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Risk in New Sexual Relationships: Trajectories of Protection*

David C. Bell

Department of Sociology, Indiana University-Purdue University Indianapolis, 425 University Blvd, Indianapolis, IN 46202-5140
dcbell@iupui.edu

Abstract

How do sex risk and protection change over the course of a relationship? It is often claimed that protection generally declines over the course of relationships. This 3-year longitudinal study examines 412 new sexual relationships described by 126 adult participants and tests this claim. Analyses identify four relationship trajectories: only 15% of new sex relationships show a declining trajectory of protection; another 12% show only a temporary decline. Population average analyses previously interpreted to show a decline in protection are shown here to be is largely explained by the attrition of the low trust, high protection relationships that creates the association between higher trust and lower protection. The long-term relationships turn out mostly *not* to have been low trust, high protection relationships at the start. Instead they have mostly always been high trust, low protection relationships. Other proposed theories, notably self-protection and power theories are not supported, while drug use is supported for 15% of the sample. Only trust and secondary partners successfully account for the observed patterns of protection and attrition. Actors seem to be concerned to protect their partners, using more protection with a secondary partner who might provide a risk to the primary partner.

Keywords: Sexual risk; sexual protection; sexual relationships; finite mixture models; trajectory models; drug use; condom use

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Introduction

It has been regularly observed that protective sexual behaviors such as condom use are less for main or primary partners than for secondary or casual partners (Dolcini, Coates, Catania, Kegeles, & Hauck, 1995; Lansky, Thomas, & Earp, 1998; Rosengard, Anderson, & Stein, 2004), less for long-term partners than short-term partners (Anderson et al., 1999; Cusick, 1998; Misovich, Fisher, & Fisher, 1997; Sheeran, Abraham, & Orbell, 1999), and less for close partners than non-close partners (Crawford et al., 2003). Since casual partners often become main partners, this pattern has been interpreted to mean that relationships in general move from high protection in the beginning to low protection as they become main, close, or primary. This hypothesized pattern will be referred to here as the hypothesis of the "declining trajectory of protection." A number of theories have been proposed to account for this purported trajectory. Although this interpretation of main/casual, primary/secondary, long term/short term partners has frequently been proposed, there do not appear to be any direct tests of this trajectory for adult relationships.

It is useful to consider the nature of risk and protection in the context of sex behaviors and HIV. Every act that allows contact with the bodily fluids of another has some risk (Centers for Disease Control and Prevention, 2018). There are two fundamental approaches to protect oneself from HIV and related infections. The first is serosorting (Eaton et al., 2007; McFarland et al., 2012; Mizuno et al., 2010). Serosorting, where persons not infected by HIV choose only partners also not infected, is the best method to avoid HIV transmission if carried out effectively. Unfortunately, people can be quite ineffective in trying to carry out this strategy. Successful serosorting requires accurate knowledge of the HIV status of one's sex partners, which depends on their open disclosure of their HIV status, a condition all too often not available (Greene, Derlega, Yep, & Petronio, 2003; Petronio, 2002). When open disclosure is not available, people are quite inaccurate in their attempts to infer partner HIV status (Ekstrand, Stall, Paul, Osmond, & Coates, 1999; Swann, De La Ronde, & Hixon, 1994).

The second approach to protection is seroadaptation (Bell, Atkinson, Mosier, Riley, & Brown, 2007; McFarland et al., 2012; Zhu & Weiss, 2013), choosing behaviors with a particular partner that reduce the chances of HIV transmission. There are three classes of protective behavior: *frequency*, fewer acts of sex is more protective than more sex; *type of sex*: oral sex is safer than vaginal sex, which is safer than anal sex; and *condom use*: a condom reduces risk of HIV transmission when used effectively and consistently. The declining trajectory of protection describes a seroadaptive process.

The purpose of this paper is to test the claim of a general declining trajectory of protection within new adult sexual relationships. Using a unique longitudinal dataset and a method that allows the detection of multiple trajectories of change, this study investigates whether the declining trajectory is true for all relationships and, if not, how many relationships follow this pattern. Five explanations proposed to explain protection are used to account for trajectories.

The Declining Trajectory of Protection

The declining pattern of protection has been described in many populations, including high school students (Misovich et al., 1997), college students (Kordoutis, Loumakou, & Sarafidou, 2000), adult injection drug users (Brettle, 1991; Paone, Clark, Shi, Purchase, & Des Jarlais, 1999; Sibthorpe, 1992), adult men who have sex with men (Adam, Sears, & Schellenberg, 2000; Crawford et al., 2003), adult men who have sex with women (Dingelstad, de Vroome, Paalman, & Sandfort, 1994; Harlow et al., 1997), and adult and young adult women (Cusick, 1998; O'Leary, 2000; Wingood & DiClemente, 1998). A number of studies of adolescents and young adults have reported that *individuals* become less protective—engage in more risky sex—over the course of adolescence (Beadnell et al., 2005; Dariotis et al., 2008; Fergus, Zimmerman, & Caldwell, 2007; Humblet, Paul, & Dickson, 2003; Tubman, Windle, & Windle, 1996). Two of these studies show that individuals then become more protective as they move into young adulthood (Dariotis et al., 2008; Fergus et al., 2007). While these studies show individual changes in risk, they do not speak to changes in protection within relationships.

Among studies that looked at relationships, Ku, Sonenstein and Pleck (1994) report a "sawtooth" pattern in their results where a new relationship starts with high protection and then drops to low protection; then with the next partner the protection again starts high and declines. Their data show that the percentage of relationships that used condoms at the start was 53%, while the percentage that used condoms later in the relationship was 44%, giving a net change in protection of nine percent. In a daily diary study of 106 young women 13-22 years old and recruited from STD and health clinics, Fortenberry and colleagues (2002) found a decline in condom use protection from 66% at the start of the relationship to 43% at last reported sex with the same partner, a net difference of 23 percent. Cusick and Rhodes (2000) provide qualitative data in which informants retrospectively recall a decline in protection over the course of a relationship.

Multiple Trajectories

Most of the studies reviewed so far include all participants in a single analysis and thus implicitly assume that behavior of all participants exhibit a shared pattern with a common explanation. Two projects have used finite mixture models (described below) to analyze individual sex risk trajectories. Moilanen and colleagues (2010) studied 1121 youth in rounds 1 through 5 of the National Longitudinal Survey of Youth (NLSY) (ages from 16-22). Using a 3-point composite scale of risk, the investigators identified 4 trajectories: low risk, increasing risk, decreasing risk, and high risk. Murphy and colleagues (2009) examined data from rounds 1 through 9 of the NLSY (participant ages range from 15-25). Individual trajectories were analyzed for over 4,000 males and over 4,000 females. For both males and females, the investigators identified low, increasing, decreasing, and high risk trajectories.

