Deciding to Disclose: Pregnancy and Alcohol Misuse

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Acronyms

FAS Foetal Alcohol Syndrome

CPT Cumulative Prospect Theory

PT Prospect Theory

NICE National Institute for Health and Care Excellence

IAPT Improving Access to Psychological Therapies

CMACE Centre for Maternal and Child Enquiries

AUDIT Alcohol Use Disorders Identification Test

T-ACE Tolerance, Annoyance, Cut down, Eye-opener

RCOG Royal College of Obstetricians and Gynecologists

AML acute myeloid leukemia

ADHD Attention Defecit Hyperactivity Disorder

PND Postnatal Depression

RCT randomised control trial

WHO the World Health Organisation

ESS Evolutionarily Stable Strategy

MCMC Markov chain monte carlo methods

DU Discounted Utility

AIC Akaike information criterion

ANOVA analysis of variance

ALSPAC Avon Longitudinal Study of Parents and Children

GEM Gaussian Emulation Machine

GEM-SA Gaussian Emulation Machine for Sensitivity Analysis

JIT Just-in-time

ABM Agent Based Model

CPT Cumulative Prospect Theory

Abstract

Background: Roots in agents, decision theory, game theory.

Objective: To pimp out this method, and maybe get some insight into reality.

Methods: Made a game, made a simulation, did a sensitivity analysis.

Results: Look! Chaos! Look! Qualitative trends! Look! More data needed.

Conclusions: This.. might actually kind of work??

Comments: Lesson learned: data should drive modelling.

This dissertation presents a method for modelling disclosure behaviour by treating the interaction as paired signalling games played by decision theoretic agents. Two theories of decision making - Bayesian risk minimisation, and Cumulative Prospect Theory (CPT) - are investigated, and a simulation developed using Python.

The feasibility of the method is examined through a case study, which considers the disclosure of the drinking behaviour of pregnant women to their midwives.

The essence of the scenario is that there is considered to be a long term benefit to disclosure - common in the healthcare arena, but an opportunity cost associated with disclosure. In the case study, this is conceptualised as arising from the perceived undesirability of drinking while pregnant. More generally this could derive from any imbalance in the long term benefit and the opportunity cost, for example the subjective benefit of a cigarette in the near future, versus the discounted benefit of better health later.

Theories of decision are driven by the weighing of probabilities and subjective gains or losses. In this case, the probabilities are generated by individual agents based on their initial preconceptions and their experiences across the simulation, using Bayesian inference.

The Bayesian risk minimising model is able to reproduce qualitative trends around increased honesty over appointments, and a negative impact of harsh judgement of drinkers on disclosure. The CPT model is less successful, which may be a result of improper, or excessively homogenous parameters, in combination with unrealistic payoffs.

A global sensitivity analysis is also conducted using Gaussian Emulation Machines, and finally recommendations for further work are dervived, along with a few key recommendations for practice - assume people are being honest, and be non-judgemental.

1 Introduction

2 Background

This chapter presents an overview of literature focusing on the impact of drinking behaviour in pregnancy, and factors affecting disclosure behaviour in the midwifery context. This is followed by a review of literature supporting the theoretical underpinning of the modelling approach, with particular reference to statistical decision theory.

2.1 Alcohol, and Disclosure in the Maternity Setting

2.1.1 Impact of Alcohol

Distinct from stigma attached to alcohol consumption in pregnancy, is the question of the real impact on woman and baby both in the antenatal period, and beyond. While the canonical example of alcohol linked disorders is Foetal Alcohol Syndrome (FAS), and others on that spectrum, heavy drinking during pregnancy has been mooted as a factor in a variety of negative health outcomes.

