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MICROECONOMIC PERSPECTIVES ON RISKY SEXUAL BEHAVIOUR

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Microeconomic Perspectives on Risky Sexual Behaviour

Abstract

This paper seeks to identify some useful insights microeconomic theory can provide into risky sexual behaviour. A neoclassical model of rational addiction and a behavioural economic model based on hyperbolic discounting are both applied to risky sex. It is argued that the phenomenon of risky sexual behaviour may best be described as a lack of self-control. Based on this, personal rules, which help linking current choices with similar future choices, provide a useful means of avoiding risky sexual behaviour.

1. Introduction

In the presence of the AIDS pandemic the importance of understanding risky sexual behaviour does not require an argument. As the major cause of HIV infections, which in turn cause AIDS, risky sex is of paramount interest. Nevertheless, the utility of applying economic techniques to the analysis of risky sexual behaviour might seem questionable to many. This paper seeks to identify some insights economics can provide into the issue.

Economic theory is more commonly used to deal with the effects of the AIDS pandemic. I approach the issue from the other side, by looking at the behaviour that is responsible for the pandemic. After applying conventional economic theory to risky sexual behaviour, I attempt to explain the phenomenon by borrowing tools from behavioural economics.

First it is helpful to go through an extended example in order to introduce some of the factors playing a role in sexual decision-making and to set the stage for the models that follow. Let's imagine a hypothetical adolescent female called Linda. Let's also define risky sexual behaviour broadly, as encompassing any sexual activity that has a non-trivial probability of resulting in a substantial cost to the person engaging in it, where the costs may take the form of a sexually transmitted disease or any other adverse effect.

When Linda makes up her mind whether to engage in sex for the first time or whether to abstain, many factors enter into the equation. Her age and her gender

are unlikely to be good predictors of her sexual knowledge (Eisen & Zellman 1986). However, her sexual knowledge plays a major role in her decisions concerning sex. For example, her knowledge of AIDS and its harmful consequences affects her intention to engage in intercourse and use a condom (Epstein et al. 1994). Of course, the more she is aware of the detrimental consequences of risky sex, the less likely she is to engage in it.

On an individual level, economics cannot say much about those who are completely ignorant of the potential adverse effects of risky sexual behaviour, since such people would choose risky sex as the unambiguously better choice, barring disincentives unrelated to health, such as cultural or religious sanctions. In this case, it does not take an economist to point out that sexual education might be the answer.

Linda's perception of her risk of getting pregnant is an important determinant in her contraceptive decision-making (Reschovsky & Gerner 1991). Also, as a female, Linda will typically view sex as more detrimental to her future goal attainment (De Gatson, Weed & Jensen 1996); and she does so rightfully. A much higher proportion of the cost of pregnancy and childbearing is likely to be borne by the mother than by the father. Furthermore, women are more vulnerable to HIV infections when engaging in unprotected sex. Therefore, estimated harmful future consequences provide us with two factors that should lead women to abstain or use protection more than men.

Linda is likely to experience peer pressure encouraging her to engage in sex, especially at the point in time when she makes the decision of whether to become sexually active for the first time, or whether to abstain (Lock & Vincent 1995; Svenson et al. 1992). The less importance she puts on peer influence, the more likely she is to abstain (Zimmerman et al. 1995). She is likely to experience less peer and other societal pressure to engage in sex than a typical male (De Gatson, Weed & Jensen 1996; Jensen, De Gatson & Weed 1994). Other societal pressures besides peer pressure that affect contraceptive use and that are experienced by both males and females include pressure from parents and religious groups (Cooksey, Rindfuss & Guilkey 1996), as well as the individual's perception of the social view regarding contraceptive use (Adler et al. 1990).

From an economic viewpoint, many societal pressures represent an opportunity cost of not engaging in a certain behaviour. For example, say Linda lived in a traditional Catholic community that frowned upon condom use. When Linda makes the decision of whether to use a condom or not, what enters the equation are not only the potential adverse effects risky sexual behaviour may have on

her health and in the case of pregnancy, on her career opportunities; in this scenario, Linda will also evaluate the social costs she might incur if she decided to use a condom. When societal costs and incentives are added to the biological and psychological costs and incentives, they will affect the likelihood of a behaviour.

When Linda goes out to a bar and decides to have a drink, her use of alcohol is likely to become a key determinant of her sexual risk behaviour (Morojele et al. 2006). Assuming she is heterosexual, the cultural context in which she acts is likely to affect her bargaining power with respect to her male partner. In South Africa, the power relationship is often strongly biased towards men, leaving women in a weaker position to negotiate over condom use (MacPhail & Campbell, 2001).

The fact that its consumption requires the interaction of two people sets sexual intercourse apart from most goods economists analyse. However, this feature does not exclude sex from economic analysis, just as it would not prohibit the economic analysis of playing tennis. So let's now turn to neoclassical economics for some more insights into the matter.

2. A Neoclassical Model of Risky Sexual Behaviour

2.1 The Discounting of Future Costs and Rewards

Besides being a central element of the model that follows, discounting by itself allows us to make some predictions about risky sex. When deciding whether to engage in risky sexual behaviour a person essentially faces a trade-off between short-term rewards and potential future costs. The short-term rewards of not using a condom might include things like the benefit of being aligned with what one's culture or religion dictates, the benefit of not having to fight with a partner who prefers unprotected sex, the greater thrill, the greater pleasure achieved by not using a condom, or getting sex at all rather than no sex on occasions when risky sex is the only option. The long-term costs might include things like unwanted pregnancy or the contraction of sexually transmitted diseases, including HIV/AIDS.

The nature of risky sexual decision-making makes it an inter-temporal choice problem. The decision-maker compares present costs and benefits with the

present value of future costs and benefits and how much she discounts the future to arrive at the present value will affect her decision. The most prominent reason for discounting is that a person always carries the risk of not being around to enjoy a future reward.

Traditionally, economic theory presumes that people, like financial institutions, discount later costs and rewards exponentially. In this paradigm, the present value of X is given by $X\,(1 + r/m)^{-mt}$, where r is the interest rate, t is the number of years and m is the number of times a year the interest is compounded. If interest is compounded continuously ($m \to \infty$), then

$$\lim_{m\to\infty}\left(1+\frac{r}{m}\right)^{-mt} = e^{-rt} \qquad \textbf{(2.1)}$$

Therefore, with continuous compounding, the present value of X is given by $X\,e^{-rt}$. It is easy to see how the name "exponential discounting" is derived. In the case of people choosing behaviours with primarily non-monetary rewards, a subjective discount rate is perhaps more appropriate for analysis than an interest rate. Then r becomes σ and

$$PV = Xe^{-\sigma t} \qquad \textbf{(2.2)}$$

Hence, as the personal discount rate, σ, increases, the present value, PV, of the future costs, X, decreases. In the context of risky sex, someone who discounts the future more heavily (someone with a higher σ) will put less weight on the future costs of her decisions and is therefore more likely to engage in risky sexual behaviour. Such a person is said to be more impulsive. The graphical analogy to a high σ and impulsivity is a steep discount curve.

