Chapter 8

Reason and Addiction

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Introduction

Some addicts are unwilling addicts. They seem to engage in voluntary, self-destructive addictive behaviour they do not want (in a sense that needs specification) to engage in. There might even be a history of failed, desperate attempts at quitting and great despair.

This paper aims to focus on the unwillingness of unwilling addicts. Since they are unwilling, that seems an important starting point for therapy in these cases. Therapy in the case of a willing addict will be different. An important aspect of this starting point is that unwilling addicts seem to have good reason to be unwilling. In this sense their unwillingness seems to be an expression of their rationality. My basic claim in this paper is that, in order to account for this potential aspect of addiction in humans, we seem to need a richer notion of normativity and rationality than that provided by the explanatory notions of rationality employed by decision theorists. I shall end this paper by giving an outline of a richer and more substantive normative framework in which one might delineate addiction. I believe we can do this while preserving the explanatory insights of decision theoretic approaches to addiction. I concentrate on norms about the discounting of future well-being, and on issues around irrational desires and motivational states. I also argue that the explanatory decision theoretic approaches base themselves on auxiliary hypotheses about rationality, and these hypotheses need independent testing.

Addiction is extremely complex. I shall start with an overview of some aspects of this complexity, and then give deeper illustrations of just two points. In the second part of the paper, I discuss Becker/Murphy’s and Ainslie’s approaches to addiction. In the third part, I outline my own framework for thinking about reason and addiction. I stress that this will be a framework, not a theory.

The Complexity of Addiction

One aspect is the many different approaches to what is thought of as one phenomenon. Addiction is approached both from brain biology, employing a neurophysiological
language, and from decision science, employing an intentional and normative language, and conceptions of rationality. There are many puzzles about the relationship between these approaches, ranging from issues around the age-old mind-body problem, issues around weak will, and issues around the relationship between the various special sciences.

Another aspect is this: the intentional and normative language of belief and desire is always an employment of conceptions of rationality, and this brings with it a whole range of issues about reason, rationality, and choice. Among these issues is whether or to what extent addictive behaviour can be seen as compatible with choice. In the neighbourhood of this issue there are other issues which relate to philosophical topics. Is the addict’s freedom of will impaired in some way or other by the loss of control which seems to characterize the addicted state? Is the responsibility of the addict impaired with regard to her continued consumption? Remember that intentional agency is not sufficient for responsibility; many intentional agents are not responsible, even if they have the ability to choose. Consider a three-year-old child — obviously a chooser, but not a responsible agent in anything but a causal sense.

A yet further complication is the fact that addiction has several characteristic stages or phases; among them are: becoming addicted; being addicted; trying to quit (and, sometimes, succeeding); and relapse. It seems entirely reasonable to demand that an adequate theory of addiction should be able to handle all these possible stages, and get the relationships between them rightly understood. Becoming addicted is a process, and we need a theory which explains why it occurs, and why sometimes it is not completed. Being addicted is a state, and one needs both to characterize this state, and relate this characterization to ways into it and out of it. (This need is basic even if there is just a gradual change from not being addicted to being addicted.) Trying to quit does not always occur, just as the process of becoming addicted is not always completed. Still, attempts at quitting occur, more frequently for some addictions than for others, and we need to understand how their occurrence is possible, and understand what happens when they succeed or fail. (Thomas Schelling has given us wonderful examples of addicts who voluntarily submit themselves to extortion to escape their own addiction. (See Schelling (1984), essays 4 and 5, and Schelling (1999a, b).) It is also a clear characteristic that all ex-addicts are prone to relapse, and this tendency should be accounted for. An approach to addiction which is in conflict with the fact that relapse often occurs cannot be an adequate approach to addiction.

Things are made even more complicated by the need to address anew the relationship between biology, decision science and contested rationality issues for each of the significant possible stages in addiction. And when we address the relationship between biology and decision science for each of these stages, we might do that in many different ways. One important way is to ask whether and to what extent there is important causal knowledge we would miss by sticking to, for instance, the biological perspective and a neurophysiological description of the processes. This way of asking stresses the fundamental importance of causal knowledge for explanation: the point of explanation is to provide causal knowledge. Our question asks whether there is causal knowledge to be had in addition to the knowledge provided by the biological approach. Such knowledge would, of course, be of great relevance for therapy. If there is no such knowledge to be had, a decision theoretic approach to addiction would be of no significance.
Illustration of First Complexity: Becoming Addicted

When becoming addicted there is a gradual change in the reward system in the brain. We might, for simplicity, think of it as a change in the mesolimbic system, a change which has different characteristics for different chemical addictions, but which also has a common element in the change in the potential for dopamine uptake in nucleus accumbens. This process can be described in detail relative to intake of the chemical substance in question, and relative to this intake the change can be well explained by brain biology. (For details, see Gardner 1999; Gardner & David 1999; Goldstein 1994; Rolls 1999, especially Chapter 6.)

An interesting question is the contrastive question of why the intake continues rather than stops, or perhaps, why the consumption of the substance(s) in question continues and increases. Causal knowledge of why the intake continues can, or so it seems, be captured by different descriptions: one at the level of a biological understanding of the reward system of the brain, and another at the level of choice: the beliefs and desires of the agent. Is one level better than the other, and to be preferred? It might also be, however, that the explanation of why the intake continues is not the same as the explanation of why the consumption continues. This is because the intake might continue even if there is no question of choice, and pure compulsion. The consumption of the substance, we might say, continues only as long as this is the better choice among the relevant alternatives. In the case of pure compulsion this framework of relevant alternatives no longer makes sense, while the biological perspective makes perfect sense; these alternatives and how they are balanced have no role in the biological explanation of the continuation of the intake. When we rightly rule out such compulsion, and see the behaviour as the result of choice, this approach must be grounded in facts about the agent.

The decision approaches therefore share something: they aim to capture special and interesting types of causal stories, and thereby provide causal knowledge the biological approach cannot provide. Decision approaches open up for social input. They open for intentionally characterized input in general. Imagine a consumer who is facing a choice about consuming an addictive substance. She believes there are some good and some bad consequences from consumption, but is not sure about how bad, and is about to consume. At this moment she is presented with newly-won knowledge to the effect that this addictive substance has some very bad effects. This new knowledge would make a difference for our imagined consumer. The new knowledge would change the way she evaluates the alternatives, and in many cases consumption would stop. Then it would make a behavioural difference. In those cases the stopping would be a causal result of being fed the new knowledge. This is an intentional causal path — a causal story. Knowledge of this causal story is not available to biology, but may be very important for us.

We can also easily imagine a different case where this consumer is already quite hooked when she receives this same new information. There are scenarios where she tries but is unable to quit, but still generates an overwhelming desire to quit, and is frustrated and angry with herself for being unable to quit. This addict would be trapped — we might in plain language say that reason cannot control her behaviour; her behaviour is controlled by some force which she might think of as alien to herself. We now have two different scenarios where this new knowledge makes a causal difference: the first case where the result is a difference in behavioural output, the other case where the result is a difference.
in attitudes towards her own continued consumption. Both these possible causal roles of this knowledge are situated in intentional descriptions.

It is natural to think that some biologically describable fact is relevant and does indeed contribute in its particular way to the explanation of why the causal role of this knowledge is different in the two cases. That is very important. Still, we can have perfectly valid intentional causal knowledge without knowing that biological fact, and our use of our intentional causal knowledge will in many ways be independent of even potential knowledge of that biological fact. It is also perfectly possible that the causal role of this new knowledge is different for two addicts with exactly the same changes in their mesolimbic system.

Illustration of the Second Complexity: Basic Issues in Rationality and Time-Discounting

If one were to address the issue, concerning the case above, of whether the choice of continued consumption is a rational choice, one would need to engage in the issue of what rational choice is. There are very different conceptions of what it is to be irrational, or "against reason," within philosophy. We have, among other things, to inquire into the source of reasons for acting some way or desiring something. Reasons for caring and acting might either be seen as provided by desires (i.e. by motivational states) or by facts about what is good or worth achieving. We might call these approaches the desire-based and the value-based approaches to reasons for acting. These are very different ways of looking at reasons, and they both run through the history of philosophy.

A desire-based view on reasons is either plain or ideal. The plain view says that we have a reason to do something just in case it might fulfill one of our present desires. In the ideal view the point is that we would have such a reason-giving desire if we knew all the facts and went through an ideal process of deliberation. Still, the basic fact about a desire-based view is that reasons are provided by motivational facts. This model can be called voluntaristic.

A value-based view holds that reasons are provided by the facts, and not by how we happen to be motivated. Motivational facts are not themselves reason-giving, but are instead seen as our (more or less rational) responses to what reasons the facts provide. The fact that we have a certain desire may, of course, indirectly give us a reason to satisfy that desire, but that is only because of the fact that the satisfaction of the desire gives us pleasure or well-being. If, however, the desire in question gives us no such fulfillment, then we have no (normative) reason to satisfy that desire. A value-based approach to reason would think of actions towards the satisfaction of such a desire as irrational, even if we were strongly motivated to satisfy it. Such motivation is irrational.

Decision-science/economics is, of course, completely dominated by a desire-based or voluntaristic approach to reasons. Recently this science, dominated by rational choice explanations, has extended its possible explananda. In order to explain more types of behaviour, traditional conceptions of rationality are being replaced by thinner, less normative and, in one sense, more subjective conceptions of rationality. The case of consistency-requirements, through time and at a point in time, is an interesting example. In the past, economics tended to see all discounting of future well-being as irrational. Recently, many have seen such discounting as rational as long as there were no dynamic inconsistencies. Some writers have
moved towards allowing dynamic inconsistencies to be rational, as long as there is consistency at each point in time. But if one's approach to reason is entirely desire-based, there is a real question about why one should stop here; people are as a matter of fact not consistent at each moment in time, and there is a question about the source for the (rational?) demand for consistency. (For an excellent overview of this development see Frederick et al. 2002).

In philosophy there is, I would say, the opposite development to that of decision science; there is a reaction against the consequences of a desire-based approach to reason, and a reaction against collapsing the normative notion of rationality into a purely explanatory notion. The value-based view on reason is becoming more widespread, especially as advocated by T. M. Scanlon at Harvard or John Broome and Derek Parfit in Oxford (see, e.g. Broome 1999; Parfit 1997: 98–130; Scanlon 1987, 1998).

Broome's and Parfit's conceptions of rationality are thick, substantive, normative, and make objectivity claims. It should be noted that explanation of behaviour can be exactly similar on such a value-based view as on a desire-based view, since behaviour is explained by how we are in fact motivated, by our motivating reasons, not by what reasons we have. (We must not identify the reasons there are with the motivating reasons.) We may, however, know that we have reason to be motivated differently from the way we are motivated. On the value-based approach, the motivations which explain behaviour will themselves be divided naturally into rational and irrational motivations.

This very distinction between a value-based and a desire-based approach to reason can be observed in the case of discounting of value in time. Here we must tread carefully for another reason as well. In standard economic theory, one discounts the value of future goods, i.e. a future table may be worth less than a present identical table. Such discounting is just right for the fertile economies we live in. (John Broome discusses in great detail the relationship between discounting of goods and discounting of well-being in his “Discounting the future” [Broome 1992, 1999].) Another question concerns the discounting of future well-being. We should pay less now for a future wine-bottle in a fertile economy than for a present wine-bottle, but the well-being or enjoyment we get out of consuming one such wine-bottle should perhaps not be discounted. Discounting of the value of future goods and discounting of the value of future well-being therefore work differently. Philosophers are routinely concerned with the latter, and economists are routinely concerned with the former. Classical economists have been much concerned with the relationship between these issues (see Lowenstein 1992).

The mechanism that characterizes many decision-based approaches to addiction is precisely a discounting of future value. This discounting must be discounting of the value of future well-being, not the discounting of the value of future goods. For the rest of this paper, discounting is discounting of future well-being. On Parfit's view on rationality, it is irrational to discount future well-being, and if such discounting is a necessary characteristic of a decision-science account of addiction, then someone cannot become addicted by successive rational choices. Scanlon has a more moderate view on irrationality, and a less substantive view on rationality, and holds that as long as a person evaluatively believes her present discounting of future well-being to be right, we should not call such a discounter irrational. On Scanlon's view a person could become addicted by choices which (in this appropriate sense) are rational. And it is indeed natural to think that it is not irrational to act on present desires even if those desires are based on false
beliefs; desires are rational when they are the right responses to what we believe (including evaluative beliefs).

We see that we here encounter a deep difference which turns on what desires ought to be subjected to rationality considerations, on whether desires in many areas are rational when they are the right responses to either what is good or to what is believed to be good. The standard economic approach is to treat desires just like tastes. In particular: is heavy discounting of the future just like a strong preference for vanilla ice cream, and just another preference? Jon Elster raises this question, and his answer is in a way “yes.” He says: “If we want to explain behaviour on the assumption that people make the most out of what they have, the idea is exactly right” (Elster 1999a, b: 146). Elster’s argument states explicitly that it is the explanation of behaviour we need the notion of rationality for. If that is so, then there are no rationality issues beyond the motivational and explanatory issues, even if there might be issues of reason and reasonableness beyond the explanatory issues. Against this I suggest a wider notion of rationality, connected with the notion of reason, but possibly with Scanlon’s modification in place; one is not irrational in one’s motivations when these are endorsed by one’s evaluative beliefs.

If we take that (moderate) line, there need be no disagreement with Elster about how potential addicts are motivated, and therefore no disagreement about how we explain the development of an addiction: People maximize utility as they subjectively see things at each moment of choice, and make the most of it relative to how they are motivated. The remaining question is why we should think that the motivating and/or explanatory reasons in this case are rational. If the agent believes that strong discounting is wrong, but still discounts strongly, then there seems to be something irrational in the motivational states of this agent, even if the agent maximizes utility relative to all motivating reasons at each moment of choice. If, on the other hand, the agent believes that she ought to discount to the exact degree that she does discount, there is no internal conflict, and no subjective irrationality. Scanlon (and I) would then say that the agent is not irrational. Still, the agent might hold a false or unreasonable evaluative belief about discounting. Really extreme discounting, no concern for the future at all, nevertheless appears irrational to most of us.

In any case, a preference for discounting future well-being seems different from a preference for vanilla or strawberry ice cream, and we normally do not even hold evaluative beliefs about the rightness or wrongness of the latter. And if presented with some visually and otherwise extremely attractive strawberry ice cream, it would not be irrational to change to preferring strawberry ice cream. However, Elster writes, about the temporal case: “I am inclined to say, nevertheless, that any viscerally induced and behaviourally manifested disregard for the future is a sign of irrationality, regardless of the exact mechanism by which the effect is produced” (Elster 1999a, b: 147). My challenge to Elster would be for him to spell out the following: How can discounting of the future both be a taste not subjected to rationality considerations, while it is also the case that a viscerally induced change in time preferences is irrational? (Viscerally induced changes in a taste are not irrational!) Elster also needs to explain why only a viscerally produced change towards disregarding the future is irrational, while the opposite viscerally produced change towards disregarding the present is not.

It seems to me that he cannot have it both ways, and that his (to my mind) correct view on the change of time preference has to be backed by a view different from his on the
general issue of the rationality of time-discounting. I believe a different view here would imply that motivational facts do not determine the rationality of time-preference, but that things are the other way around; facts about the good or our evaluational judgement determine the rationality of motivations for options at different temporal locations. Then we move towards Parfit’s view. I have earlier argued that only a modest discounting of future value is compatible with exhibiting the type of rational self-governance that is required for responsibility (see Gjelsvik 1999a, b). That partially explains why we should not treat children or mentally handicapped people as morally and legally responsible, and that fact is fully recognized in the legal systems of most countries.

