood, and thus warrants study.

The second premise is *bidirectional causality*, which captures the interaction between the individual and their environment (Thornberry & Krohn, 2005). Not only do factors from an individual's social environment change the youth's risk, but the youth's behaviors and choices also shape the social environments in which they exist (Thornberry & Krohn, 2005). The reciprocal relationship between the youth and their social environment occurs through both the interactions with individuals (e.g., parents, teachers, peers) as well as in the changing set of opportunities available to the youth. Interactions between the youth and their social environment are mutually reinforcing, resulting in behavioral trajectories (e.g., delinquency) that are path dependent (Thornberry, 1987). This process is the result of the ongoing consistency of the individual's behaviors (cumulative continuity) as well as the responses from others that maintain the individual's behaviors (interactional continuity) (Sampson & Laub, 1997). For example, a youth who skips school actively plays a role in shaping their future opportunities – if they continue to make these choices, they may fall behind in school, which

may limit their college options. At the same time, there may be maintaining responses from others such as a suspension from school or an arrest for truancy, which would contribute to the disruptions to the youth's academic progress and thus, propel the youth on their current behavioral trajectory.

Finally the third premise of the interactional theory is *proportionality of cause and effect*, which "states that as the magnitude of the causal force increases, the person's involvement in crime (a) becomes more likely and (b) increases in severity" (Thornberry & Krohn, 2005, p. 189). This approach embraces the idea of equifinality in that it isn't about specific causal factors, but rather, the accumulation of causal factors (Arthur et al., 2002).

There is some empirical evidence that supports interactional theory of delinquency, yet existing statistical approaches provide only a limited test of this theory of process -- even studies that use longitudinal data must rely upon point in time measures with large gaps between those measures (Hoffmann et al., 2013; Jang, 1999; Lee, 2003; Thornberry et al., 1991). One study tested the developmental, life-course perspective premise of interactional theory that there are age-varying effects of family, school, and delinquent peers on adolescents (Jang, 1999). Jang (1999) used multilevel modeling with five waves of data from the National Youth Survey, and found that school and peers have a curvilinear effect while families have a consistent effect on adolescents. This supports the notion that depending on the youth's developmental stage, different factors have stronger or weaker effects.

Studies testing interactional theory of delinquency have tended to focus on the bidirectional causality premise. For example, Thornberry et al. (1991) used three waves of data from the Rochester Youth Development Study, and found reciprocal relationships between a youth's bond to family and school, and engagement in delinquent behaviors. Similarly, Lee (2003) used a structural equation modeling approach with four time points from the National Youth Survey, and tested not only family, but also peers, and found that reciprocal relationships with peers play a stronger role than families. Finally, Hoffman, Erickson, & Spence (2013) also used structural equation modeling with two waves of Add Health data to test the reciprocal relationship between delinquency and academic achievement. They found partial support for interactional theory where academic achievement is related to later delinquency, but delinquency is not directly related to later academic achievement (Hoffmann et al., 2013).

While these studies provide evidence to support bidirectional causality, these rely on several point-in-time estimates that are months or years apart to establish the reciprocal relationships. Thus, existing studies provide only partial tests of the theory, and while they have been promising, they are limited. Using other approaches, such as agent-based modeling, may be useful in testing the generative mechanisms and provides a richer understanding of the phenomena under study by "triangulating" various approaches that have different strengths and limitations.

This model takes a stylized facts approach to modeling interactional theory (Heine et al., 2005). The youth's social environment is highly abstract and is represented only by two scores

(factors): risk and promotive. These scores act as the probability that a given youth in that location will be presented with an antisocial opportunity (based on risk score) or prosocial opportunity (based on promotive score). In both instances, the prosocial or antisocial opportunities could be activities (e.g., extracurricular activities, volunteer activities), or could also represent the positive or negative influence of their peers (e.g., graffiti, stealing, smoking pot). When faced with these opportunities, the youth may choose the opportunity presented to them, or may forego the opportunity depending on their own risk and promotive scores. Their choices result in increases to their tally of either antisocial or prosocial experiences, which can be thought of representing the youth's behavioral trajectory.