As would be expected, impulsivity, or steep discounting has been linked to a host of risky behaviours. Using a measure of impulsivity that captures spontaneity and a disregard for future consequences, Donohew et al. (2000) find a strong association between their measure and sexual risk taking.

2.2 The Becker-Murphy (BM) Model of Rational Addiction

Gary Becker and Kevin Murphy (1988) propose a model of rational addiction. In this section, I apply some of the ideas of the Becker-Murphy (BM) model to risky sexual behaviour. One might be suspicious of how a model of addiction is

of any value in analysing risky sex. After all, it is arguable whether there is such thing as an addiction to sex and, even if there could be, it would probably only affect a small minority. However, the application of the BM model is not limited to addictions. Instead, the model may be used to describe phenomena that contain two specific properties, which are typical, but by no means exclusive to addiction.

Becker and Murphy make the assumption that the rational consumer takes all present and future consequences of her actions into consideration. Future consequences are discounted exponentially. The consumer tries to maximise her lifetime utility by choosing her present consumption according to her present consumption capital and taking into account future consequences. The consumer's current utility from consumption of a mix of two goods y and c (including mixes where $y = 0$ and mixes where $c = 0$) is given by:

$$u(t) = u\left[y(t), c(t), S(t)\right] \qquad \textbf{(2.3)}$$

Now suppose that good c is special in that its past consumption or consumption capital, given by S, also affects the consumer's current utility. Let c be the consumption of new sexual encounters. That is, let c be a measure of the number of different people the consumer has sex with, as opposed to how often the consumer has sex. The consumption capital, S, would then be a measure of a person's past sexual encounters with different people. I define c in this way because it makes it easier to reconcile the model's insights into sexual behaviour with risky sexual behaviour.

2.3 Reinforcement and Tolerance

The two properties playing a central role in the BM model are "reinforcement" and "tolerance". Let's consider them one at a time: Reinforcement means that greater consumption capital leads to a greater desire for present consumption ($dc / dS > 0$). This entails that an increase in the consumption capital raises the marginal utility of instantaneous consumption ($\partial^2 u / \partial c \partial S > 0$).

In the context of sex, reinforcement could result from a process of learning by doing, where greater sexual experience results in greater sexual skill. Of course, greater skill, or greater means to achieve sexual pleasure, increases the marginal utility of engaging in sex. In this respect, appreciation of sex is a lot like the appreciation of good music. For many people, their appreciation of good music is a function of past consumption, since one has to invest time into music to acquire a taste for it (Stigler & Becker 1977: 78).

Also, with greater consumption capital and hence, greater experience, it is likely to get easier to meet and persuade potential sex partners. In addition to this, in current Western cultures, women are often curious about sleeping with men who have slept with lots of others.

Both of these mechanisms work to decrease the opportunity cost of a sexual encounter with increasing sexual capital (though the latter might only be applicable for men), which makes them synonymous with reinforcement.

It could be argued that like many activities, if experienced too often, sex gets boring, which might work against reinforcement. However, the same could be said about listening to music and for many people this is not true. Furthermore, boredom negating reinforcement is made less likely by the fact that an increase in consumption is defined as having sex with different, new partners.

Tolerance in the BM model means that an increase in consumption capital decreases current utility ($\partial u / \partial S < 0$). In other words, for a given level of current consumption higher past consumption leads to lower current utility. The name of this property is derived from the fact that in the context of drugs, it can be attributed to the consumer building up a tolerance for the drug as S increases (Becker, Grossman & Murphy 1991:237). However, the tolerance property can arise from any negative consequences of past consumption (Skog 1999:175). For example, most people find a trusting long-term relationship innately rewarding. It may be argued that the higher someone's sexual consumption capital, or in other words, the more promiscuous someone's immediate past, the less likely this person is to be able to sustain a rewarding relationship.[1]

Perhaps more importantly, however, a higher consumption capital leads to an increased risk of having been infected with an STD. Of course, any sexually transmitted disease or infection is going to decrease current utility. At this point, I need to make the assumption that any STDs the consumer contracted do not prohibit sexual pleasure and therefore do not negate the reinforcement property. In other words, the costs incurred due to an STD are not paid for in sexual pleasure units, but instead, they are paid for in general well-being units, or in the form of money paid into a doctor's bank account.

Another assumption is that the fact that a consumer has contracted a contagious STD does not change her consumption of new sexual encounters. This means that if she knows that she is infected with a particular contagious STD our

[1] It is promiscuity in someone's *immediate* past that matters here because consumption capital in the model decays with time unless reinforced

consumer would not decrease her consumption in order to avoid infecting future sex partners. While this may seem like a harsh assumption, completely self-interested consumption is also a feature of the original BM model. For example, for reinforcement to hold, the alcoholic cannot let the pain her consumption of alcohol causes her family and friends directly affect her consumption. However, as is the case with the consumer of sex, the alcoholic's grief over her family's misery can find its way into the alcoholic's utility function via the tolerance property.

An illustration of the two properties is given by Figure 1. The graph plots present consumption against instantaneous utility for two different levels of consumption capital, A and B. The shape of the instantaneous utility curves is a result of the assumption of the BM model that utility is a concave function of present consumption.[2] The curve labelled A represents the lower consumption capital and therefore, because of the tolerance property, it remains above B for any level of present consumption. On each curve there is a dot at the point where instantaneous utility is maximised. For a higher consumption capital, the utility-maximising point is achieved at a higher present consumption. This, of course, follows from the reinforcement property.

2.4 The Steady States and Dynamics of the BM Model

The rate of change over time in consumption capital is given by the investment function:

$$\dot{S}(t) = c(t) - \delta S(t) - h[D(t)] \qquad \textbf{(2.4)}$$

In the context of an investment function, instantaneous consumption, c, can also be interpreted as investment in learning. δ is the exogenous depreciation rate of the effects of past consumption and $D(t)$ represents expenditure on endogenous depreciation or appreciation (Becker & Murphy 1988:677).

Let's assume $h[D(t)]$ to be equal to zero. Then, in Equation 2.4, when c is equal to δS, meaning that the investment in learning cancels out the depreciation in

[2] By assumption, u is also a concave function of y and S.