Two Theories of Addiction

I have stated above that minimally, an intentionally-based theory of addiction must somehow capture the ambiguity of the unwilling addicts who consume the addictive substance but hate the fact that they do so. Such a theory must, it seems to me, provide a way in which the unwillingness to consume is the voice of reason in the conflict with the desire to consume. Only if that is so can we rationally regret our earlier choices, rationally direct anger towards ourselves, etc. That is typically what we do, and typically what, for instance, a smoker who is unsuccessfully trying to quit experiences. Of course, this requirement may be contested in various ways, but to me it seems quite clear that we need to get this ambiguity of the addict right in order to fully justify the value of an intentional approach to addiction. This type of ambiguity is not fully represented in the biological approach, but that is as it should be, that is part of what provides a need for something in addition to a biological approach.

I now want to turn to some major examples of rational choice approaches to addiction in order to see whether they can be seen as opening up properly for a satisfactory representation of this ambiguity and the unwillingness of the unwilling addict — a recognizable and well-known character in real life, ripe for various types of therapies and treatments. I shall look at two such theories, Becker’s & Murphy’s (1988), and Ainslie’s (1992a, b). I apologize for not giving a more complete survey at this point; it seems to me, at least, that these two approaches are very interesting, that a discussion of them has great value even if there are other approaches, and that a complete overview will get out of hand.

“Rational” Addiction — Becker and Murphy

Let me first turn to Becker & Murphy’s (1988) theory of rational addiction. I do this not because I think they give a full view of the state of addicts, but because they present a plausible structure for a part of an addict’s beliefs and desires when in the addicted state. Remember also that I believe we ought to move towards Parfit’s view on rationality. Beliefs about the rightness and wrongness of discounting could be a possible source of ambiguity, a source not recognized in Becker’s and Murphy’s paper.

Becker & Murphy’s theory, simply put, is this. (My presentation of the Becker/Murphy view is much indebted to Ole-Jørgen Skog’s [1999a] discussion of it.)

Consider a consumer good $G$ with two basic properties:
(a) The higher the consumption of G is in the past, the smaller the welfare (value/utility) which can be obtained from the consumption of a given number of units in the present. (This can been thought of as tolerance, but can perhaps also be seen as delayed harmful effects of past consumption.)

(b) The higher the consumption of G is in the past, the larger the gain by consuming one more unit in the present. (The mechanism can be thought of as relief from withdrawal symptoms, or perhaps related to the fact that as a result of sensitization towards a drug one seems to want it more.)

Consider facing a choice about consuming a good with these properties. The combination of properties is such that a rational consumer of the good G faces a dilemma about how to weigh the short-term effects of consuming the good against the long-term effects of consuming the good. Simply put, present high consumption will lead to future high consumption with a lower over-all welfare level. One has to weigh this future negative effect against the present benefits. How much one discounts value over time will determine one's consumption level. If one does not discount future value very much, one might settle for no or a modest consumption, whereas if one discounts future value substantially, the balance will tip in favour of high consumption.

Becker & Murphy (1988) exhibit an addict as a "rational" consumer of a good G with these properties. When an addict, the person finds herself in a state of high consumption of G and with a considerably lower overall welfare level than she would have had in a state of low consumption of G. One point to note here is that the fact that addictive substances have these ascribed properties needs full and detailed backing and support from the biological level. It is, however, quite plausible that there is some such support. There is, in fact, a basic need for all decision-theoretically-based theories of addiction to represent the well-being or utility-related properties of the addictive substance in a way that can be fully backed and explained by the biological knowledge we have available. Becker & Murphy here seems to have got something right both in methodology and as a matter of fact: The representation of the properties of the addictive substance is there and seems reasonable for the time being.

Addiction of the type of an unwilling or trapped addict, however, cannot come about if all choices are made with full information about all future consequences of one's choices, and with a stable exponential discount factor. Becker & Murphy suggest in a footnote that the discount factor might vary; perhaps one cares less about the future during a period, for example, in which one is depressed. Ole-Jørgen Skog (1999a) has treated this possibility very instructively. By allowing for variations in the exponential discount factor, we can say: there are scenarios where this basic model entails that a consumer who discounts the future a lot will start consuming G, and consume permanently at a very high level, in spite of a reduction in the longer run in the overall welfare level. The cause of the continued high consumption is the rise in marginal utility of G, given the high past consumption. This is a willing addict, who cares little about the future, for whom it is rational to start consuming a lot, even with perfect foresight of the effects. There is an intermediate level of discounting of future value where a rational consumer with perfect foresight will not start to consume G in large quantities. Even if he will not start such consumption from scratch, he will not stop consuming at a high level if the past consumption level is high enough. These people, if attuned to high consumption, are "unwillingly" big consumers when they discount future
value less. They realise that they are worse off than they would have been had they not started high consumption. They would have chosen to consume only small quantities if they had started out with the discount factor they now have. Rational consumers who discount future value fairly little will not start to consume much of G. People who discount future value very little might also be able to reduce a high level of consumption if they find themselves there, as long as the long-term reduction in welfare matters more to them than the short-term gain (for instance, in relief from withdrawal symptoms).

One group of interest in this theory of addiction is the intermediate group, the group of consumers who will not start high consumption, but who are unable to reduce consumption if they have consumed much in the recent past. A further increase in the discount-factor might lead to drastic reductions in consumption. Such an increase would in fact free one from the addiction. I repeat that a rational agent who discounts less than those of this intermediate group, and also those of this intermediate group with perfect foresight and a stable discount rate, cannot be trapped in the envisaged way.

The vital explanatory factor here is therefore the addict’s actual discount factor (in conjunction with the properties of the addictive substance). The crucial explanatory factor has to be different at different times if we are to have any chance of accounting for unwilling addicts. (The auxiliary hypotheses about variable discount-factors would, of course, need independent empirical backing.)

Now, the question I want to discuss is the question of whether the “entrapped” Becker-type addict could really, rationally try to quit and fail during a period with a stable discount factor and, relatedly, the issue of the sense in which the Becker addict is unwilling. The answer to the question of whether such a Becker addict could rationally try to quit and fail seems to be no. If such an addict were to try to quit (rationally try), the discount-factor must have increased to the point where it is rational not to consume. If the discount-factor stays at that level, quitting would not only be rational, it would be easy. Such an account of quitting goes against much of what we know about trying to quit. The theory would then fail because it cannot account for the stages of addiction, in this case the third stage.

Simultaneously we (at least I) hold the view that trying to quit is often the rational thing to do. It is hard but rational. (Note the conflict with the purely explanatory notion of rationality when I put it like that.) The Becker picture captures none of this.

This Becker-type addict is able to judge that (relative to his present discount factor) he would have been better off today if he had a different past from the one he has. But his past choices were always rational relative to the tastes he had then. Assume that there are no rationality consideration about tastes. If that is so, this person has no reason for regretting anything. Can this judgement that she would have been better off had she had different tastes in the past really result in a deeply felt desire to quit? Since the preferences are given, it is clear that this cannot result in a change of preferences or different action. It therefore cannot result in rational regret, rational anger at oneself, etc. Of course, there may be irrational regrets, but that is not the interesting issue; they are not the voice of reason. As long as we assume this person to be rational, the evaluational judgement can therefore at most result in a wish or a fancy to the effect that she were a different person with a different past from the one she has, since then she would enjoy her present tastes better. Wishes of that kind come cheap. A desire to quit which leads to actual attempts at quitting is something very different from a desire that we never started. The unwillingness of the strongly unwilling addict does
sometimes lead to attempts at quitting, attempts which might be desperate. This is what seems to be given.

On the present assumptions, Becker & Murphy’s addict did nothing in her past she needs to regret; all her choices were rational by the standards she had when she made them. Orphanides & Zervos (1995) describe rational choice under uncertainty as a way into addiction. However, in that case there is also nothing to regret (even if they claim otherwise), since all choices are rational choices under uncertainty when made. The regret they describe is (at best) irrational regret. We all know that we do not choose our preferences, that preferences might be partly determined by our past choices, and that we might, when we learn new things, wish our preferences to be different from what they are even when they are the result of rational choices. The presence of such a wish is not what we are looking for to ground the unwillingness of an unwilling addict. We need minimally an unwillingness which is manifested in a desire to quit which sometimes leads to rational action and attempts towards quitting. I claim we need more than that: we need a rationally-based unwillingness to continue the addictive consumption which is there even when we do continue, and related rational regrets and sometimes self-directed rational anger.

My conclusion is therefore that the Becker-type theory will not do. It has nevertheless taught us all a lesson about representing the utility-related properties of an addictive substance, and all workers in this area should pay attention to the need for representing also biological findings in the decision-theoretic framework. But this rational addict is very far from the addicts we meet, and Becker and Murphy have to introduce externally caused changes in the discount factor in order to get anything remotely like the unwillingness of the unwilling addict. This might seem ad hoc in itself. Still, the unwillingness they can get in does not amount to much, and not to what we want. The ambiguity they get in is strictly related to the ambiguity caused by externally caused changes in the discount factor.

**Hyperbolic Discounting of Value and Addiction — Ainslie**

George Ainslie’s work on addiction uses hyperbolic discounting of value as the basic explanatory mechanism. Our state of nature, according to Ainslie (1992a, b), is to fail to have consistent preferences through time. The latter is the exception rather than the rule. Still, at the end of the day, a human adult seems to control her or his impulsiveness. The former exception is now the rule. We need an account of how this comes about when the basic picture is that dynamic inconsistencies make up the state of nature. Achieving consistency, or achieving it in the right type of way, we can see as achieving willpower, i.e. the ability to resist temptations. This may not be all there is to willpower, but it is part of it.

This provides a very interesting picture of the way into an addiction, and one great thing it does is to bring ambiguity and temporary preference into the heart of the explanatory structure. (This can, however, also be done in different ways — see, for instance, O’Donoghue & Rabin 1999.) There are, however two problems here at the very start. One has recently been pointed out with great force by Ole-Jørgen Skog in discussions in Oslo and also in his paper at this conference (see Chapter 5), and that is that Ainslie’s theory seems to presuppose an externally-given temporal structure for occasions of consumption choice. On the whole, that is not how it is in addiction — it is very much up to us to determine this temporal structure.
Ainslie’s elegant treatment of the problem of going to bed at 11 at night vs. staying up for two more hours and be exhausted the next day is very convincing, and so is his treatment of being offered an addictive substance at a particular time every day. But this is not how it normally is. If there is no externally-given temporal structure for the decision problems in addiction, the situation we face is much more messy. Another problem is raised by Michael Bratman’s (1995) criticism of Ainslie’s account of the rationality of bundling/bunching of choices. In respect for this, I shall not assume that bunching is rational.

Let us push these problems aside for the moment and focus on another — the lesson from Becker. Theories of addiction within the hyperbolic framework need, in my judgement, to account for the change which occurs when one enters the state of being addicted. It is natural and plausible to see, as Becker does, the continued consumption of the addictive drug as bringing about changes in one’s perception of utilities, and herein might lie a clue for how to represent this important change. The change into being addicted must be directly related to the utility-related properties of the addictive substances, and these properties need to be given a basis in the biological story.

There are ways of dealing with these theoretical needs, and I have suggested one way in an earlier paper (Gjelsvik 1999a, b). My approach then involved representing the addictive substance in the decision-theoretic framework as having properties roughly similar to those it has on Becker’s view. For simplicity, that discussion introduces a finite time-perspective and a finite number of occasions of consumption the subject actually takes into consideration, and ignores issues about backward induction. Everything else remains the same as in Ainslie’s discussion. As the past contains more and more drinking, and we then add up the sums of discounted future consumption (in my example there were 30 such occasions), we soon reach a point where the preference Never Drink > Always Drink is no longer stable, even if it is when we start our drinking behaviour. (“Never Drink” is the summed discounted value of never drinking on these 30 occasions, while “Always Drink” is summed discounted value of always drinking on the next 30 occasions.) At this point in time (when the preference is no longer stable), the preference is still there most of the time, but for a brief period of time, namely at the time of consumption choice, there is the preference Always Drink > Never Drink. This period is much briefer than the period when Drink is preferred to Abstain. (“Drink” is the discounted value of drinking on the coming occasion, while “Abstain” is the corresponding value of abstaining on the coming occasion.) Still, this change in the representation of bundled choice, which occurs as a result of past consumption, implies that, with the new perception of the utilities, bunching/bundling of choices (not raising the issue of whether bunching is rational or not) will not in itself be sufficient to overcome the temptation. In this case, one needs to employ additional precommitment techniques to succeed in resisting the temptation at the point in time when consumption would be rational if one did not employ these additional techniques. The thought then is that this is the point when one enters the state of being addicted. (For a thorough discussion of important aspects of such changes in the perception of utilities, see Skog 1999b.)

To represent the change that occurs when the potential addict has become addicted in this way has various advantages. It is well suited as a representation of why abstaining now (in the addicted state) is much more difficult than it used to be when there was little drinking in the past; it also makes the explanation of relapse much easier.
The question that is my focus, however, is whether we have the right sort of basis for seeing an unwilling addict as unwilling. At each moment of choice the Ainsliean agent chooses what he sees as best at that moment. I assume also that the agent is rational in the sense that, if there is a known precommitment technique which it is rational to use at a moment in time, then using that technique will be chosen at that moment in time.

The person knows that he in fact lives out the strategy Always Drink even if she most of the time prefers Never Drink, and she might wish that that was indeed different. Still, by assumption, the person does what is rational by her own standards at each moment of choice. If the person could reflectively establish a way in which the interest Never Drink was the favoured expression of herself or of her rational self, then there would be a sense in which the rational self was frustrated when the person realizes the strategy Always Drink. But as long as discounting is just a taste, and any taste is just as rational as any other, such a strategy seems unavailable. As long as the person makes the most out of each choice, why should there be such a thing as regret or shame? Would not regret then be an irrational reaction we should just fight and get rid of?

Note that the Ainsliean hyperbolic framework might explain well the situation of an addict described by Schelling — an addict who by rational choice subjected herself to extortion to escape the addiction (see again Schelling 1999a, b). I am, I remind you, assuming that the addict we are considering is a rational addict who would go for such an option if it were available. An addict who goes for all precommitments there are that are not too expensive has no reason for rationally regretting anything, and no real reason, no rational ground, for being frustrated in her addiction. Self-blame would be appropriate if there were available options, and she failed to pursue them. On these assumptions we make, there is no reason for regretting the addictive behaviour there is, and there is no reason for being an unwilling addict. If there is a desire to quit which persists after repeated failures at quitting, this desire is not expressive of one’s rationality or reason — one has in fact done what one could to make the best out of things. Yet apparently rational regrets and rational self-directed anger seem to flourish among the unwilling addicts I know, and this reminds me of myself when I tried to quit smoking.