These studies suggesting differences among individuals—and implicitly suggesting differences among relationships—raise important questions about studies that try to fit all individual or all relationships to a single model of changes over time. If declining protection is true as a general description of sexual relationships, then it is acceptable in analysis to use a single prediction equation. If, on the other hand, declining protection is a pattern only for some persons, then the

usual statistical models which combine all observations into a single population average estimate are inappropriate and may provide misleading information and lead to misinterpretations. At the same time, if there are multiple trajectories for new sexual relationships, is each trajectory explained by a different theory, or are the multiple trajectories the result of common explanatory concepts that have their own corresponding trajectories? There are a number of theories that have been candidates to describe a single declining trajectory of protection within relationships and which might explain multiple trajectories as well.

Theories of Risk and Protection

Self- protection. Self-protection theory starts with the assertion that humans are self-interested and have a self-protection motivation that leads to a rational decision to reduce risk by increasing protection (Ajzen & Fishbein, 1980; Bandura, 1994; Becker, 1974; Brettle, 1991; Catania, Kegeles, & Coates, 1990; Fishbein & Middlestadt, 1989; Maddux & Rogers, 1983; Misovich et al., 1997; Prochaska, DiClemente, & Norcross, 1992; Rogers, 1975; Rosenstock, Strecher, & Becker, 1994; Zimmerman et al., 2007). If persons are rationally protecting themselves, then greater perceived susceptibility to HIV from the partner should lead to greater protective efforts (Crawford et al., 2003; Dolcini et al., 1993; Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2008; Ku et al., 1994; Longshore & Anglin, 1995; Prohaska, Albrecht, Levy, Sugrue, & Kim, 1990; Randolph, Torres, Gore-Felton, Lloyd, & McGarvey, 2009). That is, the actor's subjective estimate of risk is expected to determine protection. If perceived susceptibility goes down over the course of a relationship, level of protection would be predicted to decline.

Impaired rationality. Drug users have been observed to have high levels of sex risk (Choi & Wermuth, 1991; Kane, 1990; Moilanen et al., 2010; Stall, 1988). Some researchers have attributed low protection among drug users to impaired rationality (Hart, Boulton, Fitzpatrick, McLean, & Dawson, 1992; Kordoutis et al., 2000), although contradictory evidence has been reported (Cusick & Rhodes, 2000). During periods where participants in a relationship are doing drugs together, level of protection is expected to decline.

Trust. In addition to a self-protective motivation, humans are also motivated to protect people who are important to them (Bell, 2010; Bowlby, 1982; Mikulincer & Shaver, 2007). Trust is an important element in romantic and other sexual relationships. Trust implies faith that the partner will not present a risk (Afifi, 1999; Ames, Atchinson, & Rose, 1995; Flowers, Sheeran, Beail, & Smith, 1997; Misovich et al., 1997). Trust in the partner is based on a faith that one's partner will protect one. Thus, feelings of trust may lead one to underestimate risk (Gerrard, Gibbons, Benthin, & Hessling, 1996). If trust increases over the course of a relationship, then perceived risk might go down and subsequently level of protection may decline.

Secondary partner. It is not uncommon for people to have multiple sex partners (Laumann, Gagnon, Michael, & Michaels, 1994; Mosher, Chandra, & Jones, 2005). Social network research has established threats to society of concurrent partners (Morris & Kretzschmar, 1997). HIV infectivity can be high even before HIV antibodies can be detected, so multiple concurrent partners allow for rapid spread of HIV across a social network. When a person has multiple sex partners, self-protection theory says the person will protect themselves from those partners. Partner protection theory says that the person will be motivated to protect the close partner as well from

those partners. At the individual level, the partner protection motivation is expected to be stronger depending on the depth and strength of a relationship. While the trust process above suggests that a person will protect themselves *less* against a close and trusting partner, partner protection theory suggests that the person may protect a close and trusted partner *more* because of the closeness of the relationship. Thus, because multiple partners increase the risk of disease transmission, a person may be inclined to protect a primary partner indirectly by choosing a higher standard of protection in secondary relationships. If a relationship moves from being secondary to being primary, this logic suggests that level of protection may go down.

Power imbalance. Power is a method for people to satisfy their interests against resistance (Weber, 1946). Power in sex relationships have most often been associated with imputed gender roles (MacRae & Aalto, 2000; Pulerwitz, Amaro, Jong, Gortmaker, & Rudd, 2002; Schwartz, Patterson, & Steen, 1995; Tschann, Adler, & Millstein, 2002). The gendered argument is that males (assumed to have more power) prefer not to use protection during sex while females prefer more protection. In the analyses described here, we use an explicit measure of relationship power and apply it to both male-female and male-male relationships. Because the power argument asserts that power differential lowers protection, one may hypothesize that level protection increases when one partner has more power.

Method

For a longitudinal study of HIV risk, a community (non-clinical) sample of drug using and nonusing persons was recruited from high drug-use areas of Houston, Texas. The sample was drawn from participants in two previous studies of HIV risk (Bell, Montoya, & Atkinson, 2000; Montoya, Covarrubias, Patek, & Graves, 2003).

Sample

A total of 202 participants were recruited at intake. Interviews were conducted at three month intervals for 13 complete waves. Participants completed a median of 11 waves; 35% participated in all 13 waves. The interviews collected individual-level information on drug use, sexual activity, and drug injection activity, as well as relationships and behaviors engaged in with sex partners. Within the sample, 126 participants reported 412 new sex partners: 67 were male-male dyads and 345 were male-female dyads. There were 37 new female-female dyads reported, which is not enough for separate analysis; furthermore, since a major focus of the study was on the use of condoms and previous research on this population had found no condom use with oral sex, oral sex and female-female dyads are not included in analyses. New sex relationships are the focus of this paper. Because of increasing attrition in those relationships and thus increasing instability of estimates, only the first 15 months of new sex relationships are included in analyses. The 412 new sex partners were described 634 times.

Study participants and their named partners are described in Table 1. The first columns describe the study participants; the next columns describe 790 sex partners of 187 of the participants; the last columns describe 412 new sex partners of 126 participants. The sample represents a population that tends to have high numbers of concurrent partners, both to pay for drugs and as a consequence of stimulant drugs that increase libido.