2.2: Individual Decision-making

Decision-making occurs at the individual level. Each individual youth holds a set of risk and promotive factors, as well as a tally of antisocial and prosocial experiences. These four factors contribute to the youth's decision when presented with a prosocial or antisocial opportunity in school and in the neighborhood. A youth's risk score increases the likelihood of choosing an antisocial opportunity while a youth's promotive score increases the likelihood of choosing a prosocial opportunity. The interaction of these factors are represented in Figure 3.
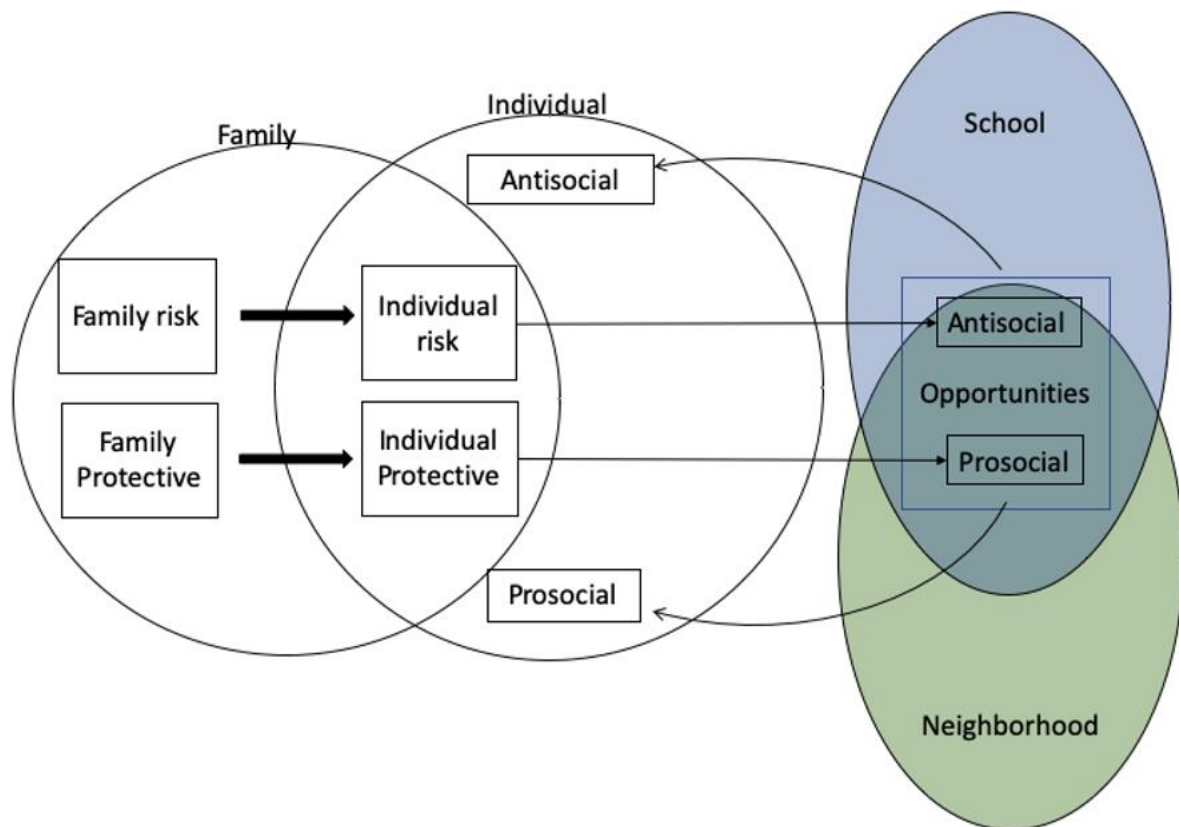
Figure 3: Logic of interactions within the model.

Every hour, the youth might move around the community. Then, depending on the risk and promotive levels of their location, they may meet a positive influence or a negative influence. Based on their individual risk or promotive level, the youth may engage in a prosocial experience (if they encounter a positive influence) or an antisocial experience (if they encounter a negative influence). In the prosocial scenario, if the youth takes the positive opportunity, their promotive level increases.
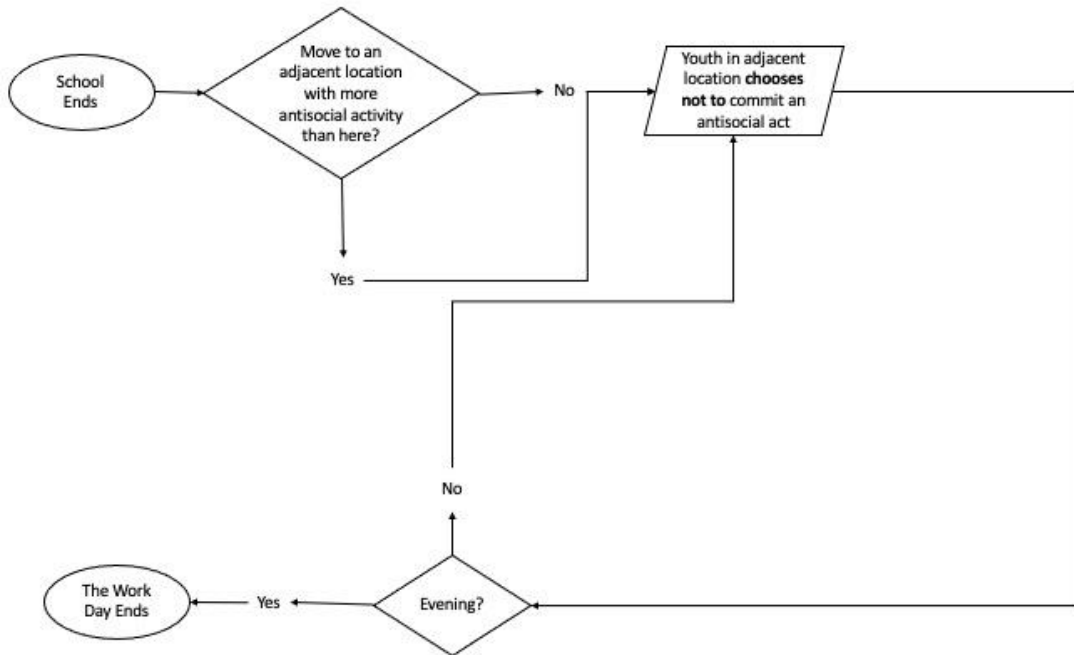
The authority agents' decision flow chart are represented in figure 4. The decision-making process differentiates the three versions of the authority agents. In the scenarios where there are authority figures, the authority figure first makes a decision about whether they will move. One fifth of the time, the probation officer will look around and see if there is a neighboring location that is a "hot spot" -- in the sense of a location where more youth are engaging in antisocial behaviors. In the Deterrent scenario, if there is an authority figure around the youth, the youth will decline a negative opportunity.