My conclusion is that the hyperbolic discounting approach to addiction succeeds greatly on some points where the Becker account fails, namely in giving a central place for motivational ambiguity, and in accounting for attempts at quitting. Still, there seems to be something missing. What I find missing in the approach is a general reason for regretting the addiction. One might try to locate such a reason in the general preference for Never Drink over Always Drink. If the price we have to pay to account for the state of being addicted is that we let such a general preference be changed into a preference we have most of the time and not all the time, and no longer at the moment of choice, then that resource for a grounding of the general desire to quit is no longer available in a strong or clean form. In the end this may not really matter all that much, however. As long as each choice is a fully rational choice by the standards set by the approach, there is no such good reason for regretting the addiction anyway. Similarly, a person in a prisoner’s dilemma has no reason for regretting pursuing the rational choice, even if another outcome is better for oneself and indeed for both players. These better choices are simply not available for rational beings, that is determined by the pay-off structure, and the wish for them is nothing but a wish for the world to be a different place from the place it is.
The general preference for *Never Drink* over *Always Drink*, therefore, cannot supply what we seem to need — a rational basis for being genuinely dissatisfied with ourselves. The ambiguity generated by the hyperbolic form of the discounting does great things in explaining what we do, but will not do for this.

The challenge was to find some other way of accounting for the state of being addicted which was compatible with a general view of the addict as a potential unwilling addict, in a way in which the unwillingness could be rational, based on something like rational regret, and where the frustrated desire to quit could be seen as expressive of reason and rationality even when frustrated. I conclude that neither of the two theories we have looked at is able to provide that fully, even if they have great strengths.

**A Different Approach**

This is our situation: Becker & Murphy's theory had one important feature, and that was the way it represented the utility-related properties of addictive substances and activities. This representation was a reasonable match with much biological knowledge, and must be interpreted as causal consequences for future well-being of continued consumption of the substance or of continuation of the activity. Ainslie's approach had the great virtue of bringing motivational ambiguity into the heart of the approach, and Ainslie has done us all a great service in showing how far one can go towards a general theory of human motivation from this starting point, where his theory of bunching of choices, or personal rules, is fascinating, even if it is contested whether bunching can be seen as rational from game-theoretic considerations. Ainslie's approach should, however, try to integrate Becker's good point above in his hyperbolic approach (as is done by O'Donoghue & Rabin 1999).

I claim these two theoretical approaches cannot account for the unwillingness of the unwilling addict. I also claim that it is important for all intentionalist approaches to addiction to capture this in order to make contact with starting points for therapy. Notice how the first point relates to the slimming or thinning of the normative concept of reason or rationality these theorists undertake when they: (a) see the rational as accounted for by the motivational — with what explains intentional behaviour —; and (b) then move away from standard normative conceptions of rationality in order to get more and more realistic about how people as a matter of fact are motivated. I claim we can perfectly well explain intentional behaviour in their (Becker's or Ainslie's) decision-theoretic framework without thinking of their respective representations of choice as exhaustive of what we think of as reason and rationality. I claim that there is a lot more to reason than actual motivation at a time. I have for instance claimed in an earlier paper that the normally developed human being in our society is responsive to norms which both rule out temporary preference (dynamic inconsistencies) and heavy discounting of value in the case of future well-being, even if our responsiveness may fall short of what it ought to be (see Gjelsvik 1999a, b). I tend to think of the status of these rules or axioms as somewhat like the status of consistency norms as they are given in von Neumann & Morgenstern's axiomatization of the norms of rational choice (see Neumann & Morgenstern 1944). Furthermore, I claim, while there are reasons for discounting the value of future goods, there are no reasons for discounting the value of future well-being. Alternatively, we could also think of the norms about discounting of well-being as norms
with a normative role parallel to that of norms constraining risk-seeking or risk-aversion. When attitudes to risk become extreme, they also become normatively open to criticism.

I now want to outline an alternative framework for thinking about addiction, where my value-based conception of reason is put to work. This will come in two parts. The first part deals with failures to live by norms we accept as right and binding in general. Breaking such norms is in that case irrational. The second addresses the need for looking at the rationality of desire in order to get an account of the unwillingness of the unwilling addict, and to make connections with therapy.

**Breaking Norms and Irrationality**

There are systematic tendencies of the human mind to break logical norms, norms about statistical reasoning, etc. An overview of some of this (especially the case of statistical reasoning) was given some time ago by Nisbett & Ross (1980) (or, e.g. Stich 1990). The case of logic is, for instance, discussed by Stich (1990), Johnson-Laird (1983) and among many others. We all assert acceptance of the logical norms in question when asked about them, still we break them, and there are systematic tendencies in our ways of breaking the logical laws. These difficulties on our part should not and do not, at least not as I see things, influence our conception of logical validity in the least. We can conceptualize these tendencies as our having difficulties with special types of salience; we are systematically prone to go for what is salient in certain situations rather than for what is logically right and valid. There might be evolutionary explanations of such tendencies, but even so they should not in any way at all influence what we hold as normatively right.

Discounting the value of future well-being can naturally be thought of as just an instance of a similar thing: Temporal closeness is a type of salience, and we have a tendency to go for what is salient and relatively speaking overvalue that, which is just the same thing as discounting the value of what is not salient. As a result we get at least some form of exponential discounting of future well-being. But salience might explain preference reversals as well. When asked whether we prefer $100 in a year or $150 in two years, neither option is really salient, and our answer may be determined by the norms we accept about discounting of future value. If, however, we are asked about $100 now or $150 in a year, then the $100 is very salient, and we go for that option. Taken in conjunction with the result above, this can be thought of as a temporal change of preference. We can, however, conceptualize this change in different ways. We can think of it as confirming that we are hyperbolic discounters. We can also think that this shows that we at bottom exponential discounters are also very prone to be over-influenced by striking salience — here as in many other parallel contexts. O'Donoghue & Rabin's (1999) representation of temporal change of preference (based on work by Laibson and others) seems to me to fit extremely well with this latter way of looking at it (Laibson 1994).

Note how the latter interpretation of temporal inconsistency sees the influence of salience as influence upon us to break norms we actually accept, just as we often break norms about logical or statistical reasoning we accept. Ainslie's view on temporal inconsistency is different; he does not see it as irrational as such, but rather like the human condition. If we stick to the former interpretation of temporal inconsistencies, we can see hyperbolic
discounting as a tool we can use to describe irrational tendencies in us, tendencies which explain preference-shift behaviour. The fact that they explain intentional behaviour should not, however, lead us to identify rationality with them; similar tendencies explain behaviour in which we systematically make logical and statistical errors.

Very many of Ainslie's insights can be preserved within the framework which I am now suggesting, the framework that sees the conceptual terrain as at bottom quite different from the way he sees this terrain. The conceptual terrain is, I suggest, that we rational human beings exhibit strong trends towards irrationalities in all our internalizations of norms we accept as correct. Furthermore I hold that developing responsiveness towards these true and correct norms, towards reason, is very much a matter of mastering and conquering the irrational influences of salience. In the case of acquiring motivational rationality, we typically fall short of realizing in behaviour the norms and values we accept and embrace theoretically if presented with them. This is only to be expected, it is in fact more naturally to be expected in the case of motivational norms than in any other part of rationality.

This conceptual approach can therefore employ hyperbolic discounting as an explanatory tool to explain irrational intentional behaviour, a pragmatically employed tool that at bottom is a reflection of our bias towards the salient option. This does mean that we do not see hyperbolic discounting as a neutral taste; it is in itself subject to considerations about acceptability or correctness. If there is little discounting or little temporal inconsistency, we can see the case as normal, as almost rational. People will themselves express the norms they accept when asked about choices where no option is salient, and they may then embrace norms which rule their own temporary preference change or heavy discounting as wrong. Since they have this (albeit limited) responsiveness towards these right or true norms, they have a rational basis for being genuinely dissatisfied with themselves when they discount and are moved by what is salient. In the addicted state, when they are addicted to a substance with the Becker-type properties, we see that their norms normally would imply that they should stop consuming this substance in order to be rational — the consequences for well-being of consuming these substances are precisely such that someone who did not discount future well-being at all would not be rationally moved to consume them. We have then, in these cases, a rational basis for these addicts' unwillingness.

I share Ainslie's commitment to temporary preference as an enormously important explanatory tool, even if I suggest that we conceptualize it differently from the way he does. Most of his explanatory insights can carry over to my position. One such feature concerns personal rules or bunching/bundling of choices. My approach, which sees no discounting of future well-being as the normatively right, has no difficulty in seeing the adoption of a personal rule as a tool to promote the interest of the correct norms. It is a tool for reducing the power of salience, and it is rational to adopt such strategies (if you can) as long as salience has power over you, and the norms you accept need help to win through in practice. Of course, there is much fragility here, and great motivational difficulties in installing such a tool; the actual preference structure, induced by salience, makes it the best rule to consume now and abstain later. People who have a less than normally solid internalization of the norms against discounting of well-being may often try to live by personal rules in order to avoid giving in to salience. Since personal rules will be more fragile than a strong internalization of norms against discounting (because personal rules base themselves on the pay-off structures induced by salience, but try to include many pay-offs instead of
just one, and the best is exception now, then follow the rule), people who rely heavily on personal rules will be more disposed to develop addictions than people with strong norms against discounting. But some people with weak norms against discounting may not even employ personal rules, and they will be even more at risk for addiction than similar people who employ personal rules. Ainsliean insights can be preserved in my different conceptual framework.

Since we think of the conceptual structure as that of salience invading our norm-informed and norm-run behaviour, and hyperbolic discounting as a pragmatically available tool to explain behaviour, then the extent to which we have the relevant decision-situation (i.e. face an externally given temporal structure) will also determine the usefulness of this tool. If there is no externally given temporal structure to speak of in the central cases of addiction, then that is not a theoretical problem for me, but the practical problem that the tool I am using is not easily applicable. I may have, however, access to other tools that do not depend on external temporal structures. Situational cues are typically both salient and powerful. We might therefore still be perfectly able to explain the behaviour which is of exactly this sort — giving in to salience — even if the explanations might typically be more easily available after the fact (the act), since the ability to predict might be much reduced if we have no knowledge of contexts and the occurrence of salient cues. We do, however, often know things about contexts and situational cues. That is a great help in those cases. Whether we do know such things does not matter conceptually, as long as there is no conceptual connection between prediction and explanation anyway, and explanation is much more important for us than prediction.

There is another side to this, and that is that the enormous importance of cues through all stages of addiction, but especially the latter stages (quitting and relapse). Unexpected exposure to various things raises the salience of options, something which can justly be seen as craving. Giving in to such craving when you know or believe you should not because of the future possible consequences of doing so can, on my approach, be directly represented in the conceptual structure as an instance of salience-induced preference reversal. (Your precommitment technique repertoire is weakened since you quit some time ago. I discuss this in Gjelsvik 1999a, b.) I think it is important that approaches to addiction put cues and cravings at center stage, and somehow give them a direct role in our explanatory theorizing — that seems to me to be what biologists are telling us. As long as we employ the intentional vocabulary, the sensitivity to perceived context is vitally important, and such insight should be preserved. The advantage for intentional causal understanding, i.e. a full intentional understanding of the unwilling addict, far outweighs any losses. The repercussions for therapy seem rich and rewarding.

My aim in this section has so far been to provide a general framework which allows us, and also some of the addicts, to see the motivations which explain and cause addictive behaviour as irrational. I achieve this by moving the notion of rationality away from behaviour and its explanation and situating rationality in a richer context. In particular, I have introduced norms about discounting, the acceptance of which would make much behaviour wrong or irrational. I have also stressed the general theoretical need for taking biological knowledge seriously, and the need for representing the utility-related properties of addictive substances in ways which do biological knowledge justice. At the same time I have introduced a value-based view of reason, a much thicker or fatter notion of normativity which as a result introduces rationality issues around the rationality of the desires that explain behaviour,
including motivational attitudes towards discounting. Such norms allow seeing discounting of the value of future well-being as irrational, and hyperbolic discounting as irrational. I believe this irrationality of the motivations that determine our addictive behaviour can be seen (even if only dimly seen) by addicts themselves, and that this might be part of what grounds the intuition that the unwillingness of the unwilling addict expresses the voice of reason. I have also suggested that tendencies towards discounting of the value of future well-being (or utility, but not future goods) should be seen as an instance of a failure to fully master salience.

Irrational Desires for Addictive Substances

There might be reasons for going even further here, and employing the resources of a value-based approach to reason in assessing our desires themselves. One biopsychological, neuro-based approach to addictive craving by Robinson & Berridge (1993) suggests that the craving developed by addicts can be characterized as extremely strong “wantings,” which are such that satisfaction of these “wantings” is associated with very little pleasure or “liking”; the latter can be (almost) zero. I have not pursued this approach since, to my knowledge, it is not (yet) a widely accepted view. If it were, it might have interesting implications. In particular, it might have the implication that the desires that lead to and explain addictive behaviour are desires that, according to a value-based approach to reason, we have no good reason to fulfill. We only have reason to satisfy a desire when that satisfaction brings something of worth with it — be it pleasure, well-being or whatever. If there is nothing of worth in fulfilling a desire, then that desire is an irrational desire. This can be known by a person with such a desire, and such a person can see the irrationality of being motivated by this same desire. My value-based approach to reason sees the desire-based view as depending for its plausibility on the general feature that we normally desire what is worth desiring. Since that is normally so, most of our desires are normally rational. The case of Robinson and Berridge’s view is interesting for me because it brings out the point that a desire for an addictive substance is not in any way worth fulfilling — there is only wanting, and no liking. If the drug addiction itself creates desires rightly describable as irrational, and internally seen as irrational by the addict, that would turn things around. The unwillingness of the unwilling addict might have another and completely different rational basis here.

One way of looking at the utility-related properties of addictive substances in Becker’s representation is indeed that consumption of these substances lead to a mismatch between how much one wants to consume the substance and what one gets out of consuming it. If rational desires are the desires worth fulfilling, we might say that consumption of addictive substances leads to the development of more and more irrational desires for consuming the substance. A precondition for knowingly consuming such substances at all, with the properties given to them by Becker, is precisely that one is subject to another unreasonableness or potential irrationality, namely the irrationality of discounting of future value we exhibit when we go against our evaluative beliefs about discounting. If we see things like this, then addiction is a state where our behaviour is not irrationally caused (by the mechanism of discounting), but caused by desires that are themselves irrational. We
can put it like this: an irrational meta-preference (discounting of future well-being) makes it possible to be moved by these irrational desires. This perspective on the interplay of irrationalities is only made available by the value-based approach to reason.

At this point, it might be useful to remind ourselves of the criteria for substance dependence listed by the American Psychiatric Association (see, e.g.: 181). There are seven criteria, and a person is said to be dependent when she satisfies three of these within a 12-month period. The two first criteria are tolerance and withdrawal. Criterion 3 invokes the notion of intention, and states that the substance is often taken in larger amounts than intended. The fourth criterion is a persistent desire to cut down, the fifth that one spends too much time and effort to obtain the substance, the sixth that important social or recreational activities are given up or reduced, and the seventh that substance use is continued despite knowledge of having a problem that is likely to be caused or exacerbated by the substance.

My point in bringing in these criteria is, of course, that so many of them are normative criteria where the normativity seems given by a value-based approach to reason. “Knowledge of a problem” is straightforwardly normative by the notion of a problem. The statement that “important social or recreational activities are given up” is at bottom a straightforwardly normative statement about the relative value of those activities for a good human life. That too much time is spent to obtain the substance is really the same type of normative statement. The psychiatric criteria are therefore couched in an intentional language, and also in a normative view on how much time it is worth spending obtaining such a substance, how much social or recreational activities it is worth giving up in a human life and so on. The normative view expressed by the diagnostic criteria is precisely the normative view that the fulfillment of the desire for the addictive substance in question is in no way worth the cost of obtaining this substance. This can be true in different ways: by the fact that one spends too much time and effort obtaining the substance, by the fact that one gives up activities important for human life, etc. At bottom these psychiatric diagnoses are given in a value-based normative frame. A human being who is not motivated by desires worth fulfilling is not just mentally ill, this human being is also most likely suffering from a biological change in the mesolimbic system and in nucleus accumbens. The normative point has priority, though, for seeing this as a psychiatric disorder.