Table 1. Sample Characteristics

	All Participants		All Sex Partners		New Sex Partners	
	N	%	N	%	N	%
Gender						
Male	113	55.9	487	61.6	243	59.0
Female	89	44.1	303	38.4	169	41.0
Race/ethnicity						
Black	111	55.0	430	54.5	220	53.5
White	33	16.3	180	22.8	112	27.3
Hispanic	58	28.7	174	22.1	78	19.0
Other			5	0.6	1	0.2
Age at baseline						
18-30	24	11.9	181	22.9	113	27.5
31-40	67	33.2	284	35.9	148	35.9
41-50	77	38.1	221	28.0	111	26.9
51 and over	34	16.8	104	13.2	40	9.7
Marital status						
Single	75	37.1				
Married	59	29.2				
Prev married	68	33.7				
Employment status						
Unemployed	98	48.5				
Odd jobs	24	11.9				
Part time	20	9.9				
Full time	60	29.7				
Drug user						
No (nonuser)	33	16.3	328	41.5	160	38.8
Yes (drug user)	169	83.7	462	58.5	252	61.2
Sex behaviors (inferred sexual orientation)						
No sex	12	5.9				
Straight	146	72.3	680	86.1	345	83.7
Gay or bi	44	21.8	110	13.9	67	16.3
HIV status						
HIV negative	177	87.6	701	88.7	366	88.8
HIV positive	25	12.4	89	11.3	46	11.2
Total N	202	100.0	790	100.0	412	100.0

Procedures

Each study participant was given a two-hour network interview in a private room at a field research center by research assistants trained in interview techniques with this population. Participants gave written informed consent for the study, which was reviewed at each interview. Procedures were approved by an institutional review board. Participants were tested for HIV once each year and

received pretest and posttest counseling. At each interview, participants were reimbursed $35 for their time.

Measurement

At each wave, participants were asked to give first name (or street name) of each person the participant had any kind of sex with in the previous 30 days. We are concerned here with sex partners. In previous work, we have found substantial reliability in naming of social networks (Bell et al., 2000; Montoya et al., 2003) and in the reporting of joint behaviors (Bell et al., 2000).

Protection. For each named sex partner, the participant reported the number of times s/he had sex with the partner in the previous 30 days, the type of sex (vaginal or anal), and the number of times a condom was used with the partner for each type of sex. The protection index is a composite measure related to the conditional probability of HIV transmission in a relationship. It considers not just condom use, but also frequency and type of sex (Bell & Trevino, 1999). Multiple acts are combined by a standard epidemiological formula (Allard, 1990). The protection index is independent of the partner's HIV status. In a world where actors regularly do not know the HIV status of their partners, the protection index is associated with the potential transmission of HIV in the worst case. The conditional probability for potential HIV transmission over 30 days ranged from .612 (a Hispanic male for having receptive anal sex 20 times and insertive anal sex 10 times with his boyfriend) to 1.0 (during a month with no sex) and has a skewness of -7.99. The 30-day protection index is highly skewed, so it cannot be transformed to a normal distribution. By combining all sex acts and scaling 30 day behaviors up to 10 years, the protection index gives a relative protectiveness value between about 0 and 1. This 10-year scale-up procedure has two benefits. It represents the long-term consequences of current sex behavior. The 10-year scale-up reduces skewness in the protection index (to -1.42, but not kurtosis); it balances low values (close to 0) and high values (close to 1). The protection index (M = .78; SD = .32) correlates -.76 with frequency of unprotected sex (M = 3.7; SD = 8.0).

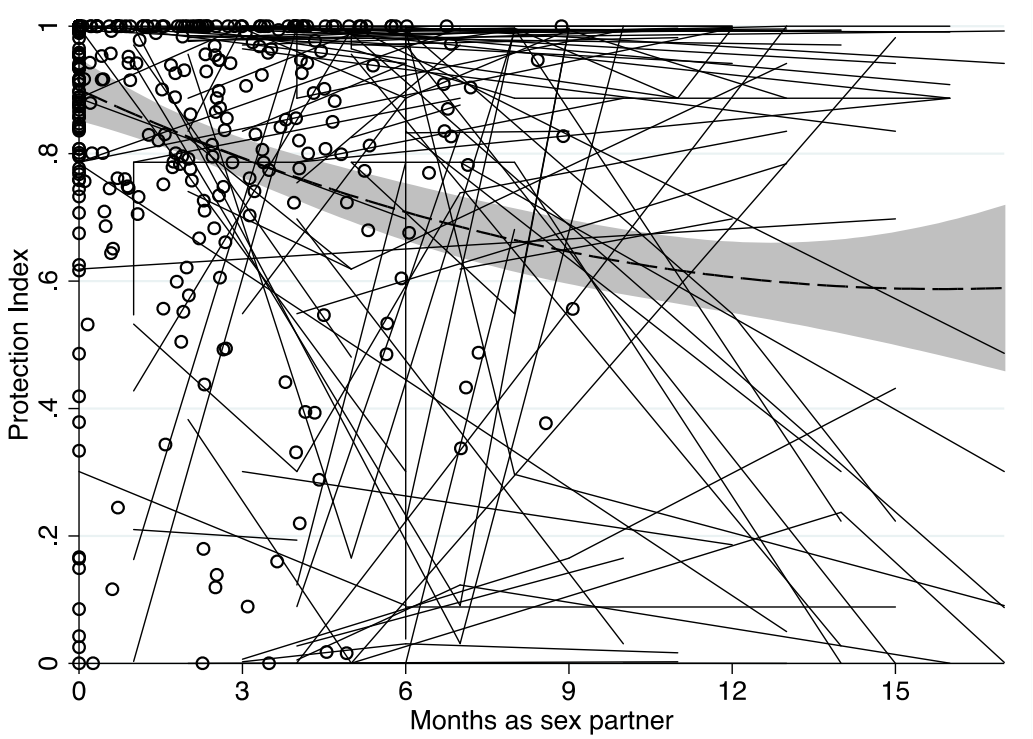
Susceptibility. Perceived susceptibility to HIV infection from the partner was measured at each wave and for each partner by subjective reports of the probability that the partner was infected with HIV. Each participant rated the probability that the partner was infected with HIV on a 5-point scale from "0" ("no chance [0%]") through 25%, 50%, and 75% to "1" ("sure chance [100%]" or "has AIDS"). This variable was set to zero if the reporting participant was HIV+ (M = .16; SD = .24).

Trust. Trust was measured at each wave and for each partner as a composite of three items measuring trust, respect, and telling the partner about "important things" on an 11-point scale (alpha =.84). For example, participants were asked, "How much do you tell important things to [*partner*] that you wouldn't tell to just anyone?" (M = 5.7; SD = 3.0).

Drug use. Participants were asked to report whether they had used drugs with the partner in the 30 days prior to the interview (M = .45; SD = .34).