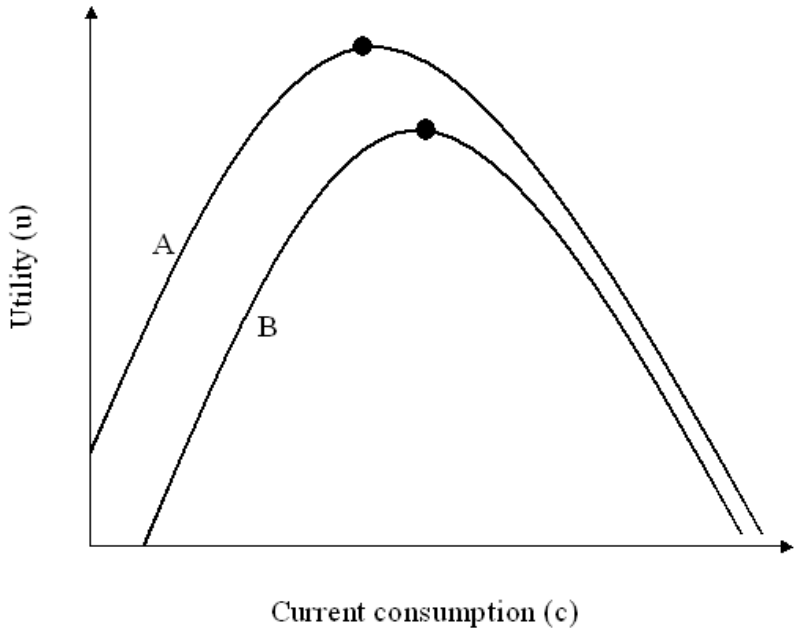

Figure 1: Utility vs. current consumption for different levels of consumption capital, S, where A = low S and B = high S. Adopted from Skog (1999:183).

consumption capital, there is no change in consumption capital. Of course, if *S* does not change, neither will *c*. Therefore, other things being equal, the consumer will be in a steady state of constant consumption.

In order to further illustrate the model's steady states and dynamics, I will use a simpler, more intuitively transparent version of the BM model developed by Skog (1999). According to Skog, the curve linking optimal current consumption to consumption capital in the BM model may look like the S-shaped curve depicted in Figure 2. The diagonal line in Figure 2 is the line $c = \delta S$, which gives the levels of c that leave S unchanged. The fact that $c = \delta S$ is a straight line implies that we assume that the depreciation rate does not change with *c* or *S*.

When the S-shaped curve is below the diagonal line, $c < \delta S$, the investment function implies that the consumption capital, *S*, will decrease until $c = \delta S$. Similarly, if the curve is above the diagonal line, *S* will increase up to the point of intersection between the curve and the line. It follows that A and C represent steady states. Furthermore, the dynamics just described dictate that A and C are

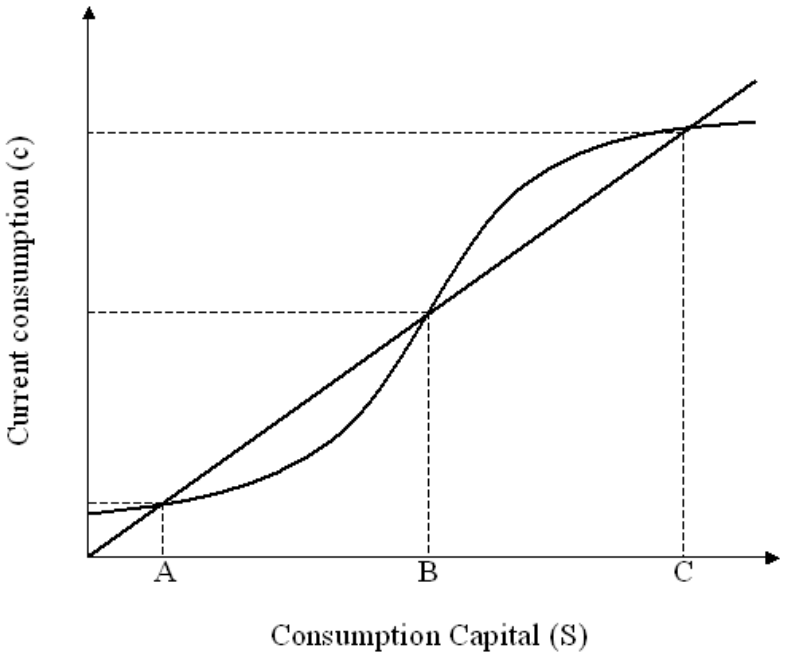

Figure 2: Optimal current consumption vs. current consumption capital. Adopted from Skog (1999:186).

stable steady states. The curve and the line also intersect at the unstable steady state B, from where even the smallest shock sends the consumer towards either A or C. A consumer starting with consumption capital between zero and B will end up at point A, while a consumer starting with consumption capital above B will end up at C.

If the overall utility at consumption level C is lower than the overall utility at consumption level A, a consumer who happened to get into a situation where her consumption capital surpassed the threshold of B might find herself caught in a suboptimal equilibrium. In other words, as a result of the tolerance and reinforcement properties, the utility maximising consumer might find herself locked into a consumption state that is not in her best interest. The problem that the consumer faces is that the present value of the substantial long-term benefits that reduced consumption would entail does not outweigh the very high short-term costs. The consumer caught at C is what Skog labels a dissonant addict, or someone who wants to abandon her habits, but feels that it is extremely difficult for her, or that she is not able to do so at all (1999:184).

Whether or not a consumer could potentially become a dissonant addict is dependent on the consumer's discount factor. A consumer who discounts future

consequences more heavily than the consumer in Figure 2 ends up with higher current consumption for any given consumption capital. This follows from the fact that she places less weight on the harmful future consequences of engaging in sex. The graphical equivalent of this scenario is an upward shift of the S-shaped curve.

Curve A in Figure 3 corresponds to a consumer, who discounts heavily. Here, the upward shift of the curve has eliminated the low-consumption equilibrium and the unstable, medium-consumption equilibrium. With the two alternative equilibria eliminated, the consumer will consume at the high-consumption steady state even if this entails considerable welfare losses. This consumer might be better off if she was forced to consume less. However, if left to her own devices even a little current consumption will eventually drive her towards the high-consumption steady state again. She is what Skog labels a consonant addict (1999:174).

Curve B in Figure 3 represents a consumer with a relatively low discount factor; someone who pays a lot of attention to future consequences. This consumer is at no risk of getting hooked. Instead she will eventually consume at a low-consumption steady state, regardless of her consumption capital.