The impact of moderate alcohol consumption in pregnancy is more contested. For example, Andersen et al. (2012) examined moderate drinking in a large Danish cohort study, finding a significant increase in the risk of spontaneous abortion at low levels of consumption early in pregnancy. Savitz (2012) questioned the extent to which this can be interpreted as a causal connection, noting that there is a known relationship between absence of morning sickness, and spontaneous abortion, and suggesting that this may explain much of the difference in risk. Kesmodel et al. (2002) examined the relationship between alcohol consumption and still-birth, finding that increased consumption lead to an increase in risk to the baby, but in contrast to Andersen et al. (2012) this was significant at term.

Considering longer term negative outcomes, a metastudy by Latino-Martel et al. (2010) examined the potential for maternal alcohol consumption in pregnancy to feature as a risk factor for onset of childhood leukaemia, finding that any alcohol consumption was associated with an increased risk of childhood acute myeloid leukemia (AML), but note the rarity of the condition as a limitation.

Huizink and Mulder (2006) reviewed literature looking at the impact of moderate consumption on neurodevelopmental and cognitive outcomes, concluding that maternal consumption can be a contributing factor to Attention Defecit Hyperactivity Disorder (ADHD), and impairments to learning and memory. They subsequently suggest that the underlying mechanism is not specific to alcohol consumption, but a more general phenomena arising from perturbations to foetal conditions (Huizink 2009), but caution that methodological issues in many of the studies reviewed may undermine this hypothesis.

Contrary to this, a meta-study by Gray and Henderson (2006) found there was insufficient evidence to suggest any harm arising from moderate (under 1.5 UK units per day) alcohol consumption. This ties to the current guidance from the National Institute for Health and Care Excellence (NICE) (National Institute for Health and Care Excellence 2010a), advising that women should avoid drinking at all in at least the first three months of pregnancy, and no more than 1-2 units once or twice a week if they do. In giving this advice, NICE acknowledge that the risks to the foetus from alcohol are a somewhat contentious subject, concluding that the evidence of harm is inconclusive, but that this is not sufficient to rule out the risk of negative outcomes. This tension is reflected by earlier guidance from the Royal College of Obstetricians and Gynecologists (RCOG) (Royal College of Obstetricians and Gynecologists 1996) suggesting no evidence of harm below 15 units per week, and subsequent criticism by Guerri et al. (1999), who suggest that this might be interpreted as legitimising binge drinking, while noting several studies indicating adverse affects linked to even a single drink per day (e.g. Day et al. (1990)). A subsequent RCOG statement (Royal College of Obstetricians and Gynaecologists 2006) revised the recommendations to incorporate newer findings, advising that there is no known safe threshold for drinking in pregnancy, and highlighting binge drinking as of particular concern.

There has recently been an increased interest in the impact of binge drinking, as a distinct pattern of consumption, with a wide variety of negative outcomes reported by Maier and West (2001), although a significant portion of their evidence base is drawn from animal studies which augers for caution in generalising findings to humans. Strandberg-larsen et al. (2008) explored links between binge drinking, and stillbirth, reporting a statistically significant increase in risk associated with more than three antenatal binge episodes.

Sun et al. (2009) looked at seizure disorders in children whose mothers binged during pregnancy. They reported significantly greater risk of both neonatal seizures (˜3 fold) and epilepsy (1.81 fold) associated with binge drinking between 11 and 16 weeks, but emphasised the exploratory nature of the results, and need for replication. In terms of neurodevelopmental outcomes, Streissguth et al. (1994) found a dose dependent association with scores on timed word, and arithmetic tests in fourteen year olds with a stronger association where bingeing occurred. A review by Henderson et al. (2007) cautiously supports the contention that binge drinking has a neurodevelopmental impact, but found no consistent support for adverse outcomes in pregnancy (e.g. stillbirth, miscarriage, etc.) and note a paucity of studies in the area. Meyer-Leu et al. (2011) considered the neonatal period, finding that both moderate and binge drinking were associated with an increased trend towards neonatal asphyxia. They also noted a large number of contradictory findings and raising methodological concerns about the studies reviewed by Henderson et al.. Barr et al. (2006) contend that binge drinking may also contribute to psychiatric issues in the later life of offspring, although in this case their findings are confined to individuals with FAS, which may in itself be a confounding factor, rather than indicating a directly causative relationship between antenatal binge drinking and subsequent psychiatric disorder in offspring.