Secondary partner. Participants reported each partner as spouse, boy/girlfriend, best friend, and so on. A distinction was made between primary and secondary sex partners. A primary partner was

Figure 1. Observed Levels of Protection
and Single-Equation Quadratic Prediction Line



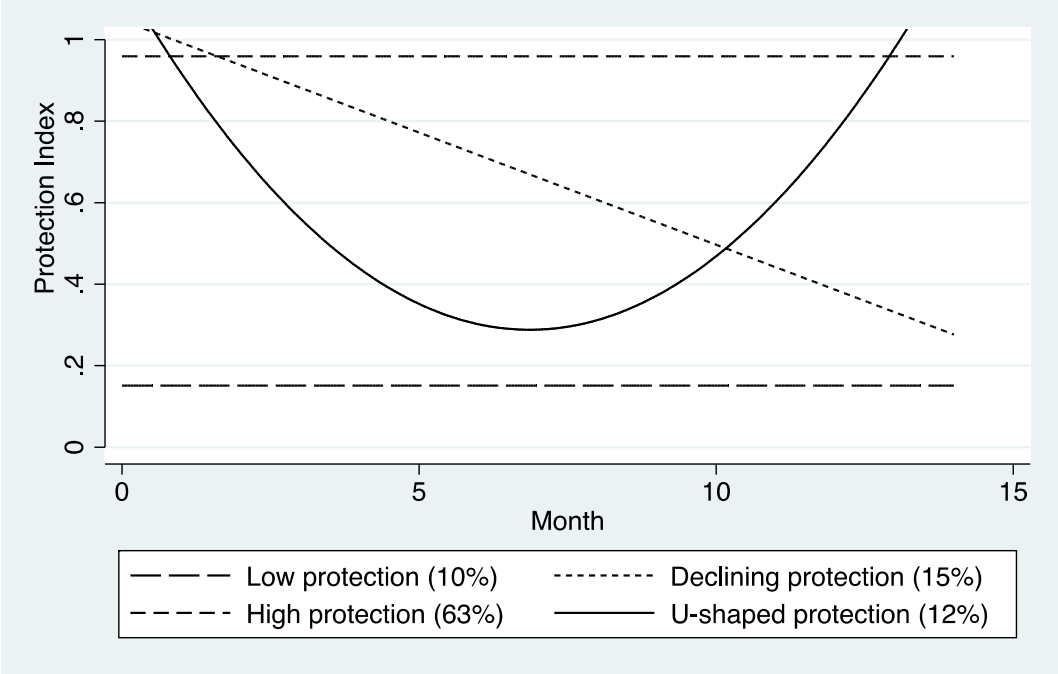
defined as someone the participant described as a "spouse," or if no spouse was named, a single boyfriend or girlfriend was considered a primary partner. A non-primary partner was coded 1 in a wave where the participant also described a main partner; in some waves a participant described multiple secondary partners. All other cases were coded 0. This variable operationalizes indirect protection of a primary partner. This variable can change over time within a relationship as the actor adds or subtracts a main partner (M = .26; SD = .44).

Power. Participants were asked, "In the last 30 days when you and [partner] had sex, who mostly decided things like when, how, and where to have sex?" Responses were coded 1 if either partner made the decisions (indicating a power imbalance) and 0 if neither or both made the decisions (indicating a relationship of equality) (M = .51; SD = .50).

Results

Figure 1 depicts the relationship trajectories of protection (the raw data) as well as an attempt to summarize these data with a single population average quadratic curve. The gray bars indicate the 95% confidence interval around the population average curve. In the figure, lines indicate values of the protection index in a relationship over multiple waves of the study. Circles indicate relationships that were described only once. The only sure interpretation that can be taken from this figure is that the summary model and its predictive curve do not capture these data well. Almost none of the individual relationship trajectories of protection conform even approximately to the summary model. An inspection of the relationship trajectories indicates that there are different kinds of relationships: some of which mostly have low protection, some which mostly

Figure 2. Trajectories of Sexual Protection.



have high protection, and some which show a great deal of change in protection during the early months of the relationship. Because a single average trajectory is clearly inadequate to represent these data, finite mixture modeling is used to identify multiple trajectories of protection (Nagin, 2005).

Multiple Trajectory Analysis

Finite mixture models assume that there is a "mixture" of a "finite" (necessarily small) number of patterns over time to represent some variable (Rabe-Hesketh & Skrondal, 2007; Särndal, Swensson, & Wretman, 1992), in the case of trajectory models, a variable over time. The procedure followed here identifies relatively homogeneous trajectories defined by different patterns of change of protection within relationships over time. The software to estimate trajectory models (-traj- within Stata) (Jones & Nagin, 2007; Jones, Nagin, & Roeder, 2001) is designed for two-level models. The data, however, contain three levels to account for multiple observations of the protection index clustered within relationships, which in turn were clustered within study participants. For the protection index, the variance accounted for by participants was 15% of the total variance. Relationship variance was 38% of total variance, leaving 47% of the variance at the level of individual waves including measurement error. That is, variations of risk and protection have much less to do with the person than with the relationship. Thus, because the variance attributable to relationships was over twice that of the variance attributable to participants, analysis was treated as a two-level model with variation between and within relationships.

Tobit-based (censored normal) trajectory models were used because values of the protection index are clustered around a minimum of zero and a maximum of one, as can be seen in Figure 1. Models were estimated to detect two, three, four, and five trajectories. The duration of each relationship was reported in terms of months, so the time variable was more finely tuned than the three-month

Table 2. Comparison of Trajectory Groups

	Protection Trajectory			
	Low	High	Declining	U-shaped
Evaluation of four-trajectory model				
Size (percent)	9.8	63.2	15.3	11.6
Protection index mean (SD)	.15 (.19)	.94 (.11)	.80 (.28)	.66 (.33)
PP	.95	.76	.70	.73
OCC	185.2	1.9	13.0	20.9
Comparison of trajectory groups				
Protection trajectory	Perceived Susceptibility mean (SE)	Trust mean (SE)	Drug use mean (SE)	Secondary partner mean (SE)	Power inequality mean (SE)
Low	.109 (.178)	6.451 (2.939)	.431 (.332)	.113 (.318)	.521 (.503)
High	.266 (.253)	5.189 (3.011)	.451 (.343)	.298 (.458)	.517 (.500)
Declining	.129 (.127)	8.505 (1.250)	.602 (.300)	.152 (.364)	.515 (.508)
U-shaped	.147 (.213)	7.289) (2.067)	.322 (.288)	.176 (.385)	.431 (.500)
Wald Chi-square	3.12	117.69**	13.16**	14.63**	0.69

Note 1: PP: Bayesian posterior probability (criterion: above .70); OCC: Odds of correct classification (criterion: above 5.0). See text for an explanation of these measures.
Note 2: ** $p < .01$. Comparison analyses control for nesting of waves within relationships.

interview frequency would indicate. As suggested by Nagin (1999), each trajectory model was initially estimated with linear, quadratic, and cubic trajectories and then nonsignificant orders were removed. The Bayesian Information Criterion (BIC= ln(n)k-2ln(L)) estimates the log likelihood of the observed data given the trajectory model estimated while adding a penalty for complex models (Nagin, 2005; Särndal et al., 1992). The four group model provided the best fit to the data (BIC = 245.52), compared to the three group model (BIC = 304.62), and the five group model (BIC = 259.48). This result is consistent with others' analyses that have identified four categories or trajectories to account for differences in individuals' unfolding sexual lives (Beadnell et al., 2005; Moilanen et al., 2010; Murphy et al., 2009; Newman & Zimmerman, 2000; Tubman et al., 1996). Figure 2 depicts the four trajectories.