In the Recidivism or Prosocial scenarios, if there is an authority figure around the youth, there are a series of rules to determine whether the youth is arrested, which takes into account the youth's assigned risk category (an abstraction of a completed risk assessment) and the probation officer's philosophical orientation. If the youth is already labelled as "antisocial" (e.g., defined as having more antisocial than prosocial experiences), high-risk youth are automatically arrested, medium youth risk might be arrested, and low risk youth are unlikely to be arrested. In the recidivism scenario, the risk category for "first time offenders" is set by the individual's risk level. In the prosocial scenario, the risk category is set by the individual's buffer level -- the individual risk level minus the individual promotive level. For "repeat offenders," the number of times the youth has already been caught (i.e., offense history) is combined with individual risk or buffer levels to adjust the risk category higher (Lee & Taxman, n.d.).
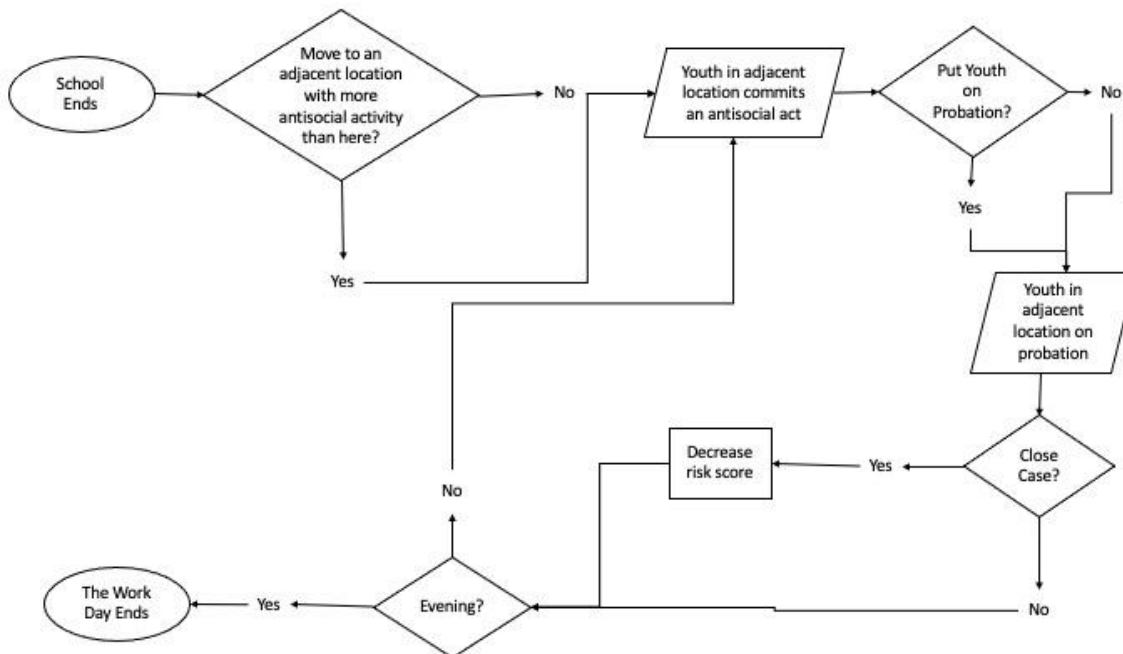
The probability of being arrested also depends on the authority figure's philosophical orientation along the punishment-treatment continuum. Thus, a punitively oriented figure is probably going to arrest the youth, someone in the middle might arrest the youth, and someone treatment oriented probably won't arrest the youth. If the youth is considered arrested, they will be put "on probation."
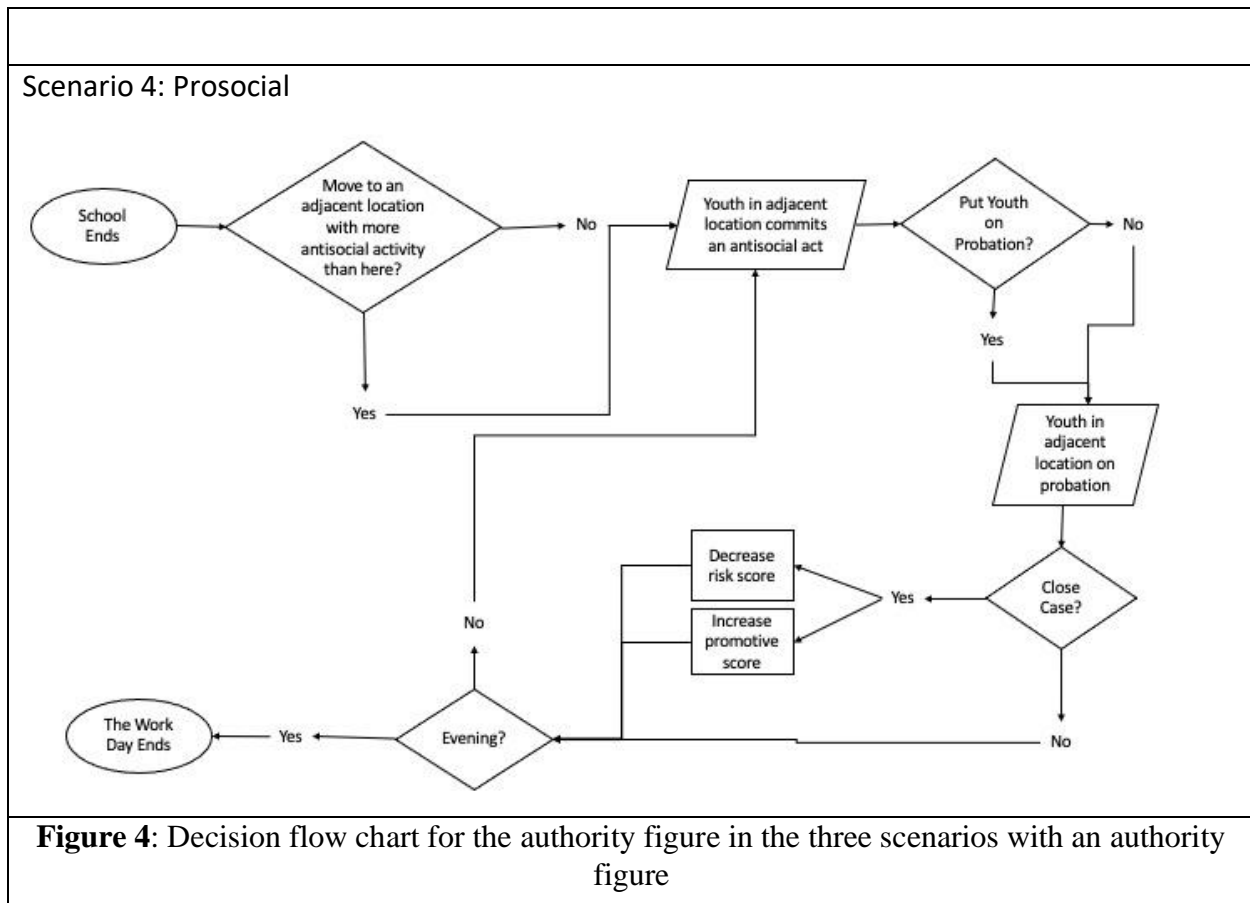
At the end of the hour, an authority figure decides whether to close any cases. They look around, and depending on the youth's number of visits to an authority figure and risk category, the case may be closed. In the recidivism scenario, the risk level will decrease at closing. In the prosocial scenario, both the risk level will decrease and the promotive level will increase.