Overall, there is a distinct lack of consensus on what, and how extensive, the effects of drinking on the immediate and long term health outcomes are for the child.

2.1.2 Disclosure

The issue of disclosure is central to the model presented here, in particular self-report by women of information that might disadvantage them, or be expected to do so in the immediate term. In general, the consensus is that alcohol self-reports have acceptable validity in the research context (Del Boca and Noll 2000), but do not correspond perfectly to alternative methods. Del Boca and Darkes (2003) claim that the validity is generally accepted, and suggest that the current focus lies on what factors and processes underlie the discrepancies rather than questioning determining their existence. In this instance, the conjecture is that the information is in some way stigmatising; that, following Goffman (1990), disclosure equates to revelation of the mark. This is not immediately contentious, for example Gomberg (1988) identified stigma surrounding alcohol abusing women in particular, an issue also highlighted by Improving Access to Psychological Therapies (IAPT) guidance (Improving Access to Psychological Therapies et al. 2012), as well as a number of other studies relating response effects to perceived negative consequences (Langenbucher and Merrill 2001; Del Boca and Noll 2000; Blair et al. 1977). In the maternity context, Radcliffe (2011) identifies stigma pertaining to substance misusing women amongst staff, and suggests that this may represent a barrier to appropriate treatment; similarly, NICE guidance on pregnancy and complex social factors (National Institute for Health and Clinical Excellence 2010) recognises concern about the attitude of staff as a source of anxiety in pregnant women who misuse substances.

Stigma, or fear of a judgemental response on the part of the practitioner should not however be taken uncritically to explain inaccurate reporting by patients. While recent NICE public health guidance advocates routine alcohol misuse screening as a part of all practice (National Institute for Health and Care Excellence 2010b), there is no specific policy for routine antenatal care beyond providing information on possible impacts of alcohol consumption (National Institute for Health and Care Excellence 2010a). NICE guidance on pregnancy and complex social factors (National Institute for Health and Clinical Excellence 2010) does specifically address women who misuse alcohol, but presupposes knowledge of the problem through medical history, or via other services. Taken in concert with the potential for harm from even moderate alcohol use (section 2.1.1), this suggests that much of the onus is on the patient to volunteer information.

Where screening is used, Kaskutas and Graves (2000) note that the most basic method, i.e. number of standard drinks consumed, can lead to inaccurate estimates of consumption arising from inability to relate the concept of a standard drink, to actual consumption. This is compounded by the impact of memory effects on recall over a number of days (Stockwell et al. 2004), and a lack of consistency in the standard drink measure (Turner 1990). Alternative screening tools, for example AUDIT, and T-ACE are available and have been shown to perform well in identifying problematic levels of drinking (Piccinelli and Tessari 1997; Bradley et al. 1998; Russell 1994; Russell and Martier 1996), although the emphasis in these cases is

on consumption at disordered levels.

Prior et al. (2003) considered a different health arena (mental health problems and GPs), with similar characteristics in terms of concealment of medically relevant information. The central finding in this case is that non-disclosure is not a result of stigma, but of mismatched ontologies surrounding mental illness. Work by Alvik et al. (2005), where the relationship between anonymity and reporting of alcohol consumption by pregnant women was investigated, found no significant relationship, suggesting that a fear of social judgement may not be a dominant factor. This draws an interesting contrast with a study by Alvik et al. (2006), which found that contemporaneous reports of consumption were significantly lower than those postpartum. Logistic regression results suggest that this trend is amplified by a number of factors, including level of alcohol consumption preceding conception, while anxiety about foetal wellbeing during pregnancy was associated with lower retrospective reports. Taken together with (Alvik et al. 2005), these results could be seen as conflicting, but may suggest self-stigmatisation (Watson et al. 2007), or reflect a lack of distinction between anonymity, and confidentiality (Malvin and Moskowitz 1983).