2.5 Reconciling Sexual Behaviour and Risky Sexual Behaviour

What we have now is a model that provides us with predictions about how many different people a person is likely to have sex with, given her personal parameters and history. However, what we are really interested in is the amount of risky sex a person has. In a paper on sexual capital, Michael (2004) links the frequency of sexual encounters with different partners to the risk of contracting an STD. The probability of contracting a disease when having sex with one partner is given by:

$$\Pr(1) = PIC \qquad \textbf{(2.5)}$$

where P is the probability that the partner is infected, I is the infectivity rate of a certain disease and C is the failure rate of the method of prevention that is used. The probability of contracting the disease in N events with N different partners is given by

$$\Pr(N, N) = 1 - (1 - PIC)^N \qquad \textbf{(2.6)}$$

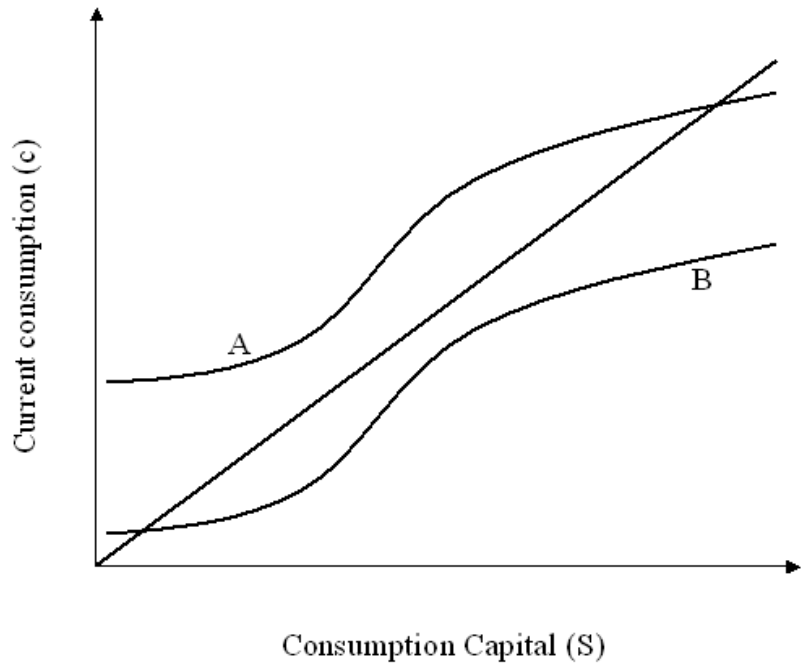

Figure 3: Optimal Current consumption vs. current consumption capital. A = consumer with high discount rate; B = consumer with low discount rate. Adopted from Skog (1999:187).

It is clear that for any given *P*, *I* and *C*, the likelihood of getting infected rises monotonically with *N*. Because *N* is the dependent variable in my application of the BM model, any conclusions reached about *N* would translate into conclusions about sex related risks. However, this is only the case if *P*, *I*, *C* and other important factors such as condom use are not related to *N* in a way that decreases the risk as *N* rises. I argue that it is reasonable to assume that *N* and other factors are not related in such a way and in fact, it is a solid finding in the literature that those with a high *N* are far more likely to have contracted a sexually transmitted infection in their life (Michael 2004:649)

The promiscuous person appears to fit the profile of the sexual risk-taker much better than the person living in a long-term, faithful relationship. For example, good communication, which is more likely to be a characteristic of a long-term relationship, is considered a key for making healthy decisions with respect to contraception (Fay & Yanoff 2000). Furthermore, it has been found that those with many sexual partners are more likely to have sex with people that also have multiple partners (Michael 2004:649). This again makes them more vulnerable to contracting an STD.

2.6 Implications and Problems of the BM Model

Bimodality

Becker and Murphy argue that strong addictions, or alternatively, behaviours featuring strong reinforcement result in a bimodal distribution of the population, with a high-consumption and a low-consumption mode. These modes would be located around points A and C in Figure 2. Skog points out that between two people, the location of A and C may vary substantially depending on other parameters of their utility function (1999:195). Therefore, unless people tend to be very similar in the parameters of their utility functions, bimodality is not at all a prediction of the model.

Despite this criticism, in most cultures a small subset of people has the majority of the sex (and an overwhelming majority of the promiscuous sex). While this points towards bimodality, the explanation for this phenomena is perhaps more likely to be found in evolutionary theory (Miller 2001). Nevertheless, given that people are endowed with a significant and significantly varying genetic aspect to their sexual capital, the BM model can explain how people can get stuck in high consumption states.

The price effect

In the context of drugs, popular wisdom has it that the quantity demanded of a drug is not very responsive to price changes, or in other words, that demand is inelastic. The BM model contradicts this view. In particular, even for addicts, it predicts the long-term price effect on drugs to be substantial (Becker, Grossman & Murphy 1991). Empirical studies on the consumption of various substances confirm this prediction.[3]

In the BM model, the long-term price effect is larger than the short-term price effect because present, past and future consumption are compliments. If HIV/AIDS education is viewed as raising the perceived price of engaging in risky sex, then adjacent complementarity implies that HIV/AIDS education and awareness has the larger proportion of its impact in the long-term, rather than immediately. If in fact true, this prediction has major implications for studies of the effectiveness of education programs. Unfortunately, testing this prediction is

[3] For some empirical studies see DeSimone and Farrelly (2003), Chaloupka, Grossman and Tauras (1998) and Becker, Grossman and Murphy (1991).

made hard by the fact that we are not dealing with readily observable prices, but instead, with subjectively observed risks.

The depreciation rate

A faster depreciation of adverse effects entails that addiction is stronger and more likely. This follows from the fact that, for any given consumption level, a larger depreciation rate leads to tolerance being smaller. Therefore, as health care for STDs gets better, addiction, or heavy consumption of risky sex might become more likely. In this context, healthcare is viewed as increasing the exogenous depreciation rate by decreasing the adverse effects of contracting a STD. This prediction is supported by international studies, which found that as HIV treatment has improved with the introduction of antiretroviral therapy, the prevalence of risky sex among homosexual men has increased.[4]

The BM model cannot account for regret and failed attempts to quit

The consumer in the BM model is aware of the future consequences of her behaviour at all times and does not make any decisions that are not aligned with her present preferences. Therefore, the BM model does not allow for the addict to feel any regret looking back on her consumption career (Chaloupka 2003:79). In reality, however, regret is a salient feature of addiction.

Orphanides and Zervos (1995) show how uncertainty about potential harm may explain how inexperienced users can get hooked and regret their consumption history retrospectively. However, it can be argued that there is still nothing to regret, since all choices that were made were rational, whether they were made under uncertainty or not (Gjelsvik, 2003:228).