There are further issues here than the need for a thick normative conception to make the right connection with therapy. I also believe that my approach makes immediate contact with many other issues in the neighbourhood of addiction, in particular issues about responsibility for one’s addictive behaviour. Responsibility requires normative insights and responsiveness to substantive norms that cannot be captured by the thin rational choice conception of rationality. If it could, we could just as well ascribe responsibility to children. The normative equipment required for responsibility is much more substantive than that of availability of simple rational choice explanations. It involves the absence of the irrationalities characteristic of addiction.

Conclusion

As a conclusion I think this is important: The fundamental choice in addiction theory is between studying addiction from a strictly biological point of view and studying addiction
within an intentional framework. There are many concerns here, and there is always a question about the usefulness of bringing in the intentional framework. I think the latter question should be seen as involving the question about whether to bring in a thick or thin intentional framework. This is because I think we should aim wider than just explaining addictive behaviour; we should try to understand addiction itself, and to do that we need a wide intentional human context in which we see things on the basis of our biological knowledge. It is the thicker and normative intentional framework which provides a coherent unity to the phenomenon of addiction, a unity that exists through all the stages of addiction, and it does that in such a way that connections with other issues, for instance the important connections with therapy and also legal issues, can be raised in a meaningful way. This framework we can and should adopt without losing any explanatory insights, and indeed this framework gives us the possibility of gaining new explanatory insights; we can, perhaps, explain the self-directed negative reactions of addicts. With this thicker framework in place, we see the need for independent empirical studies of all auxiliary hypotheses about the intentional factors whose presence are vital in intentional explanations of addiction, in particular empirical studies of what evaluative beliefs people hold about how they ought to be motivated and how those beliefs relate to how they in fact are motivated. Such studies can learn a lot from existing research into people's views about how we ought to reason in logic and statistics, in contrast to how we, as a matter of fact, do reason. The methodological issues are challenging and fascinating, and range far beyond the decision sciences.

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References


Comments on Gjelsvik

George Ainslie

I’m glad to have a philosopher at the conference, Olav Gjelsvik especially. We’ve worked together for many years at Jon Elster’s conferences. I think of myself as a philosopher. The point of my work with motivation has been to get back to what I regard as basic philosophical questions about the nature of higher mental processes. I couldn’t agree more that we “need a richer notion of rationality than that provided by the explanatory notions of rationality employed by decision theorists.” Rationality is like a Chinese puzzle, easy to fit together except for a single remaining piece, but maddeningly difficult to solve completely. Professor Gjelsvik has an excellent understanding of the flaws in current theories, including mine as I have presented it. He has shown clearly that you can’t describe an unwilling addict with the exponential curves used by Becker & Murphy (1988). He has asked me tough questions as well. I hope I’ve answered a couple of them. I think his objections are based on my not having explained my work well enough in earlier presentations.

One objection is that, without an externally given temporal structure, hyperbolic discount curves are limited in what they can explain: many impulses are continuously at hand and not given at certain time by the environment. I hope I have shown that by adopting the strategy of bundling choices into categories people convert what is essentially a temporal binding-yourself-as-you-sail-past-the-Sirens type of process to a simultaneous judging—whether-this-case-fits-a-rule. An impulse then prevails, not because of the proximity of an external lure, but because you have found an excuse or a rationalization. Thus, the temporal objection shouldn’t tell against the hyperbolic explanation for impulses, but this may not have been clear in earlier presentations.

Secondly, the repeated prisoner’s dilemma as originally formulated can’t describe intertemporal bargaining because later selves can’t retaliate against earlier ones, as shown by Bratman (1987, 1995a, b, 1998) in the works Gjelsvik cites. However, I think the demonstration of the modified prisoner’s dilemma that we just enacted here shows how there can be a rational intertemporal form.\(^1\) A person deciding whether to choose the dime for everyone vs. the dollar for herself alone is not doing anything irrational as she estimates what her behavior is apt to do to the choices of the remaining players.

Gjelsvik raises two larger questions about which I’d like to make the rest of my comments. These involve the possible inadequacies of a marketplace-based model of rationality. One is that there may be a need for some kind of ego that stands outside of the marketplace and only sometimes consults it:

A value-based view [as opposed to a desire-based or marketplace view] holds that reasons are provided [by] the facts, and not by how we happen to
be motivated. Motivational facts are not themselves reason giving, but are instead seen as our (more or less) rational responses to what reasons the facts provide. The fact that we have a certain desire may, of course, indirectly give us a reason to satisfy that desire, but that is only because the satisfaction of the desire gives us pleasure or well-being.

This reservation about relying upon a marketplace model of choice is shared by much of cognitive psychology. However, it ignores the need for a common dimension along which the reasons provided by facts must compete for being selected — a dimension that could be called rewardingness. Many philosophers from the time of Spinoza have said that value comes from emotional experience — that reason ultimately serves the passions. I argue that what Gjelsvik is calling value-based facts are really experiences seen at a distance, where some of the heat of the moment is taken out of them, and not a separate kind of motive altogether.

This is not to dismiss his objection. It is hard to describe a satisfactory interface between what we take as our human, subtle, internally fed-back motives and the gross machinery of reward. Howard Rachlin said earlier that the self could be modeled by a block of wood floating in a stream; but in order to get a fully workable marketplace model you’ve got to equip the block of wood with some kind of response capability, and this capability can’t use extra force. The model that the ego has larger forces around it and is steering among them is familiar — a canoe steering through rapids, for instance — but that model still invokes a separate kind of force, the small but autonomous strength of the canoeist. What we need to do for a really integrated theory, one that does without the separate ego standing outside of the marketplace, is to derive the logic of the canoeist or the block of wood from the properties of the rushing water itself, in some way transforming this physical inanimate force into the kind of subtlety that we experience as our own will in decision making. That is a tough challenge, but I think it’s doable. I’m not going to attempt it here, but I’m glad that Gjelsvik has pointed out the problem (see Ainslie 2001: 129–134).

Secondly, Gjelsvik raises the problem that perhaps some impulses are not from temporal discounting, but from what he’s calling salience. Salience might include things that are overvalued because they’re close, but also things that are overvalued for other reasons. The two main suggestions about such salience in the recent literature are the findings of Kahneman and his collaborators, who look for areas where we have illusions about causality (e.g. Kahneman & Tversky 1984) and the “visceral reward” that Loewenstein (1999) writes about which seems sometimes to override intention. The Kahneman illusions are simply mistakes; if people in this kind of situation are told the actual properties of their tasks they will often change their choices. In cases where they don’t change they seem to be getting additional value that was not counted in the analysis of their behavior. Gamblers, for instance, may know that the odds are against them, but gambling has a value in providing surprise and thus combating premature satiation, as I argued yesterday (see Chapter 1, this volume).

But beyond the cognitive illusion objection, there is Loewenstein’s visceral reward, an objection that is more robust. There really does seem to be a kind of experience that is positively fed back once it starts, and I’ve written about this as the mechanism of emotion control — potentially a committing tactic but also a possible source of temporary preferences (Ainslie 2001: 77–78). The question is whether it can explain
Figure 1: In the conditioning — or salience — model of appetite a conditioned cue at the upward arrow raises the value of an earlier reward at time $T$ from the shorter bar (in bold) to the taller bar. Its exponential discount curve is thus moved above that for the later-larger reward. But without amnesia for the cue and reward, a predictable sequence of appetite followed by reward should develop a curve from the higher bar all the way back, leading, "rationally," to consistent preference for the smaller reward on the basis of its earlier occurrence.

temporary preferences on a basis other than the hyperbolic discounting of the rewards it entails.

Picture the standard amount-vs.-delay situation (Figure 1) — a dessert at time $T$, say, made salient by the appearance of the dessert cart at the upward arrow. The rewards of abstaining are summarized as a point reward at $T + 4$. You generate a "conditioned" appetite at the arrow, which makes the (exponentially) discounted value of the dessert rise above that of abstaining. This would seem to be a change of preference, without resorting to hyperbolic curves. The problem is that if the sequence of appetite and dessert is predictable, the discount curve should come to be based on this from the beginning, and, if exponential, should always stay above the curve from abstention. This would describe rational behavior, even rational addiction. But not unwilling addiction.

However, Loewenstein says that you can't really learn the value of a visceral reward in such a way that you can take it into account before your appetite is aroused. He cites accounts of subjects dealing mostly with aversive experiences, who are unable to report remembering the painfulness of painful experiences. The trouble is that there are many other examples of people remembering such experiences quite well. Animals are very efficient at it (Herrnstein 1969); people, and I suppose animals, sometimes become hypermnemonic, so that the awfulness of experience is not only present but grows larger than it was. Memory for visceral experiences is quite variable. You can't rest an
entire theory on the fact that people sometimes cannot remember the emotional quality of an urge.

I would try to solve this problem by making two additional assumptions. The first is that emotions themselves, including appetites, are behaviors. This requires somewhat more explanation than I've got time for right now, but I argue in my books and in an article about Lowenstein's (1999) paper (Ainslie 1992: 39–48; 1999) that conditioning itself is not a robust explanation for the kind of phenomenon we call conditioned. Conditioning is a way of shaping a certain kind of motivated behavior. This behavior is experienced as a different kind from voluntary behavior because it occurs too rapidly or too indistinctly to be tested by personal rules — the lack that can sometimes be corrected by biofeedback (Basmajian 1989); but it is reward-dependent.

The second assumption, based on anecdotal experience, is that we do not always have direct sensory information about our potential appetites, but must try out whether “that would taste good” or “I'd be likely to panic” by what used to be called vicarious trial and error. We imagine the activity and assess our emotional reaction to it. But trying it out also starts the process of having the appetite, which is rewarding in its own right. In Figure 2, a person at time $T-4$ prefers abstention and might be well be advised to avoid trying out her appetite; but she might get away with entertaining some appetite and inhibiting it before it drives the value of the dessert too high. People tend to play this hit-and-run game with

![Recursive Appetite Diagram](image-url)

Figure 2: Assuming that discount curves are hyperbolic and appetite is shaped by reward like any other behavior, generating appetite (“appetizing”) will increase reward but may cause a shift in preference to the smaller-earlier reward. An individual at $T-4$ might thus be motivated to inhibit her appetite, but might also try to get some additional reward by appetizing and stopping before the point of preference change — a risky behavior from the viewpoint of her long range interest.
appetites, trying to enjoy them without getting to the point where their curves cross and they get captured by the impulse they are playing with. Sometimes they win and sometimes they lose. If they never lose — if they always resist the temptation — the cue stops being an occasion for appetite, ironically spoiling the game.

There's some experimental work by Roger Meyer who had actual heroin addicts taking heroin in the program out at the University of Connecticut. He showed that even though the addicts were in the same environment all the time, they would only get craving on the days when the heroin was available. In other words, the appetite seemed to actually be preparation for consuming the reward. If you never consume the reward, the appetite doesn't come. In a way, it's like having a pet. In a multiple model of self as a population of reward-dependent processes, pets are a good example. If you always feed a pet at a certain time, he will stop begging for food at other times. If you once feed him some other time you have great difficulty getting him to stop begging at that time again. Trying is cheap, but getting fed is a great reward, so the pet — or appetite — does it a lot. If you never take a dessert from the cart, I would be fairly sure that the cart stops occasioning your appetite. I would argue that you have to be susceptible to the idea that you might get the dessert from the dessert cart in order for the appetite to beg for dessert when it appears.

**Audience Question: If You Never Ate, You'll Never Get Hungry? Is That What You're Saying?**

At least to some extent that's true. There is an early twentieth century study of a group of starving people who reported that when they had lost hope of getting food they lost their subjective hunger (Carlson 1916). Of course, they still had drive. If food had appeared they'd have gotten hungry fast, but in the absence of the prospect of food and the extinction of the possible cues for food, they stopped generating hunger. So yes, that happens, but you have to be very consistent in never gratifying a desire before you stop the craving. This is more evidence that emotion and appetite are ultimately reward-dependent behavior and not a reflex activity.

The point of this somewhat sketchy argument is that hyperbolic discounting should be able to account for the full range of addictive phenomena. By the same token, I think the salience model is not up to the job. Salience as Gjelsvik presents it is an amalgam of the cognitive error theory — honoring desire over values, and consequently developing a “taste” for discounting the future steeply — and visceral reward theory — having our fancy captured by a situational cue, much as Loewenstein describes. The concept suffers from the same limitations as these components: value divorced from desire has no selective principle accessible to further study, but represents an irreducible *elan vital* with no constraints. Just look at the problems raised by the uncoerced choice of a taste for discounting: were it not for discounting, the distant future would be as valuable as the present, and a child could enjoy Christmas all year as if it were tomorrow. Who wouldn't decide to do this? Of all things, discounting has to be a factor that's imposed on us, not something we can pick by a cognition. Regarding the second component, insofar as preference-reversing visceral arousal does not depend on proximity, it depends on conditioning-cum-amnesia, a dubious mechanism as I have just argued.

Irrationality is a particularly complex form of Chinese puzzle, with the additional complication that we may not know for sure when we have solved it. If we do ever know, it will be because Professor Gjelsvik and a few like-minded analysts have bored deep enough
to ask the tough questions that are needed to reveal hidden assumptions. I'm grateful to him once more for this service.

Note

1. In an earlier discussion session the audience participated in an imaginary game show: I announced that I would go along every row, starting at the front, and give each member of the audience a chance to say "cooperate" or "defect." Each time someone said "cooperate" I awarded a (imaginary) dime to her and to everyone else in the audience. Each time someone said "defect" I awarded a dollar (also imaginary) only to her. I asked that they play this game solely to maximize their individual total income, without worrying about friendship, politeness, the common good, etc. I said that I would stop at an unpredictable point after at least twenty players had played, at which time each member could collect her earnings. After some play I discussed how, like successive motivational states within a person, each successive player had a direct interest in the behavior of each subsequent player; and she had to guess their future choices somewhat by noticing the choices already made. Realizing that her move would be the most salient of these choices right after she had made it, she had an incentive to forego a sure dollar, but only if she thought that this choice was both necessary and sufficient to make later players do likewise.

References


Reply to Ainslie

Olav Gjelsvik

George Ainslie has made wonderful contributions towards the understanding of human motivation in general and addictive behaviour in particular. In fact he is one of very few present thinkers who really have a system for understanding and explaining human behaviour. In the case of addiction, his system is applied to provide a significant theory of addiction. It is a great pleasure indeed to have his comments, especially for someone like me who neither has a philosophical system nor a full theory of addiction. I shall comment on our differences, both generally and on the two issues he focuses on.

A General Remark on Our Differences

Thinking about his comments, I find it helpful to point out that they are generated from the point of view of his system. There are deep differences between his way of thinking and mine, and they are strikingly brought out by his remark that philosophers from Spinoza onwards have held that “reason ultimately serves the passions.” Ainslie does indeed endorse this view on reason — that is a fundamental aspect of his system. This is again clearly brought out by his metaphor of the canoeist in the rapid stream. What we really need, says Ainslie, is to “describe the logic of the canoeist or the block of wood from the properties of the rushing water itself, in some way transforming this physical inanimate force into the kind of subtlety that we experience as our own will in decision making.” This is a bottom-up strategy for understanding rationality; it is a programme for building a satisfactory theory from the flow of different motivations through time. In order to succeed, there are strict constraints on what materials to build with.