In summation then, there is a consensus that alcohol consumption is generally underreported in the pregnant population, with some support for the idea that concern about social judgement associated with stigmatisation may be a contributing factor. Of particular interest in the wider context of this work, is the relationship between underreporting and consumption, i.e. that heavier drinking is associated with a greater tendency to understate intake.

2.1.3 Practice Implications

Given that alcohol consumption is thought to be underreported some consideration must be given to the implications for midwifery practice, in terms of eliciting more accurate self-reporting. Phillips et al. (2007) present a qualitative account of factors influencing the disclosure of substance misuse to midwives, identifying particularly the need to build up a rapport, potentially over a number of appointments. This was related to continuity of care, seen as necessary by both midwives and women for building up a trust relationship, itself a key component of facilitating disclosure. Stevens and McCourt (2002) looked specifically at the process of transitioning to a caseloading model of care provision in one midwifery practice, reporting that both practitioners and women felt that this offered advantages in terms of long term relationship building. Relationship building was also highlighted by Kennedy et al. (2004) in a narrative investigation of midwifery practice, where the subjects interpreted the midwife-woman dynamic as about mutuality. Kennedy et al. suggest that this arises from a recognition that interactions in this context are about information exchange, with the knowledge base of the woman as significant as that of the midwife, rather than simply a unidirectionally didactic relationship.

Hunter (2006) also focuses on much of midwifery as about relationship building, suggesting that there is an insufficiently recognised emotional labour component to practice. Observation and interview of a number of midwives as they practiced suggested that many midwives effectively took a mother type role to their patients, with implications around the nature of information exchange that was able to take place. The emotional labour component was also reported by Stevens and McCourt, who suggest that this is more evident under a caseloading system, particularly with challenging patients with complex needs. Todd et al. (1998) surveyed midwives working in a hospital environment, as well as those working in the community in a caseloading context, finding that community practice appeared to provide more job satisfaction, but was challenging to implement effectively because of limited resources. Community midwives suggested that larger team sizes, and smaller caseloads would contribute to a better realisation of the model. Farquhar et al. (2000) approached the same question from the perspective of women, also finding that faulty implementation hampered the expected benefits. They found that those cared for under a team scheme, with much higher continuity of care, reported that they had a better relationship with their midwives, but were not more satisfied in general with their care. In contrast, Biró et al. (2003) looked at a randomised control trial (RCT) of team midwifery care versus hospital care in Australia, finding a significantly higher level of satisfaction under the team model, the distinction in this case may lie in the different balance of team size to caseload size.

In terms of the impact of continuity of care on health, rather than experiential outcomes, research is

relatively sparse. Marks et al. (2003) examined the impact of continuity of care on Postnatal Depression (PND), which has similar features to alcohol in that it carries an associated stigma that can act as a barrier to help seeking (Dennis and Chung-Lee 2006). Based on the results of a RCT, they conclude that continuity of care is not protective, in the sense of reducing rates or impacting onset, but was very successful in supporting engagement with treatment. Echoing this, a 2009 Cochrane Review by Hatem et al. (2009) found no significant difference in incidence of PND, but reported benefits in terms of lower rates of episiotomies, anaesthesia, and shorter hospital stays, with higher satisfaction as found by Biró et al.. While research in this area does not specifically pertain to disclosure, the general trend in results are suggestive when taken in concert with studies emphasising the importance of relationship building as key in fostering a disclosure friendly environment. Continuity of care is generally regarded as improving patient experience, and leading to better health outcomes in the wider medical arena (Van Walraven et al. 2010), but is clearly not a cost free endeavour, with particular concern arising from the emotional cost (Todd et al. 1998), and increased rates of 'burnout' in practitioners (Sandall 1997).