The BM model also fails to explain the process of quitting. The dissonant addict recognises that, given a different consumption career, she might be consuming at a lower, higher-utility-yielding consumption level. However, because she is in a steady state, by definition she will not attempt to quit if the parameters in her utility function stay the same. She might quit if due to some external influence her discount factor rose above a certain threshold level. However, as previously discussed and illustrated in Figure 3, this would make quitting very easy. Therefore, the BM model predicts that addicts rarely attempt to quit and if they

[4] Boily et al. (2004) cite six studies from different countries that confirm this finding.

do, it is fairly easy. As Gjelsvik points out, however, in reality addicts frequently attempt to quit and the process of quitting is rarely easy (2003:228).

We would expect regret and frequent, difficult attempts to quit to be features not only of the addict's consumption career, but also of the life of our dissonant high-consumption state consumer of risky sex. Thus, just as the BM model's failure to account for these features casts doubt on its usefulness in describing addictions, it poses a challenge to the model's explanatory adequacy with regards to risky sex.

Time Discounting

It has been widely acknowledged that people discount future rewards hyperbolically and not exponentially as is assumed by the BM model (Chung & Herrnstein 1997). This has major theoretical implications. Hyperbolic discounting has us leave the realm of Neoclassical economics and venture into the field of behavioural economics.

3. Hyperbolic Discounting and a Model of Risky Sex

3.1 The Matching Law

Hyperbolic discounting is based on what is called the matching law, a theory attributed to the late Richard J. Herrnstein. It is useful to introduce the matching law before moving on to a discussion of hyperbolic discounting.

Let's imagine a task involving a choice between options that only differ in the frequency with which they provide reinforcement, or reward. Experiments done on humans and non-human animals such as pigeons and rats reveal that the relative frequency of choices favouring a certain option is equal to, or matches the relative frequency of reward obtained by the subject from this option (De Villiers & Herrnstein 1997:22). The statement that the relative rate of responding matches the relative rate of reward obtained by the subject is known as the matching law.

If we let $B1$ be the frequency of responses and $R1$ the reinforcement associated with option 1 the matching law can be expressed as follows:

$$\frac{B_1}{B_1 + B_2 + B_3 + \cdots + B_n} = \frac{R_1}{R_1 + R_2 + R_3 + \cdots + R_n} \quad \textbf{(3.1)}$$

This Equation entails that relative preference is given by:

$$\frac{B_1}{B_2} = \frac{R_1}{R_2} \quad \textbf{(3.2)}$$

It has been found that the matching law applies not only to the relative frequency of reward as an independent variable, but also to the amount and very importantly, the delay of reward (Chung & Herrnstein 1997:107). Thus, if we let *X* be the amount and *D* the delay of a reward, Equation 3.2 becomes:

$$\frac{B_1}{B_2} = \frac{R_1}{R_2} \times \frac{X_1}{X_2} \times \frac{D_2}{D_1} \quad \textbf{(3.3)}$$

Therefore, the matching law implies an inverse relationship between the relative preference of an option and the amount of time it is delayed by. If we define a good's value as its ability to compete with alternative goods, the matching law results in the following equation for a good's present value (Ainslie 1992:66):

$$PV_i = \frac{X_i}{D_i} \quad \textbf{(3.4)}$$

Mazur found that the following variant of the above equation proves more robust under empirical scrutiny (Mazur & Herrnstein 1997:141):

$$PV_i = \frac{X_i}{1 + KD_i} \quad \textbf{(3.5)}$$

where *K* is a constant that may vary across species, individuals and situations. However, despite the slightly different form of this equation, the inverse relationship between present value and delay remains intact. This inverse relationship results in hyperbolic discounting. Hyperbolic discount curves, as predicted by the matching law, are quite different from the exponential discount curves introduced in Section 2 above.

Figure 4 depicts both an exponential discount curve and, below it, a hyperbolic discount curve. The graph shows the value of a reward at different times. The undiscounted value of the reward *Xi* is given by the vertical line. The present value of the reward increases as time elapses and the delay gets smaller. The defining characteristic of the hyperbolic discount curve is that it is more deeply bowed than its exponential counterpart.

3.2 Hyperbolic Discounting and Preference Reversals

Exponential discount curves don't cross and as a result, they predict the stable preferences assumed by the BM model. Hyperbolic discounting entails this assumption is likely to be false a lot of the time. Because of the bowed shape of hyperbolic discount curves, two such curves may in fact cross. Crossing discount curves explain preference reversals, which are a common feature of human behaviour.

Figure 5[5] depicts a situation where a person is facing a choice between a smaller and sooner reward (SSR) and a larger and later reward (LLR). Sufficiently far away from both rewards, at time t1, the present value of the LLR is greater than the present value of the SSR. This means that, at t1, the LLR is preferred to the SSR. However, as time elapses there comes a point, t2, where the SSR's value increases above the LLR's value. After this point the SSR is preferred to the LLR and ultimately, the SSR is chosen. Point t2 is where the preference reversal takes place.

By accounting for preference reversals, hyperbolic discounting can explain why we find ourselves having two helpings of desert, procrastinating from studying and staying up too late, thereby abandoning our longer-term goals of achieving a healthy diet, doing well in our exams and being rested in the morning. In other words, crossing hyperbolic discount curves can explain why we sometimes betray our long-term interests for the enjoyment of imminent rewards.

If we deny ourselves the second helping of desert (the SSR) and thereby stay aligned with our long-range goal, a healthy diet (the LLR), we act self-controlled (Herrnstein 1997:121). Much of the theory on how hyperbolic discount curves can explain a lack of self-control and most of the theory on how people manage to achieve self-control is due to George Ainslie. But before we look at how people achieve self-control, let's look at how risky sexual behaviour can be understood as a lack thereof.

[5] Figure 5 is based on Mazur's equation (Equation 3.5). In simpler versions of the matching law such as Equation 3.4, the present value of the reward approaches infinity as the delay approaches zero and therefore, a SSR will always get chosen over a LLR (Herrnstein 1997:124). The 1 in the denominator of Mazur's equation helps avoid this problem.