A comparison of Figure 2 with Figure 1 confirms that these four trajectories are much more consistent with the individual relationship trajectories than the population average trajectory is. The first panel in Table 2 shows the relative sizes of the four trajectory groups in the first row. In the second row, we see that the high protection trajectory (an estimated 63% of the sample) expresses consistent low risk, high protection behavior with a mean protection index of .94. This value means that, *if the partner were HIV+* and if current sexual behaviors were continued unchanged for 10 years, there would be a 6% chance that the HIV virus would be transmitted. The low protection trajectory expresses consistent low protection behavior with a protection index of .15. There are also a declining protection trajectory and an U-shaped protection trajectory.

The third row shows Bayesian posterior probabilities. In a finite mixture model, each study participant's behavior is considered to be a combination (mixture) of the inferred trajectories. Each relationship's protection behavior over the course of the study is interpreted as a mixture of the four trajectories, with a posterior probability assigned to the relationship for each trajectory. If we

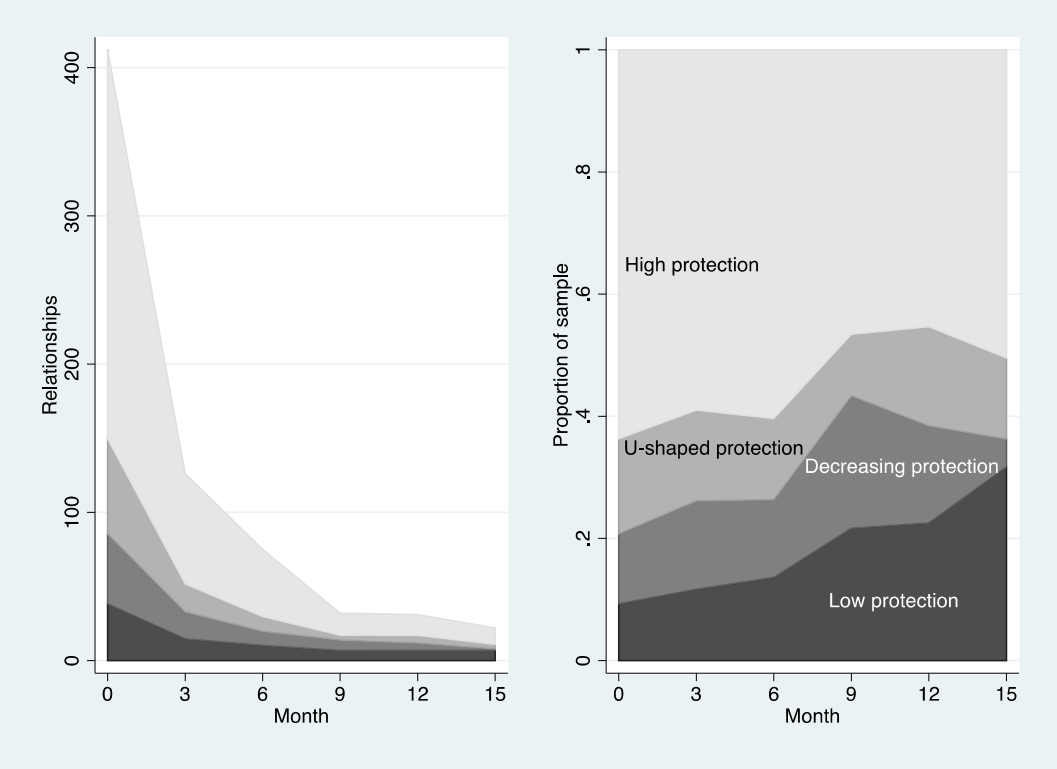
then assign each relationship to the trajectory with the highest posterior probability, the mean level of the posterior probability for all members assigned to a given trajectory is the average posterior probability (PP) for the group of relationships following that trajectory. High levels (above .70) of PP suggest a distinguishable set of trajectories (Nagin, 2005). All trajectory groups inferred in the analysis had posterior probabilities of .70 or greater. The fourth row displays the odds of correct classification (OCC). This measure involves comparing the odds that relationships were assigned to a trajectory group with the theoretical proportion of the sample in each group (the probability that a random relationship would be assigned to the group by chance). Nagin recommends that OCC should be at least 5 for each group to indicate high assignment accuracy. This diagnostic indicates that relationships were consistently assigned to the low, declining, and U-shaped trajectory groups, but that the assignment to the high protection trajectory group was problematic. The reason for the classification difficulty can be seen from Figure 2, where the relationships in the high, declining and U-shaped trajectories all start at about the same very high level of protection. Of the 412 new sexual relationships that were reported, four-fifths (80.8%) were reported only once, so one can see that it is difficult for the analysis to identify trajectories for relationships reported one time only. Since most of the one-time-only relationships do not show changes in protection, the statistical algorithm has assigned these short-term, high protection relationships to the high protection group. One might question whether they "should" have been assigned to the declining trajectory instead. However, the point is that in these data, very few relationships showed a sustained decline in protection. In fact, the number of relationships that show a consistent decline are balanced by a similar number of relationships in which an initial decline is followed by a later increase in protection. Furthermore, this algorithmic decision makes theoretical sense, since the one-time-only observations were unable to show the declines in protection associated with the declining and U-shaped group trajectories. Relationships reported one time only had higher levels on the protection index than the initial level for those reported multiple times (.86 vs. .75 , $t = 2.93$, $df = 410$, $p < .01$).

The four trajectory solution is presented in Figure 2 and described in the second panel of Table 2. One of the questions in any analysis of multiple patterns in data is posed by Bauer & Curran: "Do the components represent true latent subgroups in the population, or are they serving only to approximate what is in fact a homogeneous but nonnormal distribution" (Bauer & Curran, 2003, p. 243; see also Raudenbush, 2005). That is, do the observed patterns of protection represent empirically distinct (but theoretically homogeneous) patterns of a single set of explanatory concepts, or is each trajectory explained by a different set of concepts? Bauer & Curran (2003) have shown how data produced by processes that are not multivariately normal can produce multiple trajectories that reflect non-substantive approximations to a single underlying process. This issue can be pursued by examining the five theories for each of the inferred trajectories. Before turning to explanations for the four protection trajectories, we need to explore why population average analyses have been taken to support the declining protection hypothesis even though only 15% of relationships follow such a trajectory.

Accounting for the Declining Protection Hypothesis

The discrepancy between Figure 1 (population average trajectory) and Figure 2 (multiple trajectories) is explored in Figure 3. The first panel shows the number of relationships in each trajectory group by the duration of the relationship. The panel shows high levels of relationship

Figure 3. Protection and Retention by Trajectory Group.



attrition. Of 412 new sex relationships, by 15 months, only 22 relationships (5%) have continued. It is obvious in the figure that most new relationships are high protection relationships as long as they last.