Scenario 2: Deterrent

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│ Ends    │     ╱ Move  ╲                         │ adjacent     │
└─────────┘     ╲ to an  ╱                        │ location     │──────┐
                ╲adjacent╱                        │ chooses      │      │
                ╲location╱                        │ not to commit│      │
                 ╲  ?  ╱                          │ an antisocial│      │
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Scenario 3: Recidivism

Scenario 4: Prosocial

Figure 4: Decision flow chart for the authority figure in the three scenarios with an authority figure

2.3: Learning

While there is no learning per se, agents do adapt and change based on their experiences. A youth's risk and promotive factors and their tally of antisocial and prosocial experiences both are updated after they engage in prosocial or antisocial experiences. Their risk and promotive factors can also be updated by the family, depending on what the family's risk or promotive scores are. The youth's decision-making process does not change – only the quantities that inform their calculations.

2.4: Individual Sensing

The spatial scale of sensing is local, and occurs in the school and the neighborhood setting. Depending on the location's risk and promotive score, a youth may be faced with a prosocial or antisocial opportunity. The youth is aware of the prosocial or antisocial opportunity, if presented. The youth is also aware of whether there is an authority figure nearby.

The authority figure is also able to sense youths who are nearby, and is aware of whether the youth is engaging in antisocial behavior. Additionally, each location tracks the number of antisocial events occurring in that location. The authority figure is able to sense adjacent "hot spots" – as in the closest neighboring location where the most incidents of antisocial events occurred.

2.5: Individual Prediction

The youth do not make predictions. Our rationale for this is that their brain has not fully developed and their future orientation will continue to increase as they make the transition to adulthood; their assessment of risk is different from that of adults (Steinberg, 2008).

The authority figures do not make predictions. Our rationale is that they are tasked with responding to behavior, not attempting to predict behavior.

2.6: Interaction

This model focuses on interactions between the individual and the environment. Interaction with others is simulated at an abstract level – the individual interacts with their families in the evenings, and thus the family may influence the individual's risk or promotive score during this period. At school, a peer or a teacher's positive or negative influence is captured abstractly in the location risk and promotive score – which a youth in the model will react to.

This model also draws attention to interactions between youth and authority figures. The user can select the type of authority figure, which defines the potential responses an authority figure may have to the youth. The authority figure may simply influence the youth's decision about whether to engage in an antisocial activity. Alternatively, if the authority figure sees a youth engaging in an antisocial activity, the authority figure may choose to put the youth "on probation" and will make decisions about when to consider the youth's probation complete. When the youth's probation is complete, the youth's risk score may decrease and/or promotive factor may increase. At the same time, being on probation will increase the youth's risk level, which will increase the likelihood the youth will receive an official sanction if caught in an antisocial activity in the future.

2.7: Collectives

In the current model, there are no collectives.

2.8: Heterogeneity

Within the model, there is heterogeneity of agents, including youth, authority figures and locations. Youth vary based on their risk and promotive scores. Authority figures vary within a given model based on their personal philosophy of punitive versus treatment, which influences the probability a youth will be arrested. Each location varies based on its risk and promotive scores, where a risk score increases the likelihood that a youth in that location will be presented with an antisocial opportunity, and a promotive score increases the likelihood that a youth in that location will be presented with a prosocial opportunity.

2.9: Stochasticity

As is common in many agent-based models there is randomness in how certain attribute values are assigned at the initialization of the model. For the individual, their family risk and promotive scores are randomly assigned following an exponential distribution centered on a user-set value (as outlined in Table 1). The youth's individual risk and promotive scores are randomly assigned following a normal distribution and centered on their family risk and promotive scores. For the

location, the probability of a prosocial or antisocial opportunity is randomly assigned following an exponential distribution and centered on a user-set value. These parameters are used as probabilities. Whether a youth encounters a prosocial or antisocial influence is based on these probabilities. Additionally, whether a youth tally of prosocial or antisocial experiences is increased is also stochastic – since they will be faced with multiple opportunities, but not every opportunity will be so impactful that it affects their behavioral trajectory.

There is stochasticity associated with the authority figures as well. Their personal orientation toward punishment versus treatment is randomly assigned and defines the probability they will arrest a youth. For youth who are on probation, once they reach a minimum number of visits to a probation officer, there is a stochastic element to whether their case will be closed if they are medium or high risk.

2.10: Observation

The initial distribution of each individual's family risk and promotive factors, and the distribution of the risk and promotive score of each location are initially displayed (see Figure 1). The distribution of individual risk and promotive scores are shown at initialization, which are updated throughout the model. Additionally, the average antisocial and prosocial scores are displayed, as well as the percent of youth in the simulation with an antisocial score that is higher than their prosocial score. There is also a graph that shows the percent of youth with a higher antisocial than prosocial score, percent of youth with a higher prosocial than antisocial score, percent of youth with equal antisocial and prosocial scores, and percent of youth on probation.

There is also an indication of the percent of youth in the simulation that are on probation. To explore the youth's experiences on probation, there is an indicator of the risk category youth are assigned to and the number of times each youth was caught (to observe the distribution of "arrests" across the population of youth). To explore path dependency, there is a count of the number of times a youth switches from the antisocial to prosocial category and vice versa. There is also a line graph. These monitors are updated throughout each model run.

3: Details

3.1: Implementation Details

The model is implemented in NetLogo 6.1 (Wilensky, 1999).