2.2 Games, Signals, and Decisions

2.2.1 Signalling Games

Game theory generally deals with strategic decision making in the unusual circumstance of complete information, that is, every player has at least complete knowledge of all possible outcomes, who their opponents are, and so forth. Arguably more generally applicable is the incomplete information scenario, where players lack information about the rules of play in some fashion. Harsanyi (1967) proposed a method for effectively transforming such games into games of complete information by treating the possible variations on the rules as subgames. To determine which subgame is to be played, an additional player - nature - is introduced to make the first move, where nature conducts a lottery according to some probability distribution. If it is assumed that the underlying probability distribution is known to all players, the game is then one of complete information.

Perhaps the best known example of Bayesian games, are the signalling games codified by Kreps and Cho (1987), after initially being framed by Spence (1973) in the context of employment markets. The general form of such a game is that one player holds information known only to them, on the basis of which they send a signal to the other player(s), which the other player(s) then act upon. Much of the interest in signalling games turns on what conditions are necessary for honest signalling to be a Nash equilibrium, or in the context of evolutionary game theory, an Evolutionarily Stable Strategy (ESS) .

One approach to this requires that signalling is a costly exercise, as proposed by Grafen (1990) in examining biological signals (for example, the eye-catching but unwieldy peacock tail). Grafen demonstrated that an earlier suggestion by Zahavi (1975), who proposed that such signals were in effect a handicap demonstrating fitness, would lead to an ESS because of the costly nature of the signalling. This solution is also noted by Spence (1973), who showed that a separating equilibrium exists[1] contingent on signals being more costly for some types.

Costly signalling has been applied to explain a variety of apparently contradictory behaviours, for example Godfray (1991) in the context of offspring soliciting food from parents, where the key question is why a behaviour with potentially very high costs (namely, being eaten) would be preferred to a less risky method. In a social context, costly signalling has been proposed as an explanation for religion in human societies. Sosis (2003) developed a model of religious ritual as an exercise in costly signalling, showing that higher costs to engagement in rituals for skeptics maintains the stability of religious groups and the presumed benefits that membership confers. Henrich (2009) extended this idea, and developed an evolutionary model combining cultural transmission with costly signalling in a population, finding that for even modest costs the system moved towards universal belief. Wildman and Sosis (2011) subsequently extended the model, to address the fact that both stable equilibria are binary states, finding that the incorporation of group differentiation allowed subgroups to persist.

[1] In fact, an infinite number of them.

Signalling games have also been extended to provide models of other observed human behaviour, for example Austen-Smith and Fryer Jr. (2005) attempted to explain the observed poor academic attainment of some social groups by positing a multiple audience signalling game. They found that the introduction of a secondary signalling game with a peer audience, alongside the prototypical Spence model introduced a pooling equilibrium. Subsequent empirical work by Fryer Jr. and Torelli (2010) has provided some support for this idea. Along similar lines, Feltovich et al. (2002) examine an observed failure by high quality types to signal as would be anticipated, introducing the concept of countersignaling in scenarios where there is noisy leakage of type information. They found that where there is added noisy type information available, separating equilibriums exist where high quality senders signal either as low quality, or not at all.

2.2.2 Bayesian Decision Theory and Expected Utility

Decision theory is the theory of rational decision making (Peterson 2009), this contrasts with game theory which is concerned with strategic decision making. In the broadest sense, the field can be divided into two types of theories: normative, and descriptive. Normative theories are those which attempt to give the rational answer to a decision problem, descriptive or behavioural theories focus instead on characterising the process of human decision making. In this instance, the particular concern is with theories of decision making under uncertainty.

Underpinning almost all theories of decision making, and much of economic theory in general is the concept of expected utility, originally proposed by Bernoulli (1954). This casts decisions as choices between lotteries or gambles, with differing payoffs and probabilities.