My philosophical view is very different; I hold that Ainslie’s view that reason ultimately serves the passions, a view which is normally called Hume’s view, is a wrong view. Reason is for me a normative concept, and as such it is not, and cannot be, a servant of the passions. Reason is irreducible as other normative concepts also are. We might say that reason is a servant of the objective good or well-being in general, but that remark must then be understood within the context of the irreducibility of reason and normativity. I think we need this normative concept of reason to make room in the right way for agency in our picture of the world and to understand fully our own reactive attitudes towards our own human motivation. With this irreducible normative conception of reason in place, we can see that growing up and maturing as a person is normatively speaking a process which modifies our motivations in the direction prescribed by reason.
Two Concrete Disagreements: The Market-Place and Salience

When this is said at a general level, we might identify some of our disagreements about the two big issues Ainslie focuses on. The first concerns what he calls the marketplace-based model of rationality. This issue is seen by me as the issue of whether he is actually able to build a satisfactory model of rationality from the type of building materials he recognizes. It might, I believe, be shared ground between us that people convert what is essentially a temporal binding-yourself-as-you-sail-past-the-Sirens type of process to a process of judging-whether-this-case-fits-a-rule. The question I raise is whether Ainslie is fully entitled to describe the latter as rational, whether that can really be achieved without “animating” the “inanimate” force. I thought inter-temporal bargaining, and only that, was supposed to do this job in Ainslie’s system. It worries me that Ainslie seems to resort to descriptions of what we actually do, and describes what we do as rational, as he also does in his description of the experiment he carried out at this meeting. We need to see clearly how, by using bargaining theory or something else, he earns the right to his description of judging-whether-this-case-fits-a-rule as rational. We need that in order to see clearly how the particular rationality in question arises out of the “inanimate” “rationality” he starts out from. If that cannot be achieved, then that fact might be taken to provide grounds for holding that we should not engage in Ainslie’s “reductive” project. That would be my way of taking it.

The second large issue is about salience. Salience for me is the psychological standing out of an object — normally, but not necessarily, caused by closeness, temporal or spatial. Salience often causes a motivation different from the motivation you ought to have (normatively speaking). As a result we choose and act irrationally; even if the act is free and “rational” relative to how we are in fact motivated, we are no longer rationally motivated (normatively speaking) because of the causal influence of the salient object. Ainslie thinks this conception of salience leads to severe problems, and he dislikes my view of temporal discounting as a normatively wrong motivation caused in this way by temporal salience. He comments that “were it not for discounting, the distant future would be as valuable as the present, and a child could enjoy Christmas all year as if it were tomorrow.”

I fail to see exactly what is wrong with my view. My view is that value and worth is provided by facts. In the case of Christmas, there is the actual value of the well-being Christmas brings, which should not, normatively speaking, be discounted. If presented with a choice between that well-being and some smaller well-being closer in time, we should choose Christmas. This is a normative view, and Ainslie can of course disagree with it. His comment about the child seems to me to bring in the issue of anticipation. I think that raises other issues. We are temporal beings able to enjoy pleasures of both looking forward to/anticipating and remembering; that is part of the psychological make-up of many of us. Children seem to be very good at enjoying looking forward to things, maybe to the extent that it counteracts their strong discounting tendencies in some cases. For us a bit older, it is good to be able to enjoy memories when there is little to look forward to. The pleasure of anticipating x typically increases as we move closer to x in time. The value of the pleasure of anticipating or looking forward to Christmas will therefore (with the pleasure) to some extent depend on how far off Christmas is. These phenomena are open to empirical investigation, and I make no normative claims whatsoever about whether and to what extent we should
look forward to things. If Christmas is a long way off, however, and that is a fact, there is no way a minimally rational "child could enjoy Christmas all year as if it were tomorrow."

From where I stand the advantage gained by my view is not only normative. Another advantage is that we can explain and understand the acts and especially the later self-directed attitudes of the child who is "tricked" by the question, "Will you have this chocolate bar now and no Christmas presents, or abstain from this chocolate now and have Christmas presents instead?" But since I have dealt with that in my paper in this volume, and also in the papers of mine referred to in that paper, I shall not go further into the issue.
Chapter 9

Junk Time: Pathological Behavior as the Interaction of Evolutionary and Cultural Forces

Warren K. Bickel and Matthew W. Johnson

Introduction

A junky runs on junk time. When his junk is cut off, the clock runs down and stops. All he can do is hang on and wait for non-junk time to start (William Burroughs 1953: 87, emphasis added).

Junk time, a phrase taken from the above quote by William Burroughs, will be used here to refer to the extreme devaluing or discounting of future events by individuals who are drug dependent. We use this term because the time orientation of drug dependent individuals appears to be very different from those who are not dependent. For example, in a recent report from our group, we asked heroin dependent individuals and matched controls to complete the following story. The story started: “After awakening, Bill began to think about his future. In general, he expected to . . .” The datum of interest was not the story, but rather the time-frame involved. On average, heroin-dependent individuals referred to a future of nine days, while matched controls referred to a future of 4.7 years (Petry et al. 1998).

Our contention is that the profound difference in time orientation observed in this study is important in understanding drug dependence. More specifically, we will argue that such extreme temporal discounting both contributes to, and is affected by the development of, drug dependence.

To understand the time orientation of the drug dependent and its relation to the development of drug dependence, we will apply a relatively novel strategy to the study of drug dependence. Traditionally, the study of drug dependence explores the proximate causes of drug dependence. Proximate causes are the answer to “how” questions, and address the mechanisms that produce the behavior of interest. Addressing proximate causes has certainly been effective and has generated a wealth of knowledge. Among the important knowledge
generated by addressing proximate causes is the observation that drug dependence results from the interaction of the drug with regions of the brain that are evolutionarily quite old (Nestler & Landsman 2001). These regions, such as the limbic system, regulate an organism's response to reinforcers such as food, drink, sex, and social interaction. Indeed, Nestler & Landsman (2001: 834) state, "the loss of control that addicts show with respect to drug seeking and taking may relate to the ability of drugs of abuse to commandeering these natural reward circuits and disrupt an individual's motivation and drive for normal reinforcers."

Informed by the results of these proximate investigations into the process of drug dependence, we seek to apply a complementary and novel tactic that may identify processes that are important in the genesis of drug dependence and serve as new targets for mechanistic study. The aim of this tactic is to identify the ultimate causes of behavior and use that knowledge in proximate studies. Ultimate causes refer to "why" questions and they try to identify the evolutionary pressures that would result in the behavior of interest. Looking for ultimate causes as they relate to drug dependence, although not unprecedented, may not appear germane at first glance, because most drugs were not widely available when the regions of the brain associated with drug dependence evolved. Thus, consistent with the notion that brain systems may be commandeering (Nestler & Landsman 2001), processes selected originally to deal with other reinforcers, such as food, may come to function with a new reinforcer, namely drugs.

The utilization of an evolved feature for a new function has been termed "exaptation" (Gould 1991; Gould & Vrba 1982). Identifying exaptations requires characterizing the evolved feature, its original functions, and the environmental pressures that may have resulted in its evolution, as well as evidence that the same evolved mechanism has become involved in a new function. In order to explore whether temporal discounting is an important aspect of drug dependence that has been exapted from other functions, we will employ concepts from three distinct, but overlapping fields: namely, evolutionary psychology, human behavioral ecology (life history theory) and behavioral economics.

Evolutionary psychology endeavors to identify psychological mechanisms that underlie human behavior and the evolutionary forces that shaped these mechanisms. More specifically, evolutionary psychology assumes that these mechanisms of behavior (also referred to as modules) evolved to address specific past environmental circumstances that exerted consistent selective pressures. Also, a tenet of this approach is that these mechanisms are not general processes, but tend to be directed to specific adaptive problems.

Human behavioral ecology is concerned with examining the link between ecological conditions and adaptive behavior. A fundamental assumption of this approach is that a trade-off must occur between components of fitness because of limited resources of the organism and environment. For example, under more severe developmental conditions, trade-offs may occur favoring survival over growth. Not surprisingly, human behavioral ecology frames the study of adaptive behavior in terms of decision rules. Therefore, advocates of this approach "tend to focus on explaining behavioral variation as adaptive responses to environmental variation: They assume that this adaptive variation ( facultative behavior, phenotypic response) is governed by evolved mechanisms that instantiate the relevant conditional strategy or decision rule" (Smith 2000: 30).

Consequently, humans can rapidly shift phenotype and, therefore, are likely to be well adapted to contemporary environments. Many of these trade-offs occur along a dimension
of current vs. future allocation of resources. For example, an organism may produce a large number of offspring now, or may delay offspring production and focus resources toward current survival. This decision may be influenced by current conditions, such as the ability of the current environment to support a large number of offspring.

Behavioral economics is "the study of the allocation of behavior within a system of constraint" (Bickel et al. 1995: 258) and examines conditions that influence the consumption of commodities. One important concept of significance in understanding drug dependence is the temporal discounting of reinforcers. Temporal discounting refers to the observation that the value of a delayed reinforcer is discounted (reduced in value or considered to be worth less) compared to the value of an immediate reinforcer. Indeed, to the extent that most individuals would prefer a reinforcer now rather than later, the discounting of delayed reinforcers is intuitive (Kirby 1997). Behavioral economics assumes that temporal discounting occurs whenever a reinforcer is delayed.

In this paper, we will use concepts from these different approaches to argue that discounting is an evolved psychological mechanism that has been exapted in the process of drug dependence. To make that argument will require that we first explore some general features of temporal discounting, including evidence that it is an evolutionary endowment, that discounting has a developmental course, and that it can be influenced by our culture. After addressing these issues, we will consider the role of discounting in drug dependence. To address this, we will examine whether drug dependents discount delayed reinforcers more than other individuals, what aspects of drug dependence may be influenced by temporal discounting and, finally, what the effects are of therapeutic interventions on discounting of delayed reinforcers. Collectively, this exploration into discounting and its relationship with drug dependence will describe a process that may be integral to drug dependence and, in so doing, begin to situate drug dependence in the complex interactions of ontogeny and phylogeny.

**General Features of Discounting**

**Temporal Discounting as an Evolved Psychological Mechanism**

We argue that temporal discounting is an evolved psychological mechanism. Important issues to be addressed in the evolutionary analysis of psychological mechanisms are: (1) identification of selective pressures that were present in the evolutionary past that are responsible for the selection of the mechanism; (2) a description of the psychological mechanism selected by these pressures; and (3) the manner in which the mechanism is currently expressed in present times and its interaction with today's culture (Cosmides et al. 1992). Here, we address the first two concerns. The third matter will be discussed in more detail in the section on culture below.

To address the first issue, we must identify environmental pressures that could have produced a preference for immediate reinforcers. For this task, we must look to past environments that drove the selection of our present biology, because complex systems are unlikely to have developed in the relatively recent time since the beginning of agriculture and civilization (Buss 1999; Cosmides et al. 1992). What was pre-agricultural life like for humans? Until about 13,000 years ago (i.e. 99% of its past), the human lineage survived as
hunter-gatherers (Lee & Devore 1968). This way of life consisted of gathering wild plants and hunting wild animals (Diamond 1997). Our hunter-gatherer past is important because the adaptation of dietary systems is thought to have a strong influence over the forms of other systems. Indeed, most animals spend more waking hours in the acquisition of food than in any other activity (Tooby & DeVore 1987: 234).

Hunting and gathering are opportunistic activities, for a wild animal must be pursued immediately, and nutritive plant products must be consumed when these items are noticed because of environmental uncertainty. Competitors, accident, disease, and generally unreliable food sources make delaying consumption a very risky enterprise. Thus, procurement efforts were best directed toward immediately available resources, as delaying consumption would jeopardize future availability (Bickel & Marsch 2001). Those individuals who exhibited inflated preference for delayed reinforcers would have been at a survival disadvantage, ultimately resulting in relatively few descendents. Importantly, these factors that engendered temporal discounting in hunter-gatherer humans are present in the environments of non-human animals as well. These animals also benefit from the immediate consumption of reinforcers, and are potentially impaired by delayed consumption (Bickel & Marsch 2001). Therefore if temporal discounting is an evolved psychological mechanism, we should observe it in other species of animals. Evidence for this will be discussed below.

Much work has been done which serves to address the second issue, describing the mechanism in detail. Temporal discounting has been extensively investigated in both human and non-human animals. Mazur (1987) conducted an experiment that demonstrated that the hyperbolic function expressed in Eq. (1) accurately describes the devaluation of reinforcers over time in pigeons. In this experiment, pigeons were presented with two choice alternatives. A peck on one key led to two seconds of access to grain (the small reinforcer) after a set delay, and a peck on another key led to six seconds of access to grain (the larger reinforcer) after a delay that adjusted between trials. Two consecutive pecks on the smaller reinforcer key decreased delay to the larger reinforcer by one second. Two consecutive pecks on the larger reinforcer key increased the delay to the larger reinforcer by one second. The pigeons’ choices eventually stabilized around an indifference point, where a particular value of the adjusting delay to the larger reinforcer was equally preferred to the set (shorter) delay to the smaller reinforcer. Indifference points were determined at various set values for the delay to the smaller reinforcer, ranging between zero and 20 seconds. By finding indifference points at these various set delays to the smaller reinforcer, temporal discounting was fully described across time, and this allowed for testing of the shape of the discounting functions. Results indicated that the hyperbolic decay model expressed in Eq. (1) more accurately described the data than the exponential model expressed in Eq. (2). In both equations, $V_p$ is the present value of the reward, $V$ is the undiscounted value of the reward (i.e. value when presented immediately), $D$ is the delay from the choice until the receipt of the reward, and $k$ is a free parameter. In Eq. (2), $e$ is Euler’s number. The superiority of the hyperbolic decay model has also been demonstrated in animal work with rats serving as subjects (Mazur et al. 1987; Richards et al. 1997).

\[
V_p = \frac{V}{1 + kD} \quad (1)
\]

\[
V_p = Ve^{-kD} \quad (2)
\]
The implications for this finding are profound. Normative economic theory has defined Eq. (2) as rational (e.g., Lancaster 1963; Meyer 1976). It describes an independence of discounting rate and delay. In other words, for every unit of increased delay, value decreases by a constant proportion. In contrast, Eq. (1) describes an initially large drop in value, followed by decreases in value that are proportionally smaller with each additional unit of delay. The hyperbolic model describes a markedly impulsive style of discounting, because it readily predicts preference reversals over time even when assuming that both reinforcers are discounted at the same rate. For example, when offered a choice between a smaller sooner reinforcer and a larger later reinforcer, a subject may choose the smaller sooner alternative. However, by adding an equal delay to both alternatives, subjects may switch to the larger later reinforcer (Green et al. 1994a, b).