The second panel of Figure 3 looks at the proportion of relationships conforming to each trajectory, and thus shows the results of differential attrition over time across trajectory groups. Initially, Over 60% of all relationships were of the high protection sort, but by 15 months, this proportion had declined substantially. At the same time, the proportion of relationships in the low protection group grew from 9% to 32%. The declining protection relationships changed little in prevalence over time, as did the U-shaped trajectory relationships, except at the 15th month. At 15 months, low protection relationships have become 32% of all ongoing relationships, while declining protection relationships are 13%, U-shaped protection relationships are 5%, and high protection relationship are 50%. What appears to account for the perceived shift from high protection to low protection is a change in the mix of relationship types over the course of relationships. As high protection relationships suffer the highest attrition, it is apparent that the often reported apparent decline in protection is accounted for by this differential attrition and the differential survival of low protection relationships. It is not so much that all relationships change, but that low protection relationships endure the longest.

Explaining Protection Over Time

There are four stages in testing the five theories discussed in the introduction. First, I consider whether the overall level of the predictor corresponds to the overall levels of protection in the four trajectories. To compare trajectory groups, I assigned each relationship to the trajectory with the highest posterior probability. I conducted a mixed model analysis of variance that corrects for multiple observations nested within relationships. If a predictor accounts for protection, we would expect that there would be significant differences in the predictor between the high protection and low protection trajectories, with intermediate values in the declining and U-shaped trajectories where protection has intermediate values. These results are seen in the bottom panel of Table 2. Reading down each column, the mean value of each variable is shown for each trajectory group. Thus for perceived susceptibility, persons in relationships following the high protection trajectory perceive the highest probability that the partner has HIV (27% on average), while in relationships following the low protection trajectory there is the lowest perceived probability that the partner has HIV (11%). However, variations in perceptions of HIV within each trajectory are so high that the differences across trajectories are not statistically significant. Results show that perceived susceptibility and power inequality do not differ across trajectories, which does not support them as explanations for different trajectories. The analyses show that trust, drug use, and secondary partners have significantly different values across trajectories. High protection trajectory relationships report significant lower trust than relationships following other trajectories, such as the low trajectory. Declining trajectory relationships, on the other hand, report significantly higher trust than relationships following other trajectories. A related pattern is reported for drug use where drug use is significantly highest in relationships following the declining trajectory and lowest in the U-shaped trajectory relationships. Drug use does not differ between high and low protection trajectories. Relationships with secondary partners are most often reported by high protection trajectory relationships. This is significantly different than the level of secondary partners in the low protection trajectory, and the changing trajectory groups show intermediate values.

For the second stage in testing the theories, we can look at the changes in a predictor over time. If a predictor is a direct cause of a constant trajectory, then the predictor should not change over time, but it should change if it is a cause of a trajectory that changes. The trajectories identified by the analysis define abstract groups of relationships, so each relationship has a Bayesian posterior probability of following each trajectory. These posterior probabilities are used as weights, so that relationships that have the greatest probability of following a given trajectory are given the highest weights in estimating correlations and regressions for that trajectory. The first two results columns in each section of Table 3 gives the linear and quadratic effects of the duration of the sexual relationship on each predictor. The quadratic effect is shown only if it is significant at least at the .10 level. If not, the linear effect is computed without the quadratic effect.

Nonsignificant changes are expected in a predictor for high and low constant protection trajectories. Change expected in the predictor for the declining and U-shaped trajectories. Table 3 shows that perceived susceptibility and power inequality do not change for relationships in any trajectory, which does not support them as explanations for changes in protection. Drug use decreases for one of the constant and one of the changing trajectories. Trust increases linearly for the low protection trajectory and increases at a decreasing rate for both changing trajectories. Secondary partners decrease at least marginally for all trajectories.

Table 3. Explaining Protection Changes, by Trajectory

Constant trajectories	Low Protection			High Protection		
	Time	Time^2	Protection	Time	Time^2	Protection
	b (SE)	b (SE)	b (SE)	b (SE)	b (se)	b (SE)
Perc susceptibility	.002 (.006)	.--	.001 (.073)	-.001 (.006)	.--	.010 (.026)
Trust	.137 (.059)*	.--	-.006 (.008)	.208 (.041)	.--	-.004 (.002)*
Drug use	-.021 (.008)**	.--	-.131 (.035)**	-.000 (.006)	.--	.014 (.014)
Secondary partner	-.062 (.022)**	.003 (.001)*	.239 (.045)**	-.011 (.006)+	.--	-.001 (.011)
Power inequality	-.010 (.013)	.--	.007 (.033)	-.010 (.007)	.--	-.004 (.011)
Changing trajectories	Declining Protection			U-Shaped Protection		
	Time	Time^2	Protection	Time	Time^2	Protection
	b (SE)	b (SE)	b (SE)	b (SE)	b (se)	b (SE)
Perc susceptibility	-.002 (.004)	.--	.021 (.097)	.003 (.008)	.--	-.106 (.063)
Trust	.639 (.117)**	-.022 (007)**	-.033 (.007)**	.496 (.177)**	-.022 (.012)+	-.021 (.010)*
Drug use	-.012 (.006)*	.--	-.047 (.048)	-..012 (.008)	.--	.105 (.071)
Secondary partner	-.021 (.006)**	.--	.115 (.046)*	-.064 (018)**	.004 (.002)*	.142 (.043)**
Power inequality	-.006 (.016)	.--	.016 (.054)	-.002 (.015)	.--	.026 (.059)

Note: + p < .10; * p < .05; ** p < .01. "Perc susceptibility" = "Perceived susceptibility"

All analyses control for nesting of waves within relationships.

For the third stage test, we can look at the independent effect of each predictor on protection, controlling for other predictors and for gender, race, ethnicity, and sexual orientation. If a predictor is a direct cause of a participant's level of protection, then a weighted mixed model that accounts for multiple observations nested within relationships should find a significant direct effect, at least for the declining and U-shaped trajectories. For the low and high protection constant trajectories, there may not be a significant effect because of insufficient variation in the dependent variable. Table 3 shows the results of an analysis weighted by each relationship's posterior probability for the trajectory in the third column of each panel. It shows that perceived susceptibility and power inequality do not predict protection for relationships following any of the trajectories, which argues against them as explanations for changes in protection. Drug use with the partner predicts protection only within the low protection trajectory where using drugs with the partner decreases over time and reduces protection (i.e., not using drugs in a relationship increases protection). Trust predicts protection within both changing trajectories. Trust also explains why some high protection trajectories are lower than others. Relationships with secondary partners predict increasing protection in the changing trajectories and also predicts its differences among relationships in the low protection trajectory. Of particular note is that both trust and secondary partners have quadratic changes that predict the U-shaped trajectory as trust evens out after increasing and as having a secondary partner goes back up for relationships in the U-shaped trajectory.