3.2: Initialization

Upon initialization, the world is created (see Figure 1), which consists of the youths' homes (blue), their schools (brown), and their neighborhoods (green). A youth's movements are likely more restricted at home and at school. Thus, these areas are smaller than the neighborhood, where youth likely have more autonomy and a less predictable range of experiences.

Table 1 shows the initialization values for each variable. Each school cell (which in the model is a unit within the landscape) and neighborhood cell is assigned a probability of encountering both risk and prosocial opportunities, which can be manipulated by the user. This allows the

user to systematically altered the youth's environmental risk in order to examine the effect of each on youth outcomes (see Figure 1). Each school and neighborhood location is randomly assigned a risk and promotive probability following an exponential distribution and centered on a user-provided value. The exponential distribution was selected based on studies that suggest that risk tends to cluster environmentally (Harris et al., 2011; Rodriguez, 2013; Sampson et al., 2002), and thus would resemble a distribution with more frequent low-risk locations and a few higher risk locations, such as an exponential distribution. These scores are restricted to between 0.01 and 0.99 since in this model, they act as probabilities. In life, there is always some uncertainty, so actual values of 0 and 1 are not assigned.

Next, 200 youth are created and sent to their homes, which is set based on the size of the grid that represents the world so that randomly sending youth to a home cell results in a combination of both spread (i.e., multiple families are represented) and overlap (i.e., households can have more than one youth). The youth are grey, but they will become red if their antisocial experience score is higher than their prosocial experience score, and they will become green if their prosocial experience score is higher than their antisocial experience score. They will become violet if they are on probation. Youth, rather than home cells, are assigned their family-risk and family-protective scores. Similar to the distribution of school and neighborhood risk and prosocial opportunity scores, the family scores are assumed to follow an exponential distribution. This is based on the distribution of actual data from youth on probation from one mid-Atlantic state, where the family risk subscale appears to follow an exponential distribution (see Figure 5). These scores are also restricted to between 0.01 and 0.99, since they act as probabilities in this model. In life, there is always some uncertainty, so actual values of 0 and 1 are not assigned.

Next, if the user has selected one of the scenarios with an authority figure, a user-defined number (between 1-30) will be created. Each authority figure is assigned a personal orientation toward punitiveness or treatment, on a scale from 1 (most punitive) to 5 (most rehabilitative). This reflects the heterogeneity that individual probation officers bring to their jobs, which will underly they work with each youth. In this model, this personal orientation defines the probability they will arrest a youth that they observe engaging in an antisocial activity.
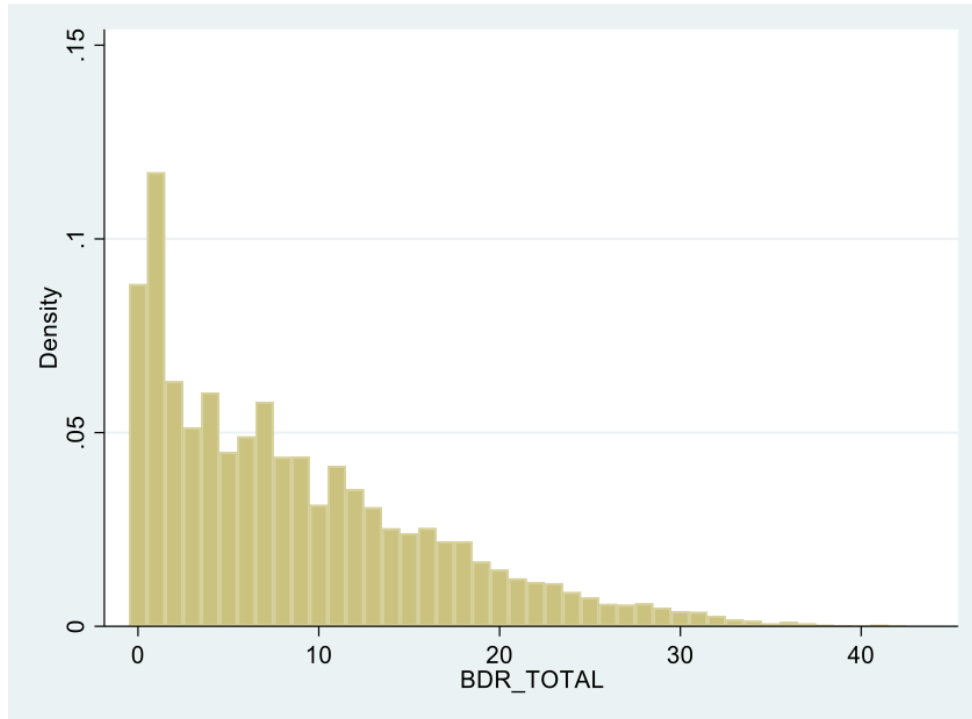
Figure 5: Family dynamic risk scores for youth on probation from one state.