Researchers have also successfully used similar procedures to understand temporal discounting in humans. These experiments typically offer the research participant a series of discrete choices between two amounts of money, holding the delay of the larger later reward fixed while varying the magnitude of a smaller immediate reward in order to determine each indifference point. These indifference points are then used to construct discounting functions analogous to those in the animal literature (Rachlin et al. 1991). Although there are a number of differences between temporal discounting experiments done with non-human animals and humans, including reinforcers studied and time frames involved, the hyperbolic model has consistently prevailed over the exponential model in both non-humans and humans (Green et al. 1981; Green et al. 1994a, b; Green et al. 1996, 1997; Green & Myerson 1993; Kirby 1997; Kirby & Marakovi 1996). Although there are vast differences in the $k$ discount rate parameter (humans having a rate several orders of magnitude smaller than pigeons and rats), the hyperbolic shape of the function is shared across species, suggesting common descent or convergent evolution due to similar environmental pressures. Common descent of the trait would suggest that temporal discounting might be an extremely ancient psychological mechanism, given the deep time suggested by a common ancestor of pigeons and humans. Figure 1 illustrates the qualitatively fixed nature of discounting as observed across humans, rats, and pigeons. This qualitative similarity is consistent with the uncertain environments shared by non-human animals and humanity's hunter-gatherer ancestors.

Temporal discounting appears to be consistent with the notion of an evolved psychological mechanism; however, one aspect of discounting may call into question its role as an evolved mechanism. Several authors have noted that, in order to be appropriately classified as an evolved mechanism, a trait must have performed a specific task that solved specific adaptive problems better than alternative traits did in the evolutionary past (Buss 1999; Smith 2000; Symons 1992). General notions such as "learning" or "fitness maximizing" are rejected as adapted mechanisms due to a failure to meet this criterion (Symons 1992). Hyperbolic temporal discounting, however, may violate this criterion because it appears to be independent of reinforcer type. The same form is observed in humans discounting money (e.g., Rachlin et al. 1991), humans discounting their drug of dependence (Madden et al. 1997), and in non-human animals discounting food (e.g., Mazur 1987; Mazur et al. 1987). This pervasiveness across reinforcer types might be viewed as a violation of the task-specificity criterion for adapted mechanisms, and may suggest that, in the case of reinforcers absent during the evolutionary past such as money and drugs, temporal discounting in humans functions as an exaptation, rather than an adaptation.
Another possible objection to our argument arises from our assertion that the temporal discounting observed in human and non-human animal research reflects the same underlying process. Because human experiments ask participants to make prospective judgments about future rewards, these experiments might be qualitatively different than non-human animal experiments, in which subjects actually experience delay within the experiment. In other words, in the non-human animal experiments, animals are actually exposed to the delay-reinforcer magnitude combinations in the titration process, while humans are presented with hypothetical questions or are promised real rewards, but these are only delivered after the experiment is complete (e.g. Johnson & Bickel 2002). One possible interpretation is that humans are making decisions based on the results of higher order cognitive processes (i.e. consciously decided), resulting in a qualitatively different discounting process than that employed by the animals in non-human animal experiments.

In order to address this concern and argue that both human and non-human discounting research involve the same underlying behavioral process, we propose that three factors be evaluated. First, we suggest that adaptive pressures driving the two situations be considered. As suggested earlier in this paper, both non-human animals and ancestral human hunter-gatherers were faced with adaptive challenges of resource acquisition that made temporal discounting beneficial. Second, we suggest that similarities in empirical data be considered. As mentioned earlier, extensive research in both humans and non-humans suggests that the hyperbolic decay model expressed in Eq. (1) accurately describes the data.

Figure 1: Temporal discounting curves from experimental group data in three different species. Although discounting rate differed drastically, the hyperbolic decay model (Eq. (1)), accounted for a high degree of variance in all three studies.
in both situations. Importantly, in humans this model consistently outperforms Eq. (2), an equation economists had long thought to describe intertemporal choice because of its “rationality.” If human prospective decision making fundamentally involves more sophisticated decision processes, how odd that our temporal discounting more closely resembles the pattern observed in non-humans, as opposed to this more “rational” model. Thirdly, we suggest that evidence for the biological substrates in the two situations be examined. The neurotransmitter serotonin appears to play an important role in impulsivity for both humans and non-human animals. Rats given drugs that increase serotonin function, such as fenfluramine, increase their preference for larger delayed reinforcers relative to smaller sooner reinforcers (Poulos et al. 1996). Additionally, drugs that decrease serotonin function increase preference for smaller sooner reinforcers relative to larger delayed ones (Bizot et al. 1999). Consistent with animals studies of intertemporal choice, fenfluramine has also been shown to decreased impulsive responding in adult human males with conduct disorder in a choice procedure similar to the studies conducted in our laboratory (Cherek & Lane 2000). In addition, low serotonin function has been shown to play a role in human impulsive behaviors such as suicide (Mann & Arango 1999). Taken together, these lines of evidence suggest that a similar biological substrate underlies impulsive decision making in both humans and non-humans.

Developmental Course of Discounting

In the prior section, uncertainty was identified as an important selective pressure that would favor greater temporal discounting among species. Uncertainty may also play a role at various points in the life history of individuals. Indeed, uncertainty may loom largest during childhood and adolescence. Childhood and adolescence, in particular, are portions of the life cycle that may be associated with greater uncertainty and perhaps, as we outline below, this is an important factor contributing to the widely held view that the young live today as if tomorrow will never come. Also, implicit in such a widely held notion that the young experience more uncertainty and are “reckless” as a result is the complementary notion that older individuals tend to experience more certainty and therefore may consider the future more. Collectively, these two complementary notions suggest that discounting may have a developmental course.

To address the evolutionary forces that would select such developmental changes, we need to recognize and differentiate the type of developmental activities or work necessary to leave descendents or to be reproductively fit (Chisholm 1999). Specifically, to leave descendents requires survival, preparation for reproduction (including growth, development, maturation), and reproduction. Reproduction can be further subdivided into the production of offspring and their rearing. These are the developmental tasks that any organism must successfully complete to meet the criterion of reproductive fitness. Completing these tasks might be relatively easy in an environment where food and potential reproductive partners abound. However, such an Eden rarely exists and scarcity is, more often than not, the rule. Thus, to complete these developmental tasks in the face of scarcity and uncertainty requires the organism to engage in a variety of trade-offs, such as survival vs. reproduction, growth vs. reproduction, and quantity vs. quality of offspring. Thus,
not surprisingly, we would expect “natural selection to favor mechanisms or algorithms for selecting between or making decisions about alternative ways to allocate resources” (Chisholm 1999: 41).

Many of these trade-offs occur along a dimension of current vs. future allocation of resources. For example, producing a large number of offspring instead of focusing resources on a smaller number of offspring might be an effective decision in environments characterized by considerable uncertainty such as mortality by disease, homicide, or other environmental hazards. By having a large number of offspring, one increases the odds that at least one or more offspring will survive these uncontrollable hazards. Also, by immediately producing these offspring, there is a chance that some will survive even if the parent dies relatively early in the development of offspring. On the other hand, in environments characterized by stability, a more successful strategy might be to produce relatively few offspring and focus resources on them, so that each is maximally prepared for survival. In this case, instead of placing more resources into immediate quantity of reproduction, the organism can ensure the transmission of its genetics by continued allocation of resources to the future quality of offspring development. This scenario also introduces the first major source of uncertainty in childhood; that is, the degree of parental investment (Chisholm 1999). The degree of parental investment is not guaranteed for any one particular offspring. Therefore, offspring are best served by immediately utilizing resources offered by the parent. During the vast periods of time that humans were hunter-gatherers, those children who chose immediate over delayed consumption in the face of uncertain parental investment may have been better equipped to survive and eventually reproduce.

During adolescence and after puberty, there may be intense competition among males for the acquisition of resources. This acquisition of resources may lead to better development and enhance attractiveness to potential mates. Such competitiveness may lead to aggression among the youth and lead potentially to homicide. This evolutionary source of competitiveness among males has been suggested as a factor in the largely invariant age related pattern in crime and homicide. More specifically, starting between ages 10 and 12 homicides and other crimes increase dramatically among youth. The percentage of youth participating in these activities peaks around age 18 to 22 and then begins to decline. Also, this competitiveness among males may suggest a reason for the gender differences in crime, drug abuse, and other behavioral problems (Hirschi & Gottfredson 1983; Wilson & Daly 1985).

Also, in our contemporary society, the ability to predict what one’s life may be like in the next 10 years is considerably harder among adolescents than among adults. This relative lack of certainty may also promote discounting and, similarly, the relatively greater predictability of the future by adults may lead to less discounting. Collectively, this characterization of uncertainty during the life cycle suggests that discounting should have a developmental course with greater discounting early in life and relatively less discounting later in life.

Only a few studies permit a test of this hypothesis of age-related differences in discounting. The most comprehensive of these is a study by Green et al. (1994a, b). That study compared the discounting of hypothetical monetary rewards ($100 to $10 000) among children (mean age of 12.1 years), young adults (mean age of 20.3 years), and older adults (mean age of 67.9 years). Figure 2 presents the results from this study and shows that children discounted the most, older adults discounted the least, and the young adults’ discounting was intermediate between them. The hyperbolic function (Eq. (1))
well described the data for all three groups. Support for these results is found when across study comparisons of time preference (discounting) are made between college students (Horowitz 1991; Thaler 1981) and adults nearing retirement (Kotlikoff et al. 1982). An interesting question that remains is whether these age-related changes are largely biological (developing nervous system) in nature or are perhaps culturally derived. Both processes are likely involved and in the next section we will consider the issue of culture in greater detail.

**Cultural Influences on Discounting**

In the section on the evolutionary basis of temporal discounting, humans and non-humans were shown to share the same hyperbolic discounting function, demonstrating cross-species generality and supporting our view of discounting as an evolved psychological mechanism. Differences between human and non-human temporal discounting, however, were also noted; namely, humans generally discount future events less so than non-humans. Explaining the cross-species discontinuity in the degree of discounting suggests at least two possibilities (Bickel & Marsch 2000). One possibility is that the relatively limited discounting observed in humans results from the unique genetic endowment of humans that evolved at some time since the human lineage separated from non-humans. An alternative possibility is that humans like non-humans were temporally myopic in the beginning of their phylogenetic history, but humans, as a result of their ability to cumulatively acquire knowledge across generations, learned to have longer temporal views. Such changes were likely in response to environmental changes that were eventually incorporated into cultural practices. From this perspective, temporal discounting could be related to the process of socialization in our culture and suggests that our biology can accommodate either limited or considerable temporal discounting. This point suggests that discounting may be qualitatively fixed (hyperbolic in form) and quantitatively flexible (degree of discounting). Of course, these two possible sources (genetically or culturally based) of the limited temporal discounting of humans may represent extremes along a continuum, with the answer lying in between.

Nonetheless, our view is that the development of an extended temporal horizon is largely learned from our culture and, therefore, our culture may constrict or expand considerations...
of the future, over time, depending upon the prevailing contingencies (quantitatively flexible). These changes in temporal horizon, once incorporated into the culture, may then influence successive generations. In reviewing evidence in support of this argument, we will briefly review several important developments in human history that led to the adoption of different time horizons (see Bickel & Marsch 2000 for a more detailed review).

As we noted earlier, humans have an extensive history as hunter-gatherers that likely supported a relatively short temporal horizon. Actions in this mode are opportunistic responses to the circumstances that present themselves. All this changed 13,000 years ago, when a new technology, agriculture, developed that changed the economic activity of humans from an event-based to a time-based mode. With the advent of agriculture, concerns moved from seeking food or obtaining food when it was available to planning for tomorrow by planting seeds today. Agriculture eliminated the social system based on roving bands of humans and permitted permanent settlements with larger numbers of individuals. Larger populations were possible because farmers and herders could feed 10 to 100 more individuals per acre of land than from hunting and gathering (Diamond 1997). These permanent settlements are what later permitted the development of specialized skills, governments, technology, and other advances of civilization.

The next important epoch in the development of temporal discounting in humans resulted from the transition from temporal views evidenced in antiquity to the ones introduced by the Judeo-Christian heritage. Circular views of time were widespread in antiquity. The Egyptians, for example, regarded time as a succession of recurring phases (circa 1500 BC) where the world was essentially static and unchanging. Such a temporal view is evident in their approach to chronology. Time was marked by the years of a pharaoh’s reign. Time was restarted with each new pharaoh (Whitrow 1989). Although in ancient Greece a greater number of views were evident, a circular view of time was prevalent. Indeed, from 500 BC forward, there was generally little belief in the progress of the future. In this regard, Whitrow (1989: 46) noted, “the typical Greek tended to be backward looking, since the future appeared to him to be the domain of total uncertainty, his only guide to it being delusive expectation.” Similarly, Imperial Rome was primarily focused on the past and the present, and not the future.

This view of time largely changed with the advent and popularization of Judeo-Christian beliefs. The Jews believed in a linear concept of time and that the future gradually revealed God’s purpose (Whitrow 1989). This view was continued and elaborated by Christianity. Christians believed that individuals can be changed, saved, and, in the future, enter the kingdom of God. With its attention to the future, Christianity ushered in what serves as our contemporary view of time. Specifically, a central notion of Christianity was that one worked today for the future.

The most recent event that changed temporal perspective is the contemporary culture of consumerism and leisure. Prior to the industrialization of America (circa 1870), and particularly in agricultural and artisan settings, leisure was seamlessly woven into the fabric of life. As O’Malley (1996: 257) noted, “Preindustrial societies enjoyed less of a distinction between ‘work’ and ‘rest’...they intermingled constantly in the course of living. A wise and diligent farmer, finishing one task, went straight to work on another, and even at rest, the farmer remained a farmer; there was relatively little sense of ‘time off.’” Prior to the late 1800s, individuals purchased fewer leisure goods and services, and often made their own music and toys (Butsch 1990). During this time, Victorian culture
was a strong force in American society. Victorian ideals “taught people to work hard, to postpone gratification, to repress themselves sexually, and to improve themselves and to be sober, conscientious and even compulsive” (Howe 1976: 17) — indeed, to have extended temporal horizons.

Industrialization produced a profound change by dramatically separating leisure from work, particularly with the advent of factory work. A growing number of wage earners enjoyed a new kind of free time, and with that free time the commercialization of leisure began (Rosenzweig 1983). Among the innovations that filled leisure time were movies, phonographs, and saloons. Indeed, such leisure, with its immediately available commodities, may have shortened temporal horizons, and this change was evidenced in our monetary budgets. The proportion of income that was spent on items other than food, clothing and shelter increased from 10 to 25% from 1875 to the 1930s in working class families. By the 1980s, 40% of income was allocated to “goods intensive” recreation (Horowitz 1985). Not surprisingly, recent longitudinal studies of rates of saving confirm that there has been a major and apparently permanent decline in saving in modern times in 23 western countries that comprise 60% of the world’s output (Maital & Maital 1994). A decrease in savings is certainly suggestive of a shortened temporal horizon. Collectively, these changes lead to a replacement of a restrictive culture with one characterized by increased permissiveness and self-indulgence. Thus, sanctions against impulsive behavior or short temporal horizons were dramatically lessened in this new permissive culture. These trends certainly carry through to contemporary times with an ever-increasing array of immediately available food and recreational items.

Next we consider an additional factor in modern society that may promote a myopic temporal perspective that is manifested in the form of “deviant,” shortsighted behavior. In so doing, we will discuss how environments that have considerable economic deterioration and destabilization are associated with a high prevalence of environmental risk and uncertainty. These environments are also associated with considerable criminal, drug use, and other shortsighted behaviors. In discussing the “culture of poverty,” we are not suggesting that economic poverty per se causes shortsighted behavior (e.g. drug use or criminal behavior). Rather, as Lewis (1966) suggests, the culture of poverty represents a culture of instability, criminality, violence, and deprivation — indeed, a culture that fails to promote consideration of the future consequences of behavior.