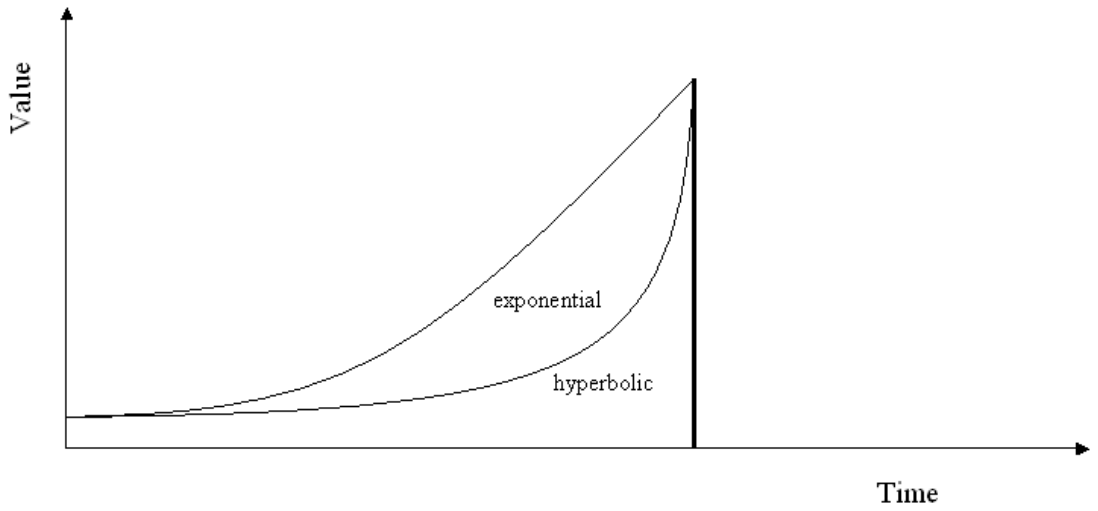

Figure 4: An exponential and a hyperbolic discount curve. Adopted from Ainslie (2001:31).

3.3 Hyperbolic Discounting and Risky Sex

The decision of whether to engage in risky sex or not involves a trade-off between short-term benefits and long-term costs. The short-term benefits of risky sex such as greater pleasure, or getting to have sex at all when risky sex is the only option, can be viewed as the SSR in Figure 5. The potential long-term costs of risky sex include contracting HIV and other STDs or suffering an unwanted pregnancy. These potential costs can be accounted for by viewing the LLR in Figure 5 as the benefit of living a life free of the potential negative consequences of risky sex.

Then, Figure 5 depicts a case in which a person who is aware of the potential harmful consequences of risky sex favours the LLR and hence, prefers not to engage in risky sex, before time t2. However, as time elapses and the opportunity to engage in risky sex comes closer, at time t2, the SSR's value increases above that of the LLR. At this point, a person may give in to the SSR's temptation and engage in risky sex even though it might not be in her long-term interest.

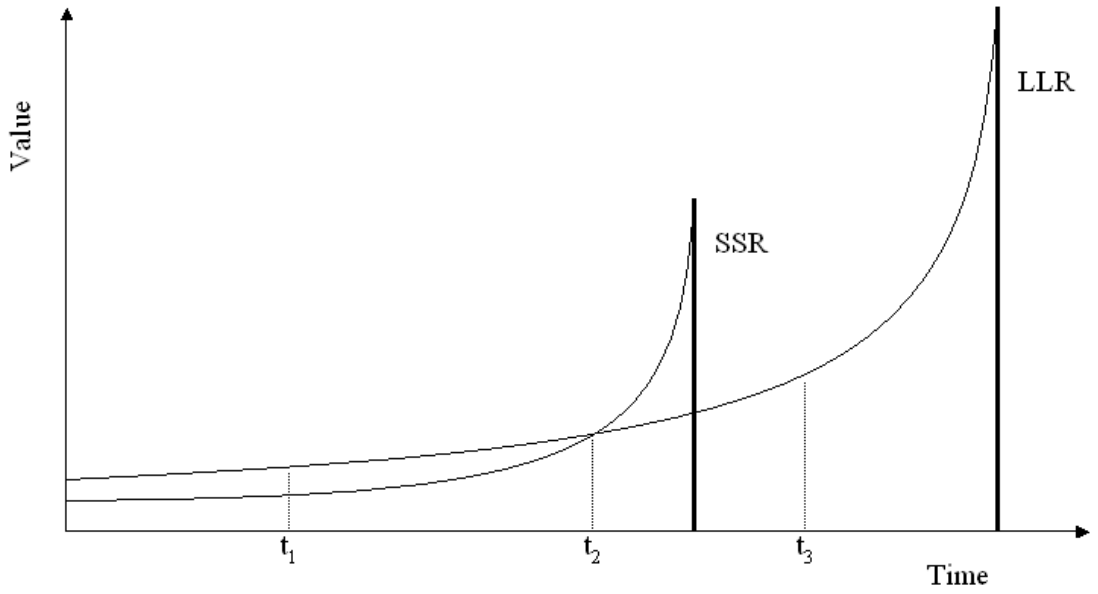

Figure 5: The hyperbolic discount curves of two rewards, which have different sizes and are available at different times. Adopted from Ainslie (2001:32).

In the case of risky sex, the LLR is not concentrated around a certain point in time. Instead, a life free of the negative consequences of risky sex must be seen as a prolonged reward with small benefits accruing to a person over a period of time. This means we should be cautious in interpreting the LLR in Figure 5. It should be viewed as the sum or integral of the discounted segments of the prolonged reward (Ainslie 1992:147).

According to Ainslie hyperbolic discounting can explain a number of different phenomena depending on the duration of the temporary preference. The temporary preference refers to the time that elapses between the preference reversal and the realisation of the SSR. Risky sexual behaviour most probably fits best into what Ainslie calls the "short-term addictions" range of temporary preferences, in which the duration of a temporary preference can be anything from seconds (as in the case of an itch one would rather not scratch but scratches anyway) to days (2001:48).

An activity in this category is characterised by three main features: It is avoided if it is foreseen from a distance; the prospect of its reward is hard to resist as the opportunity to engage in the activity becomes imminent; and engaging in the

activity is regretted afterwards (Ainslie 2001:49). Regret sets in after the consumption of the SSR (i.e. at t3 in Figure 5).

The test for whether Ainslie's model provides a better account of risky sex than the BM model is whether it does a better job at predicting the observable features of risky sexual behaviour. For example, unlike the BM model, Ainslie's model predicts regret. While it seems intuitive and very plausible that the person engaging in risky sex feels regret afterwards, there is no quantitative data to back up this intuition up. Nevertheless, regret features in some of the qualitative interviews employed by psychologists studying risky sex. For example, a qualitative study on alcohol use and sexual behaviour in Gauteng found that:

"Males in particular reported having strong feelings of regret after alcohol-induced sexual encounters. … However, such feelings hardly deterred them from placing themselves at risk."
(Morojele et al. 2006:224)

Future research would have to answer the question of whether the majority of risky sex is had by people who prefer to avoid it from a distance, succumb to it once it becomes imminent and regret it afterwards. If this was the case, hyperbolic discounting can describe the behaviour.

3.4 Impulsivity Revisited

For the exponential discounter, higher impulsivity is synonymous with a steeper discount curve. Given certain short-term rewards and long-term costs, the exponential discounter consistently prefers to either engage, or not to engage in risky sex. Other things being equal, the more impulsive the exponential discounter is, the more likely she is to categorically prefer the short-term reward. In the BM model, the more impulsive a person is, the more likely she is to end up locked into a high-consumption steady state.