Under this model, the expected utility of any gamble is a function of the probability of the outcomes, their utility to the gambler, and the gambler's risk aversion. Essentially this is an extension of the expected value criterion, which assumes that the expected value is based only on the probability and objective value of outcomes. By contrast, the utility framing is a subjective measure, allowing differing preferences between gamblers. Von Neumann and Morgenstern (1953) later formalised the theory, defining rational decision as acting to maximise expected utility, where an individual's preferences are shown to fulfil four axioms, namely completeness, transitivity, independence, and continuity. Completeness requires that for any two lotteries A and B, the decision maker prefers one to the other, or is indifferent. Transitivity requires that if A is preferred to B, and B is preferred to C, then A is also preferred to C. Continuity states that given a scenario as in the transitivity axiom, there is some combination of lotteries A and C where the decision maker is indifferent between that combined lottery and B. Finally, independence maintains that if one were to prefer gamble A to B, that preference holds if both are combined with lottery C.

While vastly influential, the expected utility theory has been substantially criticised, generally for failing to predict real behaviour. Allais (1953) attacked the independence axiom in particular, suggesting that in some scenarios people's choices would be inconsistent where expected utility implies otherwise. A number of studies (e.g. (Oliver 2003; Burke et al. 1996)) have since supported the intuition to some extent.

More recently, support for some aspects of the expected utility theory, particularly the concept of utility as a common currency for comparison, has come from neurology, for example following work by Platt and Glimcher (1999), Padoa-Schioppa and Assad (2006, 2008) report neuronal firing corresponding to economic value in decision making tasks undertaken by monkeys, while Christopoulos et al. (2009) found similarly indicative results for risk aversion. The suggestion implicit in the model proposed here, that this also applies to social judgements, is less investigated, although both Watson and Platt (2012), and Willis et al. (2010) found that lesions in the brain area[2] identified by Padoa-Schioppa and Assad lead to abnormal social judgements in humans and primates.

Bayesian decision theory, as expounded by Robbins (1964) applies Bayesian inference to the process of decision making under some degree of uncertainty, on the basis that the decision is a repeated one. The central idea is relatively straightforward, and assumes that the loss or gain of some action to resolve a decision is contingent on an unknown parameter. To solve the problem, the decision maker chooses whichever action will minimise the risk, where the risk of an action is $\sum_i \lambda(a_j|w_i)P(w_i|x)$, i.e. the loss incurred for taking

[2]The orbitofrontal cortex.

action a_j given that the true state of the world is w_i, multiplied by the belief that this is the true state of world given evidence x, summed across all possible worlds. Essentially this is identical with expected value, with Bayesian style probabilities. This allows an additional process of inference to progressively update the distribution from which $P(w_i|x)$ derives, as new evidence is obtained after each decision.

This approach has been used in a wide variety of scenarios, for example McNamara and Houston (1980) have applied statistical decision theory as a framework for understanding animal learning[3], while Harsanyi (1978) has derived an ethical framework from the principles. Less controversially, in contexts where optimality is desirable as an outcome, Dorazio and Johnson (2003) have used Bayesian decision methods in combination with Markov chain monte carlo methods (MCMC) to solve complex waterfowl habitat management problems, and Kristensen (1997) has developed robots which utilise Bayesian decision analysis to plan sensor operations.

As with standard expected utility, the Bayesian approach can be criticised, in this case on the grounds of plausibility. The question of plausibility arises from the suggestion that Bayesian inference is in some way a model of human inductive reasoning, as argued by some branches of cognitive science. For example, Tenenbaum et al. argue for the Bayesian approach as a top-down model of inductive reasoning in humans (Tenenbaum et al. 2006; Griffiths et al. 2010), a general approach criticised by Bowers and Davis (2012) as unfalsifiable, overcomplicated, and relying on an unrealistic conceptualisation of the brain as optimal. Miller (2012) also applied similar criticism to claims by Gallistel (2012) that Bayesian inference better characterises learning as opposed to associative conditioning type models, suggesting that this relies on an assumption of optimality which is unfounded.