In the fourth stage of the test of the theories, I extend the analysis of protection to duration of relationships, Because we have seen that attrition, or relationship termination, accounts for the misleading appearance of a general declining trajectory of protection, we look to see whether the theories we have considered can account for the attrition. Table 4 shows the results of a Cox regression analysis controlling for nesting of waves within relationships. The first four columns show how each theory accounts for entry into each trajectory. These columns look at the initial conditions of the relationship. It shows that the initial perceived susceptibility, power, or being a secondary partner do not have an enduring effect on the likelihood of a relationship to terminate (the Overall column). However, initially more trusting relationships as well as initially drug-using relationships are less likely to terminate in general. The effect of initial trust and drug use in preserving a relationship is concentrated in high protection trajectory relationships. It is in both the low and high protection trajectories that relationships that begin as secondary partners lead to early termination. Second, the table shows that levels of perceived susceptibility, trust, drug use, and inequality do not affect the ongoing (time-varying) likelihood of termination. In any wave where the relationship partner becomes a secondary partner, the likelihood of termination increases.

Results from Tables 2, 3, and 4 are summarized in Table 5. We see that neither self-protection (as indicated by perceived susceptibility to HIV) nor power inequality are viable explanations for protection in these data. They do not show differences in mean levels across trajectories (Table 2). Both remain constant for both constant and changing protection trajectories and do not predict protection for relationships following the varying trajectories (Table 3). Furthermore, they are not associated with relationship termination, so they do not account for the population average decline in protection (Table 4). Drug use distinguishes among the trajectories, being highest for the declining and lowest for the U-shaped trajectories. Drug use declines over time for one of the constant and one of the changing trajectories, but it predicts only local changes in protection and only in the constant low trajectory. Relationships that start with drug use (or perhaps relationships

Table 4. Cox Regression to Predict Relationship Termination

	Low b (SE)	High b (SE)	Declining b (SE)	U-shaped b (SE)	Overall b (SE)
Initial predictors					
Perc susceptibility	0.225(0.706)	0.021(0.206)	-0.967(2.601)	-1.188(0.907)	0.031(0.219)
Trust	-0.073(0.046)	-0.070(0.018)**	0.118(0.248)	0.016(0.108)	-0.070(0.019)**
Drug use	-0.132(0.525)	-0.259(0.132)*	-2.048(1.311)	0.586(0.767)	-0.329(0.151)*
Secondary partner	0.697(0.307)*	0.213(0.096)*	0.105(1.053)	-0.821(0.739)	0.126(0.108)
Power inequality	-0.043(0.359)	0.051(0.090)	-0.071(0.636)	-0.466(0.422)	0.025(0.100)
Time-varying predictors					
Perc susceptibility					-0.044(0.047)
Trust					-0.007(0.005)
Drug use					-0.004(0.036)
Secondary partner					0.078(0.024)**
Power inequality					-0.026(0.023)

Note: * $p < .05$; ** $p < .01$. Cox proportional hazards analysis controlling for nesting of waves within relationships.

that grow out of a drug using relationship) tend to be of lower duration. However, drug use within the relationship during a wave does not affect its likelihood of termination.

Discussion

Research on sexual behaviors has shown that actors in close, intimate, long-term relationships have lower levels of protective sex than actors in casual, short-term relationships. This pattern has been interpreted to suggest that relationships change from higher protection to lower protection over time, what has been called here the hypothesis of a declining trajectory of protection. This paper set out to test five theories that might provide a basis for such a hypothesis. However, we found that observed levels of protection seldom conformed to the hypothesized average decline in protection (Figure 1). A finite mixture model analysis based on 412 new sexual relationships described by 126 participants contradicted this declining protection pattern as a general description of sex relationships. Analysis revealed four patterns reflecting different trajectories of protection; only one of these trajectories follows the declining protection pattern and accounts for only 15% of observed relationships.

The discovery of multiple trajectories raised the question of whether the inferred trajectories represent different trajectory generating processes or different manifestations of the same trajectory generating process. Do the multiple trajectories indeed represent heterogeneous theoretical processes or do they represent different components within a single theoretical explanation? If a single predictor is to explain protection for all relationships, then we expect that:

- Mean levels of the predictor should have extreme values for relationships in the high and low protection trajectories, with intermediate values in the other trajectories. Only secondary partners satisfied this condition.

- The pattern of change in the predictor should map onto the pattern of change in protection. This makes the declining and U-shaped trajectories of particular theoretical interest. Whatever explains their shapes should be something that also so shows a similar shape. Trust increases and secondary partners decrease for both changing trajectory groups; drug use decreases for the declining trajectory group.

- The predictor should predict the level of protection. Especially in the U-shaped trajectory, the predictor should have its own curvilinear shape to successfully explain the decline and then increase in protection. Trust increases protection and secondary partners decreases protection for both changing trajectory groups; drug use declines for the declining trajectory group.

- For it to be responsible for the declining pattern of protection, the predictor must also account for relationship duration. Because the population average observation of declining protection results from relationship attrition, the predictor should account for this attrition. At any wave where a partner is secondary, the chance of ending the relationship is higher.

We have seen in Tables 2-4, summarized in Table 5, that self-protection theory as represented by perceived susceptibility and power imbalance failed all of these tests. Drug use, seen as a barrier to implementing self-protection, found consistent support for the 15% of study participants who follow the declining trajectory.

The two predictors that are supported by these results involve trust and secondary partners, both of which represent partner protection theory. Secondary partners has the most consistent support in these data. This predictor is unequivocal in its ability to distinguish levels of protection across trajectories, being highest in the high protection trajectory and lowest in the low protection trajectory. Its own trajectory is consistent with both declining and U-shaped protection trajectories while predicting the level of protection over the course of those trajectories. During any wave where the partner is secondary, the chance of termination increases.

Trust is not quite so successful. The pattern of means is only partially consistent with theory. The change in trust over time is sometimes consistent with protection trajectories (high and U-shaped trajectories), but trust also increases substantially for relationships in the low protection trajectory and shows a declining rate of growth when protection decreases linearly in the declining trajectory. Trust consistently predicts protection across the three less frequent trajectories. Trust starts low and stays low during unstable high protection relationships. Results suggest that lack of trust at the beginning of a relationship successfully accounts for attrition, especially in high protection trajectory relationships.