Environments characterized by economic deterioration and destabilization, in which the future outcomes of one’s behavior are typically characterized by risk and uncertainty, may select for shortsighted behavior. In many inner-city environments, where community instability and decay (e.g. poverty and violence) are endemic (e.g. Greene 1996), considering one’s future may seem a fruitless endeavor for individuals who may not expect to experience the future. In such a situation, the most adaptive strategy may be to consider exclusively the immediate consequences of a behavior (Strathman et al. 1994). Indeed, a variety of studies have demonstrated that behaviors leading to unpredictable future outcomes may be replaced by behaviors that result in more immediate predictable outcomes (e.g. Christensen et al. 1988; King & Logue 1992; Navarick 1987). In general, individuals living in an environment permeated by unpredictability and risk may engage in more present-oriented rather than future-oriented behavior. In contrast, individuals living in a more predictable environment may be more future-oriented and engage in less risky behavior (Hill et al. 1997).
Indeed, the prevalence of substance abuse, criminal and many other types of risk behavior is highest in urban and low SES residential environments (e.g. Crum et al. 1996; Harrell & Peterson 1992). For example, in a meta-analysis of predictors of homicide, resource deprivation or poverty has been shown to be the strongest predictor of high homicide rates (Land et al. 1990). Furthermore, a strong correlation ($r$ correlation $= 0.88$) has been reported between the average life expectancy of individuals in an urban environment and their neighborhood homicide rates, with those individuals with the shortest life expectancy also living in places where homicide rates are highest (Wilson & Daly 1997). In addition, teenage pregnancy is highest among those in low SES, urban environments where individuals also experience poorer and more uncertain health, as well as higher age-specific mortality rates, than individuals in non-urban or higher SES contexts (Geronimus 1987, 1996).

Importantly, four studies measured temporal discounting or some reasonable proxy measure (e.g. impulsivity) as a function of SES and neighborhood variables. O’Rand & Ellis (1974) measured time perspective as a function of social class. Specifically, they examined time perspective in two samples of adolescents of comparable age who came from differing backgrounds. The two groups came from a lower-class and a middle-class background. The results reveal that lower-class youth had a more restricted temporal view than youth from the middle-class, that upwardly mobile lower-class youth have incorporated some features of the temporal perspective evidenced by the middle-class youth, and that temporal perspective influenced success in performance roles. The second study by Lawrance (1991) used econometric methods to measure temporal perspective and found temporal discounting to be negatively related to income and educational level. One possible interpretation of the data is that high temporal discounting may reduce investment in education, which, in turn, has a negative impact on income. The third study examined the interaction of impulsivity and neighborhood context on juvenile criminal offending (Lynam et al. 2000). Results indicated that impulsivity interacted with neighborhood context to influence juvenile offending. Specifically, impulsivity placed juvenile boys at great risk for offending in the poorest neighborhoods, while impulsivity posed little risk for offending in better neighborhoods. A fourth study (Green et al. 1996) showed that low-income older adults temporally discounted money to a greater extent than high-income older adults.

Collectively, the account provided in this section shows that temporal discounting is flexible and can either be increased or decreased depending upon the cultural conditions. Indeed, the history of humans with respect to temporal perspective may be conceptualized as an inverted U-shaped function, where first considerable discounting was evidenced followed by a lesser degree of discounting, and most recently by greater discounting. This account is consistent with human behavioral ecology that suggests that differing “strategies” will be employed under differing environmental consequences.

**Temporal Discounting and Drug Dependence**

**Is Temporal Discounting Involved in Drug Dependence?**

Several published studies have investigated the link between temporal discounting and drug dependence (Bickel & Marsch 2001). The majority of these studies have employed
group designs, comparing drug dependents to non-drug dependents. These studies have revealed that drug dependents discount the future to a greater extent than normals. The fact that this observation has been made for a variety of drugs across drug classes suggests that the increased discounting is fundamentally related to drug abuse, as opposed to any one particular drug.

Several studies have examined temporal discounting rates among heroin abusers. Madden et al. (1999) and Madden et al. (1997) used a procedure developed by Rachlin et al. (1991) to measure discounting in both heroin addicts and matched control normals. Participants were presented with two hypothetical choices. One choice was $1000 at a specific delay and the other choice was a smaller amount available now. This smaller reward amount was varied in order to find the point at which the subject was indifferent between the larger later and the smaller sooner reward. Seven delays were examined (ranging one week to 25 years) and discounting functions were determined by fitting the seven obtained indifference points to Eq. (1). In addition, a similar analysis was conducted with choices between $1000 dollars worth of heroin and a smaller amount of heroin, so that discounting for the drug itself could be evaluated.

Results in both studies revealed that opioid-dependent subjects discounted money significantly more than normals, and opioid dependents discounted heroin more than money. Figure 3 shows that for control subjects, $1000 lost 60% of its value when delayed by five years, while for opioid-dependent subjects, $1000 lost 60% of its value in only one year, a five-fold difference. Additionally Figure 3 shows that, among opioid dependents, heroin lost 60% of its value in only one week, a 52-fold difference compared to their discounting of money. Another study by Kirby et al. (1999) replicated the finding that heroin addicts discount money more than normals. But unlike the two studies mentioned above, the choices in this study were not purely hypothetical. Out of all choices made, one choice was randomly determined, and the subject had a one in six chance of receiving the selected reward on this choice. Finally, Odum et al. (2000) examined temporal discounting across subgroups of heroin addicts. In-treatment opioid-dependent subjects were categorized in two groups based on self-report: whether the subject would or would not engage in needle sharing with a friend if no clean needle were available. Needle sharers discounted money rewards to a greater extent than those who would not share needles. No significant difference was found between the groups for discounting of heroin. However, as in previous studies, both groups discounted heroin more than money.

A few studies have also examined temporal discounting in tobacco cigarette smokers. Mitchell (1999) used a choice procedure to examine the temporal discounting for money reward in regular smokers and subjects who had never smoked. The choices here were potentially real. Subjects could win one reward, selected randomly, from among the choices made during the experiment. These two groups were also compared on various personality and behavioral measures of impulsivity. Smokers discounted future rewards to a significantly greater degree than never-smokers. In addition, smokers scored more impulsively than never-smokers on the other behavioral tasks and most of the personality tasks. Bickel et al. (1999) also examined smokers' temporal discounting. This study compared current smokers, never-smokers, and ex-smokers in discounting for $1000. Discounting was also measured in current smokers for the amount of cigarettes the subject
Figure 3: Group indifference points and hyperbolic (Eq. (1)) discounting curves for money and heroin. Opioid dependents and control subjects are compared with money in the top panel. The bottom panel compares discounting of heroin and money within the opioid-dependent group.

could purchase for $1000. Current smokers discounted future money rewards significantly more than never-smokers and ex-smokers; however, no significant difference was found between money discounting for never-smokers and ex-smokers, suggesting that increased discounting in the cigarette smoker may be a reversible phenomenon. In addition, the current smokers discounted cigarettes significantly more steeply than money. Thus, as was demonstrated in heroin addicts (Madden et al. 1997, 1999), the abused drug is discounted more than the money needed to purchase that drug.

Temporal discounting has been studied in alcohol drinkers using a choice procedure (Vuchinich & Simpson 1998). Two studies were conducted: one comparing heavy vs. light drinkers, and one comparing problem vs. light drinkers. These studies found that
both problem and heavy drinkers discounted future money consequences more than light drinkers. These studies also compared the groups on questionnaires designed to study impulsiveness and time orientation. Light drinkers were found be less impulsive than the other groups; however, there was no strong correlation between these measures and the discounting rate determined via the choice procedure.

Two additional studies examined temporal discounting in heterogeneous groups of substance abusers. Ainslie & Haendel (1983) compared inpatient substance abusers and a group of employees of that inpatient facility. The patients discounted delayed money significantly more than the employees. Petry & Casarella (1999) compared problem gambling substance abusers, non-problem gambling substance abusers, and non-problem gambler non-substance abuser controls. Substance abusers discounted money to a significantly greater extent than non-substance abusers. Moreover, problem gambling substance abusers discounted money more than non-problem gambling substance abusers. These results suggest that, even among substance abusers, temporal discounting rates are sensitive enough to discriminate among subgroups.

Collectively, the studies reviewed in this section suggest that steep discounting is associated with drug abuse in general and risky drug injection practices in particular. Additionally, these studies suggest that both drug dependent and control subjects discount hyperbolically, but differ in the degree of discounting. If discounting is shown to be related to the development of drug abuse, then this may suggest a normal source of pathological behavior. An interesting and potentially important implication of these studies is that steep discounting may provide both a marker of risk and a target for risk.

**Discounting and its Relationship to Dependence Processes**

There are several phenomena that are related to drug dependence that have yet to be adequately explained or understood. Among these phenomena are the risk for drug abuse among youth, the maturing out of drug dependence, the increasing prevalence of drug dependence throughout our century, and the loss of control associated with drug dependence. We will consider each of these phenomena and their relationship to discounting below.

Drug use and dependence typically start in adolescence and end spontaneously as the drug dependent matures and ages. Let us consider the natural history of heroin dependence as an exemplar. The age of first drug use in the heroin dependent, which is usually marijuana, is approximately age 14. By age 16, in the typical life course of the drug dependent individual, he or she has been arrested, and has had considerable school difficulty. The age of first use of heroin is approximately 18, with the first signs of dependence exhibited at around age 20. The heroin dependent individual's age at the time he or she first seeks treatment is age 26. These data on the life history of heroin dependence are somewhat dated, and may be less relevant today in the emerging epidemic of heroin dependence, where adolescents are trying heroin and becoming dependent at ever-earlier ages. The other phenomenon is that drug dependent individuals often mature out of drug dependence. More specifically, the drug dependent often stop using drugs in their 40s and 50s. The exact reasons for these two age-dependent phenomena have never been adequately explained, nor adequately addressed in any theory of drug dependence.
Figure 4: The upper-left panel shows percent alcohol dependent in last year by age in 1999 (Department of Health and Human Services 2000). The upper-right panel shows percent illicit drug dependent in last year by age in 1999 (Department of Health and Human Services 2000). The bottom-left panel shows age of first heroin use by percent of client pool among opioid-dependent patients in 2001 at the University of Vermont's Substance Abuse Treatment Center. The bottom-right panel shows standardized arrest rates by age in the United States for 1977 (Hirschi & Gottfredson 1983).

One way to make sense of these two phenomena is to first recognize that they appear to be related to the life course of many other behaviors. Consider the graphs presented in Figure 4. Each of the panels shows the frequency of individuals engaging in drug use, criminal behavior, or homicides as a function of age. Each graph for all intents and purposes is similar in form. These graphs suggest that the likelihood of engaging in these behaviors increases dramatically in early adolescence, reaching a peak in the early 20s and declining thereafter. The fact that these age-dependent functions are so similar across behaviors suggests that we are looking at a phenomenon that may be dampened or increased by particular cultural forces, but is unchanging in its underlying biological process.

Delay discounting is one process that may account for these phenomena. As was discussed earlier, delay discounting is a developmental phenomenon in which children and adolescents discount the future the most. Perhaps this is a risk factor for drug use anddependence. For example, perhaps those adolescents that discount the future more are the adolescents that are at greater risk for engaging in all sorts of behaviors that provide brief intense reinforcement. If so, drug of dependence would certainly be one set of events that could provide brief intense reinforcement.
Based on our review earlier we also established that degree of discounting decreases as one grows older. Perhaps the drug dependent show the same age related decline in discounting, but tend to discount more than peers of equivalent age. If so, then this may provide a basis for the commonly observed pattern of the drug dependent discontinuing drug use at an older age. Perhaps this "maturing out" phenomenon is a consequence of gaining sufficient temporal perspective.

The third phenomenon we would like to address is the effects of culture on drug dependence. In the section on culture above, we noted that culture's influence on delay discounting could be considered an inverted U-shaped function where greater discounting is more likely to occur in contemporary times because of our consumer culture. If that is true and if greater discounting relates to a greater likelihood of becoming drug dependent, then we should observe that the likelihood of becoming drug dependent increases as a function of birth cohort in the 20th century.

Increasing drug dependence as a function of when an individual was born in the last century is in fact observed. This was shown in a study reported by Warner et al. (1995). They assessed the prevalence of drug use and dependence in over 8,000 individuals, comprising four U.S. birth cohorts. Four 10-year cohorts were assessed for five different 5-year age intervals (ages 4, 9, 14, 19 and 24), including Cohort I (born 1966–1975), Cohort II (born 1956–1965), Cohort III (born 1946–1955) and Cohort IV (born 1936–1945). Results indicated that Cohort IV (born pre-WWII and modern society) had the lowest prevalence of drug use, with drug use tending to increase with each successive generation. Of course, these data may simply reflect the fact that drugs have become increasingly more available throughout the century. What is important for our point is that this study looked at the probability of becoming drug dependent if the individuals had used the drug. Looking at the probability of being drug dependent amongst those that had used drugs in part controls for drug availability. The data show a more robust effect when the probability of drug dependence increases with successive cohorts throughout the century. Other similar effects have been noted in the drug dependent (Bickel & Marsch 2000). Similar birth cohort effects have been noted in criminal behavior, depression, single mother births, obesity, and childhood behavioral problems (see Bickel & Marsch 2000 for a review).

The fourth phenomenon of drug dependence that may be related to discounting is "loss of control"; that is, drug dependent individuals may state a preference for the larger, more delayed reward, yet nonetheless later choose the smaller, more immediate reward, thus demonstrating a reversal in preference. For example, drug dependent individuals may express a strong preference for employment or participation in relationships with family and friends over drug use. However, a short time before a drug becomes available the individual may choose using drugs instead of going to work or spending time with their family. Similarly, intravenous drug users may prefer using clean needles, yet may willingly share needles when offered the opportunity to use drugs (e.g. Abdul-Quader et al. 1987). Also (to the consternation of treatment providers), many drug dependent individuals voluntarily participate in outpatient drug treatment programs, but continue to abuse drugs (Milby 1988). Some of these patients declare a preference for not using drugs upon entering treatment, but nonetheless relapse to drug use at some later point in treatment, indicating a reversal in preference.
Hyperbolic discounting can account for preference reversals and this is illustrated by the familiar depiction of preference reversal due to hyperbolic discount curves (see, e.g. Ainslie & Monterosso, Chapter 1, this volume). One reward is a sooner, smaller magnitude reward, and the other a delayed, larger magnitude reward. Note that these two rewards are separated by time. The two curves indicate the present value of the rewards as a function of time until their availability. Importantly, they are hyperbolic in shape and cross each other. Thus, in this example, the larger reward has the greater value to a subject than the smaller reward at a time point long before either reward is available. However, as time progresses and the smaller reward becomes imminently available, the value of the two rewards reverse and the smaller reward has greater value (i.e. an impulsive choice is made). This reversal in preference occurs even though the objective magnitude of the rewards and the time between their availability remains constant. Hyperbolic discounting of delayed rewards suggests that when the events in question are temporally distant, choices are made that could be referred to as “self-controlled,” “rational,” and consistent with the objective magnitude of the rewards (e.g. “I want to work, be with my family, and not use drugs”). However, as the smaller sooner reward becomes available, preference reverses resulting in a choice that could be described as “impulsive,” “irrational,” and inconsistent with both the objective magnitude of the rewards and the prior expressed preference. Thus, not only does delay discounting account for the seemingly irrational behavior of drug dependents when they “lose control,” but it also accounts for experiences of non-drug dependent individuals, e.g. the change in reference demonstrated when setting an early alarm the night before to get more work done, and then hitting the snooze button in the morning (Rachlin 2000). This suggests a normal source of pathological behavior.