2.2.3 Descriptive Decision Theory

Arguably the most significant criticism of theories of decision making, is their failure to correspond to empirically observed decision making [4]. This was probably first raised by Simon (1956), who proposed that the apparent divergence derived from a tendency to satisfice, rather than optimise. This suggestion rests on the not unreasonable assumption that people do not have unlimited cognitive capacity (i.e. bounded rationality (Simon 2000)), and hence use heuristic means to make decisions, namely by choosing the first 'good enough' option. Simon suggests that this process nevertheless leads to the optimal solution is most cases.

Subsequent work on descriptive theories largely follows the same framework in assuming that in reality, human decision making is a heuristic process. Tversky and Kahneman (1974) developed three heuristics to explain observed systematic errors in reasoning - representativeness, availability, and anchoring. Representativeness suggests that when asked to judge how related one object or event is to another, they do this based on the extent to which they resemble one another - crucially they will ignore additional, better information when available. Availability claims that when tasked with estimating probabilities, people will rely on the ease with which they can call examples to mind (note that this might be considered an example of satisficing). Finally, anchoring proposes that when estimating, people start with some initial value and progressively update from there, i.e. they will tend to overweight prior evidence at the expense of new information.

Subsequently, Kahneman and Tversky (1984); Tversky and Kahneman (1986) also identified framing effects, which imply that the decisions people make are impacted by the fashion in which the problem is presented. The essential outcome from these findings is that people are risk seeking when faced with outcomes framed as losses, but risk averse towards gains, and regard any loss as greater than an equivalent gain. The impact of framing in itself has been shown to be significant, for example Toll et al. (2007) found improved abstinence rates in smoking cessation where quitting was framed as a gain, and NICE recommend considering the framing of treatment outcomes when presenting options to patients (National Institute for Health and Care Excellence 2007).

[3] Although they note that this is in the sense of how animals 'should' learn, rather than how they do learn

[4] This critique is not unique to decision theory, and has also been levelled at game theory (e.g. Fehr and Fischbacher (2003) on the irrational altruism of humans playing the prisoners' dilemma).

Prospect Theory (PT) (Kahneman and Tversky 1979) attempts to provide a decision rule accounting for the heuristic nature of decision making and incorporate framing effects, which successfully explains many perceived failures of rationality. A revised version, CPT (Tversky and Kahneman 1992) addressing a violation of first order stochastic dominance possible under the original formulation, extends the theory to allow decisions with more than two options, but sacrifices the editing phase. Camerer (2004) reviews a number of successes in explaining apparent anomalies with CPT, and argues that should replace expected utility in general usage. Thaler (2000) regards the theory as promising, but points out that it is in many ways incomplete, citing the lack of explanation as to how people construct frames as an example of this.

A significant weakness of CPT as a general theory of decision making is that it fails to account for behaviour under intertemporal choice, or rather does not attempt to address it. Generally, intertemporal choice is assumed to be underpinned by the Discounted Utility (DU) model of Samuelson (1937), which proposes that the value of a thing right now is greater than the value of it at some point in the future (jam today has more utility than jam tomorrow), following an exponential relationship. A more nuanced view of this has been proposed by Ainslie (1991), suggesting that the relationship is hyperbolic rather than exponential. Both models however fail to explain several inconsistencies, for example Thaler (1981) found that discounting rates were different between gains and losses. Loewenstein and Prelec (1992) report a number of additional inconsistencies that are not adequately resolved by DU models, and propose an alternative along the lines of CPT to resolve them while retaining the capabilities of Kahneman and Tversky's model in immediate term choices.

3 Model

3.1 Disclosure Game

3.2 Agent Models

3.3 Model Implementation

4 Method

4.1 Qualitative Trends

4.2 Global Sensitivity Analysis

5 Results

6 Discussion and Conclusions

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