The subjective constant, K, in Mazur's Equation (Equation 3.5) is the hyperbolic counterpart of the subjective discount factor, σ, in Equation 1.2. Impulsivity manifests itself in a relatively high K and the impulsive hyperbolic discounter has a relatively steeper and more deeply bowed discount curve.

Similar to the exponential discounter, the more impulsive a hyperbolic discounter is, the more likely it is that the present value of the LLR remains below the present value of the SSR at all times. However, even if the present value of the LLR initially lies above the present value of the SSR, impulsivity

increases the likelihood of the SSR's value spiking above the LLR's value eventually. Therefore, the impulsive hyperbolic discounter is more likely to suffer from a lack of self-control.

3.5 Achieving Self-Control through Personal Rules

Hyperbolic discounting entails that people's preferences are not always consistent through time. This means that we can expect people to act irrationally in the sense of traditional economic theory. Unfortunately, however, not acting rationally or a lack of self-control makes us vulnerable to the exploitation by those who act rationally. Ainslie illustrates this point nicely in an example involving two people, one who is a hyperbolic and one who is an exponential discounter (2001:31). Every spring, the hyperbolic discounter would sell her winter coat to the exponential discounter, because with the winter being at a far distance, hyperbolic discounting would depress the coat's value by more than exponential discounting. As fall comes to an end and hyperbolic discounting sends the value of the winter coat into a spike, the exponential discounter could sell the coat back to the hyperbolic discounter at a profit.

However, people often manage to act rationally and in their long-term interests and usually we don't find ourselves exploited by exponential discounters. But given that people discount hyperbolically, how do we often manage to resemble the more self-controlled exponential discounters? Ainslie shows how extrapsychic mechanisms, control of attention, preparation of emotion and personal rules provide four means to achieve self-control (1992:130). I will focus my discussion on the fourth and most important one, personal rules.

To demonstrate how personal rules work let's start with the obvious example. Say I have a personal rule to never engage in risky sex. Then, as the opportunity to engage in risky sex becomes imminent, I can either decide to abandon my personal rule and choose the SSR, or I can stick to my personal rule and choose the LLR.

Up to this point I have only discussed choices between a single SSR and a single LLR. However, life is often made up of a series of similar choices between SSRs and LLRs. The personal rule to never engage in risky sex says: "Always choose the LLR." In this way personal rules have us choose rewards in bundles of LLRs and SSRs rather than choosing them individually. To bundle rewards is to view each individual choice as a choice between a series of SSRs and a series of LLRs.

We need to assume that hyperbolic curves combine additively. Then, the bundling resulting from personal rules gives rise to an advantage of the LLRs over the SSRs. Figure 6 illustrates how the sum of a series of LLRs may be greater than the sum of a series of SSRs at all times. In the diagram the person would consistently choose the SSR if she was to make her choices one at a time. However, if she bundles the rewards, the LLRs' aggregate value rises above the SSRs' value, which leads to choices that are consistently in her long-term interest. The claim that bundling increases self-control has been empirically validated (Kirby & Guastello 2001).

But what, one may ask, makes the choice between the SSR and the LLR in pair 1 in Figure 6 fundamentally different from the choice between a single SSR and LLR? The answer is that, in the presence of a personal rule, choosing the SSR comes at the additional cost of abandoning one's personal rule. The personal rule is an asset, which is devalued in the present if the hyperbolic discounter chooses the SSR. It derives its value from helping the hyperbolic discounter choose the stream of LLRs in the future, which, as illustrated in Figure 6, is more desirable on aggregate. Therefore, the personal rule transfers some of the future costs of choosing the SSR into the present.

The mechanism that makes personal rules effective and ultimately results in bundling is perceiving one's current choice as a precedent, or the main determinant of a whole series of choices (Ainslie, 1992:145). The hyperbolic discounter uses the fact that choosing the SSR over the LLR now would very likely result in similar preference reversals in the future to avoid the current preference reversal.

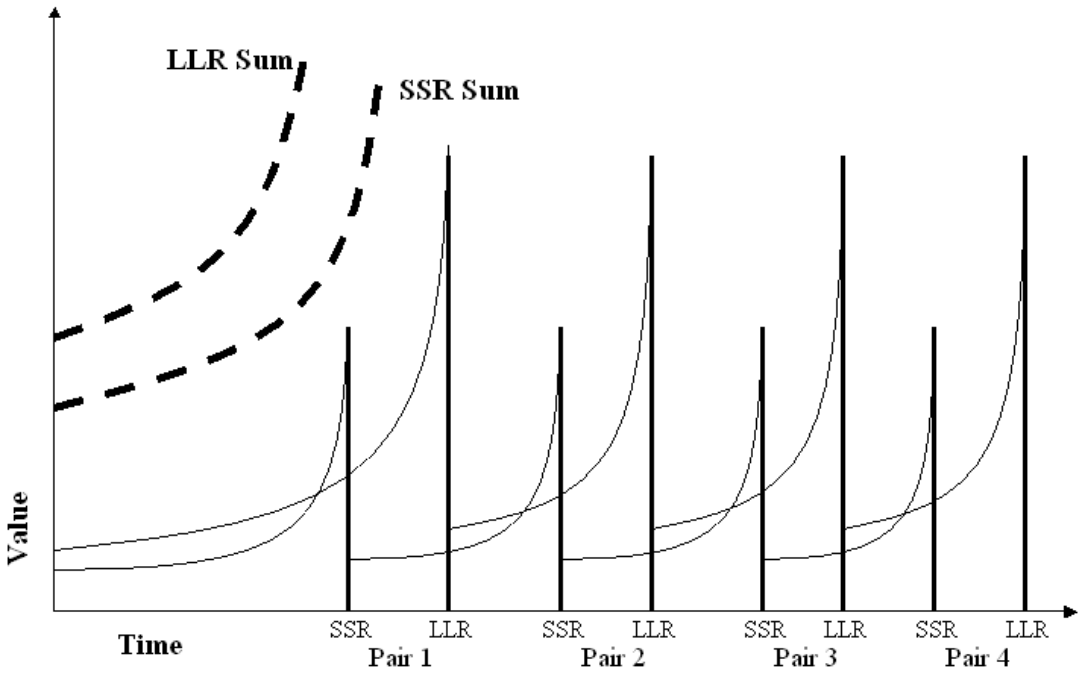

Figure 6: A series of pairs each consisting of a smaller and sooner rewards (SSR) and a larger and later reward (LLR). The bold dashed curves are the sums of the four LLRs and the four SSRs respectively. Adopted from Ross et al. (2005:59).