Thus we can conclude that the four trajectories seem to be generated by the same processes. Furthermore, since trust and secondary partners also tend to account for differential attrition among the trajectories, they also account for the misleading interpretation of a population average declining trajectory of protection. The declining protection trajectory detected by population average analyses that has often been interpreted as a within-relationship change, appears instead

Table 5. Summary of Tests of Five Theories of Protection

	Difference (Table 2)	Time (Table 3)	Protection (Table 3)	Duration (Table 4)
Perceived susceptibility	–	–	–	–
Trust	–	+	+	+/-
Drug use	–	+/-	+/-	+/-
Secondary partner	+	+	+	+/-
Power inequality	–	–	–	–

Note: + Consistent with theory across trajectories; – Never consistent; +/- Sometimes consistent. Difference: Difference in means across trajectories; Time: Change over time consistent with protection trajectory; Protection: Affects protection level; Duration: Affects relationship termination.

to represent between-relationship differences. Results here show that, unlike the hypothesis of a declining trajectory, the effect of trust and secondary partners is not mainly developmental over the course of a relationship—instead their main effect is on relationship termination. The observed pattern of declining protection can be seen to be accounted for by the lower level of attrition in low protection/high risk relationships over the first 15 months.

The support for trust and secondary partners suggest two contradictory effects of the emotions involved in relationships. On the one hand, low trust leads directly to the high protection trajectory and then leads to early termination of the relationship. There is a general pattern of trust increasing over the course of relationships, except for high protection relationships that tend not to last very long. Trust shows a U-shape for the U-shaped protection trajectory, and trust shows a similar U-shape for the declining trajectory. High trust can lead to initial protection that rapidly declines as trust continues to increase, or it can lead directly to a low protection trajectory. Thus we can make the claim that even though trust decreases protection only within a small number of relationships, it is a major contributor to the patterns of protection that we see. Unfortunately, at the same time it is a major contributor to actors' vulnerability to HIV and other sexually transmitted infections that results from low protection.

On the other hand, having secondary partners shows the same shape as changing trajectories of protection, linear declining for the declining trajectory, and declining with a quadratic reversal for the U-shaped trajectory. Actors seem to be concerned to protect their partners, using more protection with a secondary partner who might provide a risk to the primary partner. If we think of secondary partners as posing a large risk of infection, then secondary relationships have a strong and consistent effect of increasing protection as a temporary benefit. In addition, secondary partners also tend to increase relationship termination as a long-term benefit. However, the infection-protection scope of secondary partners is limited. In this sample with a large number of drug users, mostly cocaine which is known to increase libido (Henderson, Boyd, & Whitmarsh, 1995; MacDonald, Waldorf, Reinarman, & Murphy, 1988), only 32% of relationships are with a secondary partner. The secondary partner effect indirectly protects the primary partner. Relationships that endure tend to increase in trust, and they also tend to shed secondary partners as the relationship becomes more serious. Thus the vulnerability created by trust is somewhat ameliorated by some increase in fidelity.

The discovery that low trust relationships show highest levels of protection is not unique to this study (Afifi, 1999; Ames et al., 1995; Flowers et al., 1997; Misovich et al., 1997). Nor is the discovery that low trust relationships are of short duration (Burt, 2000; Wellman, Wong, Tindall, & Nazer, 1997). But what this study has contributed is the realization that it is the attrition of the low trust, high protection relationships that creates the association between higher trust and lower protection. The high trust, low protection, long-term relationships that have previously been noted turn out mostly *not* to have been low trust, high protection relationships previously. Instead they have mostly always been high trust, low protection relationships.

There are limitations in this study. The study is conducted in a single large city. Results might be different in other locations. The sample contains a large number of drug users. Drug users are at a particularly high risk of HIV, both directly from drug injection with shared equipment and indirectly from sex related to drug use, so that this is a very important population to study in terms of disease transmission compared to more convenient samples of adolescents and young adults. However, we cannot necessarily generalize these results to a non-using population. Because participants described sex behaviors in the previous 30 days, while the research design conducted interviews at 3-month intervals, many short-term partners may have been missed (those sexual relationships that started and ended between 31 and 90 days previously were not elicited from study participants unless those partners were current drug users, social support partners, or close friends).

Public health researchers have always hoped that informed rational actors would respond to their own vulnerability to a debilitating disease by protecting themselves, and interventions have been designed to implement this hope (Bell et al., 2007; Bell, Mosier, & Atkinson, 2003). The analyses carried out here show that some two-thirds of new sex relationships follow a high protection trajectory for as long as they last, supporting the success of these self-protection efforts. But while self-protection is a strong motive, it is not the only motivation. What the results here have shown is that it is not variation in self-protection motivation that accounts for lack of protection in sex relationships. Rather it is the variation in partner protection motivation and trust that explains many differences in protection. While trust that grows into primary relationships creates direct vulnerability, the existence of a primary relationship also has the effect of increasing protection in secondary relationships.

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Appendix

Participant Characteristics by Wave (percent)

Wave:	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Gender														
Male	56	57	57	57	56	57	57	55	53	54	54	55	51	55
Female	44	43	43	43	44	43	43	45	47	46	46	45	49	45
Race														
Black	55	58	59	59	60	61	59	58	57	59	59	59	59	58
Anglo	16	12	13	12	11	11	13	14	14	14	12	14	14	13
Hispanic	29	30	29	29	29	28	28	28	29	27	30	27	26	28
Age at baseline														
18-30	11	9	8	9	8	8	7	9	7	9	8	6	6	8
31-40	33	31	33	31	33	29	28	28	30	26	22	25	24	29
41-50	38	43	39	40	39	44	43	39	39	42	44	45	43	41
51 and over	17	17	20	22	20	19	21	24	24	24	26	24	27	22
Employment														
Unemployed	49	51	54	47	50	56	51	51	48	47	55	47	43	50
Odd jobs	12	8	9	15	10	9	17	14	22	16	16	19	16	14
Part time	10	12	13	18	12	13	11	14	11	15	10	13	20	13
Full time	30	30	24	21	28	22	21	21	19	22	20	21	20	23
Marital status at baseline														
Never married	37	33	31	29	29	27	27	33	33	29	35	38	29	32
Married	15	13	13	17	16	17	17	14	12	14	12	14	14	15
Living as married	14	14	17	18	20	20	20	16	19	21	16	13	17	17
Separated	12	12	17	13	14	17	14	16	14	12	14	12	14	14
Divorced	18	23	18	17	15	14	16	14	15	15	16	14	17	16

Widowed	4	5	5	6	5	6	6	7	7	8	8	9	9	6
Drug use														
None	14	14	13	12	14	15	15	16	17	19	18	18	16	16
Mari/alco only	14	17	19	19	16	19	16	16	21	16	16	13	20	17
Hard drugs	71	69	67	68	70	65	69	68	61	65	66	68	64	67
HIV status role														
Role 1	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Ever Role 2	43	43	43	43	43	43	43	43	43	43	43	43	43	43
Always Role 3	45	45	45	45	45	45	45	45	45	45	45	45	45	45
HIV status														
HIV negative	88	88	90	91	90	89	91	90	90	89	90	91	91	90
HIV positive	12	12	10	9	10	11	9	10	10	11	10	9	9	10
Sample size	202	162	150	144	147	139	150	153	149	149	147	141	138	202