3.3: Input Data

There is no input data.

3.4: Submodels

The model consists of three processes, which is determined by the youth's location and time of day. Throughout these processes, risk and promotive scores act as probabilities: if a location has a higher risk score, there is a higher probability the youth will be presented with an antisocial opportunity. If the youth has a higher risk score, there is a higher probability the youth will choose any antisocial opportunities presented to them. Conversely, if a location has a higher promotive score, there is a higher probability the youth will be presented with a prosocial opportunity. If the youth has a higher promotive score, there is a higher probability the youth will choose any prosocial opportunities presented to them.

At the start of the day, the youth goes directly to school, where they spend 6 hours (7am-2pm). This duration is an estimate based on a typical high school day. At each hour, the youth may be presented with a prosocial opportunity, depending on the probability of a prosocial opportunity assigned to the school location the youth is on. These hourly choices roughly approximate students switching classes during the school day and the interactions/exchanges that occur during those transitional periods. If the youth chooses the prosocial opportunity, which is based on their individual promotive score (a probability), they move to a different location in the school. If not, they youth may be presented with an antisocial opportunity, depending on the probability of a risk opportunity assigned to the school location the youth is on. In this

model, the antisocial opportunity is leaving school early (i.e., playing hooky). Whether the youth takes the opportunity depends on their individual risk score (a probability).

If the youth stays in school for the whole day, the youth's tally of prosocial experiences may increase depending on the youth location's promotive score (i.e., probability of having a lasting positive impact on a student). If the youth leaves school early (i.e., plays hooky), depending on the youth location's risk opportunity, the youth's tally of antisocial experiences may increase (i.e., probability of having a lasting negative impact on the student). If the tally increases, whether prosocial or antisocial, it increases in an equal increment – the overall score relative to the other youth in the model is more informative than a single instance of increasing a youth's tally. This randomness is programmed since it is assumed that every event will not be equally impactful on the youth.

After school ends, the youth has free time. The youth is assumed to be in the neighborhood for 5 hours (2pm-7pm). This represents the youth's growing autonomy, which coincides with the growing influence of peers during this period (Stoddard et al., 2012). During this time, the youth may encounter a prosocial influence depending on their location's promotive score (a probability). These prosocial opportunities could be playing on a soccer team, finding a job at the local pool, or participating in a religious group. If the youth chooses the prosocial opportunity, based on their individual promotive score (a probability), their tally of prosocial experiences will increase. If they do not encounter a prosocial influence, they have a chance of encountering an antisocial influence depending on their location's risk score (a probability). These antisocial influences could be smoking marijuana or drinking alcohol at a party, vandalizing a wall, or stealing some clothes. If the youth chooses the antisocial opportunity, based on their individual risk score (a probability), then their tally of antisocial experiences increases. If the tally increases, whether prosocial or antisocial, it increases in an equal increment – the overall score relative to the other youth in the model is more informative than a single instance of increasing a youth's tally. This randomness is programmed since it is assumed that every event will not be equally impactful on the youth. Table 2 outlines the rules for the accumulation of risk and protective scores and antisocial and prosocial opportunities as the model runs, for each user-selected justice intervention scenario.

When presented with an antisocial opportunity, there may be interaction with an authority figure. In the Deterrence scenario, a youth will look around and only accept the antisocial activity if there are no authority figures around. In the other two scenarios, the authority figure makes the decision as to whether to arrest a youth engaging in an antisocial activity. This decision is based on both the youth's risk category and the authority figure's personal orientation toward youth justice. The youth is in a "none" category until they are arrested. Once they are arrested (and every time thereafter), their risk category is assessed based on 1) their existing risk category, 2) their individual risk score, and 3) the number of times they've been arrested (i.e., legal history). Once a youth is arrested and put on probation, each time they are near a probation officer is considered a "visit". After a certain number of visits (depending on their risk category), the authority figure may decide to close the case. When this occurs, there is a probability that a youth's risk score will be decreased in both the Recidivism and

Prosocial scenarios. Additionally, there is a probability that the youth's promotive score will increase in the Prosocial scenario.

Table 2: Rules for updating youth variables, by youth justice scenario

Variable	Youth Justice Scenario			
	None	Deterrence	Recidivism	Prosocial
Individual-risk	Every 6 months, youth have a probability (based on family-risk score) of their risk score either increasing by .001 for antisocial youth or decreasing by .001 for prosocial youth.	Every 6 months, youth have a probability (based on family-risk score) of their risk score either increasing by .001 for antisocial youth or decreasing by .001 for prosocial youth.	Every 6 months, youth have a probability (based on family-risk score) of their risk score either increasing by .001 for antisocial youth or decreasing by .001 for prosocial youth. **Reduces risk score by .01 when probation case closes**	Every 6 months, youth have a probability (based on family-risk score) of their risk score either increasing by .001 for antisocial youth or decreasing by .001 for prosocial youth. **Reduces risk score by .01 when probation case closes**
Individual-promotive			Every 6 months, youth have a probability (based on family-protective score) of their protective score either increasing by .001 for prosocial youth or decreasing by .001 for antisocial youth.	Every 6 months, youth have a probability (based on family-protective score) of their protective score either increasing by .001 for prosocial youth or decreasing by .001 for antisocial youth. **Increases promotive score by .01 when probation case closes**
Prosocial experiences	Increases .10 if at school at the end of the day and the	Increases .10 if at school at the end of the day and the	Increases .10 if at school at the end of the day and the	Increases .10 if at school at the end of the day and the