3.6 Avoiding Risky Sex with the Aid of Personal Rules

The comparability and rivalry of financial transactions such as the winter coat example help people to bundle and achieve rational behaviour in situations involving financial transactions (Ainslie 1991). However, personal rules based self-control may also be a feature of sexual behaviour.

It is likely that a person faces the decision of whether or not to engage in risky sex on several occasions in her lifetime. However, the question remains whether we can reasonably assume that a present choice sets the precedent for future choices. In other words, is my choosing risky sex today making it more likely that I will choose risky sex in the future or alternatively, is my abstaining from risky sex today making it more likely that I will abstain again?

The reinforcement and tolerance properties featuring in the BM model might provide the answer for why we should view the choice of engaging in risky sex or not as a precedent for future choices. Choosing risky sex today will increase reinforcement and tolerance, since both rise with consumption. Facing a similar choice tomorrow, factors influencing reinforcement, such as the lower opportunity cost of sexual intercourse and greater sexual skill, will have increased the SSR of risky sex.

An increase in tolerance, on the other hand, is more likely to have its effect on the LLR. For example, after having engaged in risky sex, the probability of living a life free of its negative consequences such as HIV/AIDS has been decreased. Therefore, other things being equal, after having chosen risky sex (the SSR) the first time, the next time around a person faces a higher SSR and a lower LLR and is therefore more likely to opt for the SSR again.

The above argument provides the rationale for using personal rules and bundling to help avoid risky sex. Then, according to Ainslie's hyperbolic discounting model, risky sex may be explained as a failure to bundle.

It has been argued that hyperbolic discounting by itself might not be sufficient to provide a full-blown theory of addiction (Herrnstein & Prelec 1997:184). In fact, theories like Herrnstein's melioration or Rachlin's relative theory of addiction are likely to be better suited to account of addictive behaviour. However, since risky sex can and should *not* be understood as an addiction, viewing it as a lack of self-control may be sufficient and even preferable.

3.7 Bright Lines and Fidelity

Facing the choice between a series of SSRs and a series of LLRs there is one strategy that could potentially be superior to always choosing LLRs. From the perspective of one's current self it is preferable to choose only the most imminent SSR and choose only the LLRs after this. For example, the alcoholic would ideally prefer to drink a bottle of whiskey tonight and enjoy a life of sobriety thereafter. We know, however, that drinking a bottle of whiskey is likely to destroy our personal rule's credibility. In other words, a bottle of whiskey is likely to set a precedent for choosing the SSR again in the future. Therefore, choosing the SSR destroys the personal rule's value and as this devaluation occurs in the present, the cost can motivate resistance to the lure of the SSR even in the hyperbolic discounter.

However, the chooser might look for a way in which she can indulge her preference for the SSR without damaging her personal rule. She might try to achieve this by looking for plausible exceptions to a personal rule that are unlikely to set precedents for breaking the rule in the future. For example, the recovering alcoholic may decide to drink only today because it is Christmas. As a result, her personal rule should still keep her from drinking on all days that are not special holidays. Unfortunately, however, the recovering alcoholic is likely to soon find herself drinking on Africa Day and eventually, every weekend. Borrowing the term from lawyers, Ainslie argues that in order to avoid stepping on this sort of slippery slope, we build, or at least, should build our personal rules along bright lines (Ainslie 2001:96).

As Alcoholics Anonymous realises, drinking only on special holidays just does not constitute a bright line. The bright line is to not drink at all, ever. Bright lines that are shared by the majority in a society may appear as social norms. I now introduce a social norm that functions as a bright line and helps govern our sexual behaviour and therefore provides evidence for the importance of personal rules and bundling in the context of risky sex.

In most Western cultures there exists a relatively narrow view of what constitutes infidelity. Infidelity is to be in a long-term relationship and cheat on one's partner by having sex with a third person. Let cheating be the SSR and the sustainable long-term relationship be the LLR. The bright line here is copulation as opposed to, adoring, flirting with, or even kissing another person. It is having sex outside the marriage, not flirting, that has the potential to render you guilty in a divorce and is morally frowned upon by most people.

So why do we draw the line before sex, while other forms of romantic betrayal might be equally painful and are not fundamentally different in a moral sense? The answer is twofold. First, in a marriage, extra-marital sex may potentially bring disease and extra-marital children into the marriage, both coming at a substantial cost to the faithful. Kissing, or flirting is not as costly (in evolutionary fitness terms) to the faithful partner. Second, sex is easily distinguished from no sex. It is a much better bright line than no flirting or even no kissing, which makes it less vulnerable to providing exceptions to a personal rule.

There is evidence that infidelity is less common among humans than other mammals that form long-term pair bonds (Miller 2001:332). However, like other animals, we discount hyperbolically. Thus, in this context, the major difference between us and other animals might be that we have well defined personal rules along bright lines.

This is further supported by the fact that from an evolutionary perspective, the best strategy might be to be in a faithful relationship and only cheat on the rare occasion that a potential sexual partner that is substantially fitter than the current partner comes along (Miller 2001:334). In fact, this sort of behaviour is not uncommon. However, it is not an openly and commonly observed social norm, which may be explained by the fact that even highly selective cheating is likely to eventually deteriorate into excessive infidelity. "A substantially fitter partner" is a concept that lacks the bright-line-character required for highly selective cheating to be a good personal rule. Therefore, if fidelity is evolutionarily preferable to no fidelity at all, we would expect fidelity being enforced by relatively uncompromising personal rules. This may also partially explain some religions' strict condemnation of extra-marital sex.

The fact that it is useful to define our personal rules along bright lines and that this tactic is successfully used in guiding our sexual behaviour has implications for HIV/AIDS education. Education suggesting personal rules to avoid HIV infection should define those rules along bright lines. Thus, personal rules should read "Under *no* circumstance must I have unprotected sex with someone without having been tested for HIV with this person." instead of "I must make sure that I use a condom when I am not sure whether someone might be infected."

4. Conclusion

Hyperbolic discounting provides an explanation for how people who are fully educated about the harmful consequences of risky sex and who are free from societal pressures may still give in to the imminent temptation. Ainslie's theory then uses the fact that people are hyperbolic discounters and shows how we may use personal rules to achieve self-control and act in our long-term interests. While Ainslie provides a theory of how people strive to become rational, Becker and Murphy make the assumption that they already are and even though the BM model faces some serious challenges, it warns us that the rational person may still end up at a suboptimal high-risky-sex-consumption steady state (Skog 1999:192).

Research aiming at identifying the determinants of risky sexual behaviour should take seriously the self-control issues suggested by Ainslie. If risky sex is in fact to be understood as a lack of self-control, research should aim at identifying factors that inhibit the successful use of personal rules and bundling in situations where risky sex frequently occurs. Bundling-inhibiting factors such as impulsivity and the lack of bright lines could then be targeted by education and policy.

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