This section has shown discounting to be potentially applicable to several phenomena in drug dependence. In particular, we speculated about the relationship of delay discounting and the age-dependent entry and exit from drug dependence, and the role of culture in rendering individuals more at risk for drug dependence and a wide variety of other behaviors. Moreover, we demonstrated how hyperbolic discounting could predict preference reversals that are used to diagnose the drug dependent. Of course, this section speaks mostly to the potential of delay discounting to account for these interesting phenomena. Further research will be necessary to determine if such speculations are supported by the facts.

**Is Increased Temporal Discounting in Drug Dependence a Reversible Phenomenon?**

Two interpretations of the group differences between drug dependents and matched control normals exist. One explanation is that individuals who have higher temporal discount rates, whether this is a consequence of genetic, cultural, developmental, or a combination of influences, tend to be the ones who start abusing drugs. An alternative explanation is that active drug abuse shortens temporal horizon and actually causes increased discounting. And, of course, both explanations may be true. That is, those who have higher discount rates may tend to start abusing drugs, and then drug abuse may tend to make these individuals discount the future even further.

In a recently completed study from our laboratory, we attempted to explore the causal direction of drug dependence and temporal discounting (Bickel et al. under review).
Specifically, we have taken cigarette-dependent individuals and randomly assigned them to two groups. Both groups perform a procedure measuring temporal discounting rate for $1000 on a Friday. During the following Monday through Friday, one group must come into our laboratory and give a carbon monoxide (CO) breath sample (an indicator of recent smoking) three times daily. If the reading indicates that a participant has not smoked, he or she is immediately rewarded with $10 in cash. The control group is asked only to follow their regular smoking patterns during this time. On the Friday of this week (one week after initial discounting assessment), delay discounting is once again measured for $1000 in both groups.

Analyses indicate that subjects assigned to the abstinence group have statistically lower temporal discount rates after the week of abstinence than before, i.e. more self-control. No such change is observed in the control group. No difference is detected between groups at the beginning, but the abstinent group is more self-controlled than the control group at the end session. These findings suggest that increased temporal discounting may be a reversible consequence of cigarette dependence, and perhaps drug dependence in general. Importantly, these results suggest that cigarette dependence causes an increase in discount rate, but does not rule out the other potential relationship, that those with initially high discount rates are the ones that tend to go on to abuse drugs.

Conclusion

In this paper, we have made several points about discounting and its relationship to drug dependence. First, we showed that discounting appears to be an evolved psychological mechanism (qualitatively fixed) that appears to have been exapted in the process of drug dependence. Second, we show that discounting has a developmental course that coincides with the onset of drug dependence and with the maturing-out phenomenon often observed in the drug dependent. Third, we have made an argument that discounting may be influenced by culture and that this notion is consistent with the increases in the prevalence of certain disorders observed across the 20th century, especially drug dependence. Fourth, exaggerated discounting is directly observed in the drug dependent. In particular, drug dependent individuals discount future monetary rewards more than matched controls and drug dependents discount the drug of dependence more than money. Fifth, discounting can theoretically account for reversals in preference, often termed loss of control, which are considered indicative of drug dependence. Sixth, we showed data from a recent study in which discounting appeared to be a reversible effect of drug use. Collectively, these observations support the notion that discounting is a behavioral process that may be driven by evolutionarily old brain systems selected to secure vital resources, and these processes appear to be commandeered in drug dependence. Indeed, as a commandeered process, discounting could be a normal source of pathological behavior.

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References


Comments on Bickel and Johnson

Keith Humphreys

This is a rich and ambitious paper. I particularly enjoy reading articles like this one that combine detailed research findings with wide-ranging conceptual analysis. (Too many papers we write include only one or the other, I think). On the empirical side, Bickel and Johnson present compelling evidence that drug dependent people discount future rewards to a much greater extent than do non-users. Further, they establish the clinically important fact that smokers apparently can return to a normative level of temporal discounting if they cease using nicotine. Bickel and Johnson place their intriguing laboratory findings in three conceptual contexts that I will comment upon here: evolutionary, developmental, and historical.

The Evolutionary Context

To begin with the evolutionary context, Bickel and Johnson argue that, in humanity’s hunter-gathering period, temporal discounting was disadvantageous and impulsivity advantageous in the process of natural selection. Obviously, a species that never listened at all to its impulses, for example refused to eat even when starving, would die off in a generation or two at most. But beyond that truism, I think Bickel and Johnson may be focusing on the wrong human characteristic in their evolutionary argument. Rather than try to explain why humans don’t value the future rationally and perfectly, I think we should direct our analysis towards explaining what makes us different from other animals — namely, that we can consider future rewards at all, even at a discount. For example, earlier today Dr. Ainslie asked members of the audience to choose whether they would rather have a dollar for themselves or give everyone else in the room a dime. My thought about my answer as he went around the room was, “Well, were I a rat or a pigeon, I’d take the dollar. But because I am a human I will vote that everyone receives a dime. This is because I think about the future. Specifically, I know that one year, two years, maybe even five years from now, one or more of the scholars in this room is going to be on a grant review board and see a proposal with my name on it, and I don’t want their reaction to be ‘Here's where I pay back that cheap bastard who stole my dime!'”

Levity aside, Bickel and Johnson’s wonderful charts show that homo sapiens discounts the future far less than any other species we have studied, and contrary to Bickel and Johnson I believe that this trait was genetically advantageous even during our hunter-gatherer period. Imagine two hunter-gatherers named Jumpy and Pokey. Jumpy is impulsive
and never met an immediate gratification he didn’t like. In contrast, Pokey often delays smaller, sooner rewards for later, larger ones. Who does better at Darwin’s grand game?

When Jumpy gets angry at his children, he gives in to his impulse to strike them with the nearest object to hand, or he simply abandons them. In contrast, when Pokey gets angry he takes a long slow walk around the campsite to cool off before disciplining his progeny in a way that would not put his genes at risk.

After a long day’s hunting, Jumpy gives in to his immediate desire to sleep, whereas Pokey forces himself to stay up an extra hour each night tanning hides. Come winter, Jumpy freezes to death while Pokey stays warm and comfortable.

When Jumpy is out walking and sees a strange new fruit or vegetable, he eats it immediately. Though just as hungry, Pokey waits to see whether or not Jumpy dies before he partakes. If Jumpy lives, Pokey knows he can eat safely. And if Jumpy dies, he can go home to comfort Jumpy’s widow, thereby gaining another chance to spread his genes.

Similar examples of temporal discounting being adaptive also come easily to mind if one shifts the level of analysis from individuals to groups (e.g. tribes, bands, etc.). For example, the jumpy Great Plains tribe would focus its buffalo hunting on baby buffalo because they are slower and easier to kill, and in a year or two the tribe would starve as the herd disappeared. In contrast, the Pokey tribe would focus its hunting efforts on the old male buffalo, knowing that next season this year’s baby buffalo will come back as a larger potential food source.

My perspective that temporal discounting gave an evolutionary advantage in hunter-gatherer societies also escapes what I believe is a logical problem within Bickel and Johnson’s argument. They maintains that impulsiveness was genetically advantageous prior to the advent of agriculture. But if natural selection was making humans more and more impulsive and temporal discount-oriented with each generation, we should have developed Nintendo and MTV rather than farming 13,000 years ago. In contrast, if one assumes that valuing delayed rewards was advantageous and therefore its genetic component was becoming more and more prevalent in humans over time through natural selection, the emergence of agriculture is much easier to explain.

The Developmental Context

I found Bickel & Johnson’s developmental analysis more persuasive, especially their observation that young people both discount the future more and use drugs more than do older adults. They note that this may stem from the young facing a more unpredictable future than do adults. This observation seems sound as a general proposition, but may not be sufficient to explain extreme temporal discounting among those young people who perceive their future as predictably short and painful. This is a sadly common phenomenon among low-income youth who live in violent cities such as Moscow, Rio de Janeiro and Chicago (cf. Kotlowitz 1991), to which Bickel and Johnson allude by commenting, “Considering one’s future may seem a fruitless endeavor for individuals who may not expect to experience the future.” Low-income adolescents who are convinced that they will die before the age of 40 or 50 actually have an extremely high amount of certainty about a future, at least compared to their middle income counterparts who expect a much longer and varied adulthood. Given
this certainty about the future, why are young, low-income inner-city dwellers prone to temporal discounting? In the same vein, who has heard of a prisoner facing the electric chair who ordered a final meal of tofu, egg beaters, skim milk and dry toast? Yet the future of such a person is quite predictable. At different points in their paper Bickel and Johnson seem to take different perspectives on this issue, so I would just ask them to clarify his view: do they believe it is predictability per se or predictable future rewards that reduce temporal discounting?

The Historical Context

Finally, let me praise in unqualified terms Bickel and Johnson's efforts to place temporal discounting in an historical and cultural context. To use classic public health language, a genetic predisposition for extreme temporal discounting could be construed as a risk factor, and the current culture's view of time and gratification as an exacerbating or protective factor. The combination of these individual and environmental forces influences the host’s vulnerability for temporal discounting and, by extension, drug use. Under this argument, those individuals with “jumpy” genes would be at even more risk in a culture such as the Roman Empire, which as Bickel & Johnson note emphasized the value of the present rather than the future. Indeed, many Western languages include a word describing people and events that operate at a painfully slow pace or show an intolerable lack of impulsiveness and spontaneity. (In English, it is “cunctatory”). These words derive from a Roman insult, originally applied to Quintius Fabius Maximus because he refused to rush in and take on Hannibal directly (Plutarch, 75/2002), preferring instead a series of small delaying actions in the hope that a better opportunity for victory would arise later. He was branded as “Cunctator” (delayer) and kicked out, whereupon the new consul general sent the army marching straight into Hannibal’s forces at Cannae, thereby converting 80,000 Jumpy Romans into elephant pavement.

I agree with Bickel and Johnson that the spread of Christianity made Western culture less supportive of temporal discounting. The obvious example is the idea that one’s humble hard work and suffering on earth will be compensated for in heaven (Brown 1997). The Egyptians believed in an afterlife, of course, but it was still going to be much better for the Pharoahs than for the starving masses, who lived under no more encouraging parable than, “Yea, the sleek shall inhibit their girth.” In the Christian vision, everyone is equal in the eyes of God, such that every person who subscribes to the faith can have a comparable expectation of a large, delayed reward. Bickel & Johnson’s trenchant comments on how modern consumer culture make any individual-level temporal discounting tendencies stronger becomes even more compelling when one considers that the post-WWII rise of consumerism has been accompanied by a sharp drop within developed nations in belief in Christianity and in heaven (Wilson 1999). Bickel and Johnson argue that whatever jumpiness we brought forward from our evolutionary history may be expressed more strongly at this historical moment than in previous ones. For society's sake, I wish they were wrong on this point but believe that they are right, an ominous sign given that substances that provide short-term rewards at high long-term costs have never been more widely available.
References

It is not the strongest of the species that survives, nor the most intelligent; it is the one that is most adaptable to change (Charles Darwin, as cited in Augustine 1997).

Humphreys provides a careful analysis of our paper, and raises some important concerns that may be shared by other readers. Here, we will focus on addressing two of these intriguing questions. Humphreys argues that natural selection should have favored less impulsive choices and that uncertainty of the future does not always cause impulsive choice. We will address each in turn.

**Should Natural Selection Favor Less Impulsive Choices?**

Humphreys argues that natural selection should favor self-controlled choice over impulsive choice. He vividly illustrates these options with his two characters, Jumpy (impulsive choice) and Pokey (self-controlled choice). Our view is that the language of dichotomies can be both constraining and misleading. Instead, the discounting of delayed reinforcers refers to a continuum that is bounded by impulsive and self-controlled choice, but permits many more subtle shades between those extremes. Thus, instead of the dichotomy proposed by Humphreys' example of Jumpy and Pokey, we suggest that hunter-gatherers may exhibit behaviors that could be described as jumpy in some circumstances, and pokey in other circumstances. Furthermore, in some situations the human may behave in a slightly jumpy manner (i.e. a relatively high degree discounting), and in other circumstances behave in a very jumpy manner (i.e. an even higher degree of discounting). Natural selection would operate on individuals who display a variety of these behaviors, and may favor those whose behavior tends to reside along one area on the continuum vs. another only if the environment consistently favors one end or the other of the continuum. In inconsistent environments, humans that could dynamically change their discounting may be selected. As may be suggested by Darwin's quote above, flexibility in one's discount rate may be a key to survival.

Our proposition is not that humans never faced circumstances where delayed reward was the adaptive choice. In fact, Humphreys suggests several excellent examples of such circumstances. Extremely impulsive choices (e.g. eating great amounts of a novel food)
would, of course, have a selective disadvantage. Our proposition is, however, that the hunter-gatherer environment selected for relatively high discounting rates, and perhaps selected for flexibility within this limited range.

Viewing impulsivity along a continuum also relates to Humphreys' assertion that "...we should direct our analysis towards explaining what makes us different from other animals — namely, that we can consider future rewards at all, even at a discount." Particularly with the development of verbal abilities, humans presumably developed a time horizon that extended beyond that of non-human animals in many circumstances (e.g. intertemporal reciprocity between individuals), but so long as humans relied on a hunter-gatherer lifestyle, the time horizon would still be kept relatively short.

Humphreys states that if humans were impulsive 13,000 years ago, we should have developed MTV and Nintendo in place of agriculture. His point is that agriculture seems to be a very self-controlled enterprise, therefore how did these impulsive creatures develop such a system? Humans, although still relatively impulsive from our hunter-gatherer background, were presumably less impulsive than non-human animals in many respects, placing us somewhat more on the self-control side of the continuum. This, along with the notion that agriculture developed through necessity rather than inspiration (Diamond 1987), should explain why we were able to develop a system that necessitated such self-control.

Does Uncertainty of the Future Always Cause Impulsive Choice?

The second point we address by Humphreys is that uncertainty of the future does not always cause impulsive choice. He states that low-income adolescents who are convinced of an early death by 40 or 50 years of age actually have a predictable future (predicting that life will be short). In behavioral ecology, the certainty of ultimate importance is the certainty of gene reproduction. For the low-income youths in question, there may be a great deal of uncertainty on whether they will be able pass on genes, for a number of reasons, including the chance of dying before having children and uncertainty about having the resources necessary to ensure that offspring successfully develop. Humphreys claims that their middle-income counterparts expect a more varied adult life. They may be uncertain as to which profession to choose or automobile to purchase; however, this choice causes less uncertainty over the fundamental question of whether one will survive and leave viable offspring. This would seem consistent with research on risk sensitivity. In some species, when energy gains exceed demands (perhaps analogous to the low-income individual), the animal shows risk-prone behavior in the acquisition of food, but when demands exceed gains (perhaps analogous to the middle-income individual), the animal shows risk-averse behavior (Bateson & Kacelnik 1998). For the current discussion, the relevance of this finding is that uncertainty in the acquisition of a resource necessary for survival and future reproduction can dynamically cause shifts in basic behavioral processes.
References