	school's prosocial opportunity score is greater than a random number. While in the community, if there is a positive opportunity at the youth's location, if their promotive score is higher than a random number, their prosocial experience increases by .10.	school's prosocial opportunity score is greater than a random number. While in the community, if there is a positive opportunity at the youth's location, if their promotive score is higher than a random number, their prosocial experience increases by .10.	school's prosocial opportunity score is greater than a random number. While in the community, if there is a positive opportunity at the youth's location, if their promotive score is higher than a random number, their prosocial experience increases by .10.	school's prosocial opportunity score is greater than a random number. While in the community, if there is a positive opportunity at the youth's location, if their promotive score is higher than a random number, their prosocial experience increases by .10.
Antisocial experiences	Increases .10 at the end of the school day if the youth left school early and the community location's risk opportunity score is greater than a random number If the youth does not encounter a positive influence, they may, instead, encounter a negative influence. If their risk score is higher than a random number, their antisocial score increases by .10.	Increases .10 at the end of the school day if the youth left school early and the community location's risk opportunity score is greater than a random number If the youth does not encounter a positive influence, they may, instead, encounter a negative influence. **If there is no probation officer nearby, and** if their risk score is higher than a random number, their antisocial score increases by .10.	Increases .10 at the end of the school day if the youth left school early and the community location's risk opportunity score is greater than a random number If the youth does not encounter a positive influence, they may, instead, encounter a negative influence. If their risk score is higher than a random number, their antisocial score increases by .10.	Increases .10 at the end of the school day if the youth left school early and the community location's risk opportunity score is greater than a random number If the youth does not encounter a positive influence, they may, instead, encounter a negative influence. If their risk score is higher than a random number, their antisocial score increases by .10.
Number of times caught	Not applicable	Not applicable	Increases by 1 each time a youth is put on probation.	Increases by 1 each time a youth is put on probation.

Risk category	Not applicable	Not applicable	When a youth is put on probation, set to **high, medium, or low** based on 1) current risk category; 2) individual's risk score; and 3) history of times on probation.	When a youth is put on probation, set to **high, medium, or low** based on 1) current risk category; 2) individual's buffer score (risk score – protective score); and 3) history of times on probation.
On Probation?	Not applicable	Not applicable	Set to true if youth is near a probation officer when they commit an antisocial act AND a probability based on the PO's philosophy, where a punitive approach = 75% likelihood and rehabilitative approach = 10% likelihood. This is adjusted to a higher probability if the youth's risk category is medium or high. Can be set to false after the youth reaches a minimum number of visits with a PO, and in combination with their risk category (i.e., they are on probation longer if they are in a higher risk category)	Set to true if youth is near a probation officer when they commit an antisocial act AND a probability based on the PO's philosophy, where a punitive approach = 75% likelihood and rehabilitative approach = 10% likelihood. This is adjusted to a higher probability if the youth's risk category is medium or high. Can be set to false after the youth reaches a minimum number of visits with a PO, and in combination with their risk category (i.e., they are on probation longer if they are in a higher risk category)
Visits to PO	Not applicable	Not applicable	If youth on probation and is in the community	If youth is on probation and is in the community

			adjacent to a PO, visits increase by 1.	adjacent to a PO, visits increase by 1.

At the end of the day, the youth returns to a home location and we assume stays there and awake for 4 hours (7pm-11pm). This is approximately the time it takes to participate in dinner (cooking, eating, and/or cleaning up) and allows for time after dinner before bed. During this time, the individual risk or promotive score can be modified through their families, who are one of their primary socializing influences (J. S. Lee, 2014). Youth may be influenced positively or negatively depending on the family risk and promotive scores (Stoddard et al., 2012). Whether the youth is susceptible to the influence is dependent on their own individual scores. If the youth's risk score is greater, they are susceptible to the antisocial influence. If the youth's promotive score is greater, they are susceptible to the prosocial influence. This operates as a positive feedback loop. Thornberry (1987) describes the youth's behavioral trajectory, where the reciprocal nature of interactions reinforce each other, resulting in an increasing likelihood of engagement in crime or alternatively, prosocial behaviors.

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