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The effects of behavioral and outcome feedback on prudent decision-making under conditions of present and future uncertainty

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Abstract

One of the largest reasons decision-makers make bad decisions (act imprudently) is that the world is full of uncertainty, we feel uncertain about the consequences of our actions. Participants played a repeated game in which decisions were made under various types of uncertainty (either no uncertainty, uncertainty about the present consequences of behaviors, uncertainty about the future consequences of behavior, or both types of uncertainty). The game required prudent decision making for success. While playing the game one of three types of feedback was placed between trials, either no feedback, behavioral feedback, or behavioral plus outcome feedback. Prudent decision-making decreased when both types of uncertainty were added. Further, the addition of feedback increased prudent decision-making when future uncertainty was present. The increase in prudent decisions appears to be from feedback's ability to allow us to create probabilities associated with behaviors and their consequences, implying that anything that reduces the uncertainty people feel in a world full of uncertainty will increase their ability to make prudent decisions.

Keywords: uncertainty, decision-making, feedback, prudence, human experimentation

1 Introduction

Nearly every imprudent behavior (unhealthy, risky or dangerous), such as drug use, unprotected sex, smoking or gambling can be thought of as the result of an inability to properly weigh future consequences against current pleasures (Rachlin, 1997). Usually, these types of behaviors lead to pleasure today at the expense of pain tomorrow. As long as these imprudent behaviors are chosen only occasionally, they probably will not interfere with our ability to function as productive members of society. However, at some point these poor choices can come to dominate a person's life and lead to negative long-term consequences. Prudent decision-making can be thought of as decision-making driven by long-term consequences rather than immediate outcomes.

The consequences of our decisions can fall on others or they can fall to ourselves. In decisions involving social interactions, the consequences of my good or bad behavior are felt by others. If I am rude, others will suffer. If I am considerate, others will benefit. In decisions involving self-interactions, the consequences of my good or bad behavior are felt by myself. If I, in the present, choose to save or spend money today, my future self is the beneficiary or victim of a larger or smaller savings account. Brown and Rachlin (1999) showed that these two decision-making situations are treated similarly by the individual. Our social interactions can be thought of as a competition between us and them; our self-interactions can be thought of as a competition between our present-self and our future-self (see also Rachlin, Brown, & Baker, 2001).

In a single-player iterated decision making situation, a player's present self (trial N) is in competition with the player's future self (trial $N + 1$). One type of game in which this competition with the self is studied is prisoner's dilemma games in which a human player plays against a dummy opponent that is programmed to play the game using a tit-for-tat strategy (the dummy player's choices mirror the human player's choices). In these single player prisoner's dilemma games a conflict exists between maximization of local and global reinforcement (Yi & Rachlin, 2004). Choices which maximally benefit the present self often harm the future self (imprudent options) and choices which maximally benefit the future self are usually undesirable to the present self (prudent options). Even though both "players" are the same person, it may be difficult for individuals to make effective choices here because both the present and future consequences of decisions are rarely set in stone. The college student which forgoes the party in favor of studying will usually receive less utility during the night of studying than they could have received from the party, but usually will maximize long-term utility in the form of better grades and etc. If a player chooses selfishly (imprudently) on trial N, he or she will usually benefit on trial

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N, the consequences of the imprudent behavior from trial *N* (if indeed there are any) are not felt until trial *N* + 1. Similarly, if a player chooses wisely (prudently) on trial *N*, he or she will usually suffer on trial *N*, any possible benefits for the prudent behavior on trial *N* will not be felt until trial *N* + 1. (Brown & Rachlin, 1999; Green, Price & Hamburger, 1995). It may be argued however, that a game such as this is not a game of self-control but rather an issue of cognitive impulsiveness, an overwhelming of the individual by the immediate consequences such that long-term consequences are never seen or considered (Herrnstein, Loewenstein, Prelec, & Vaughn, 1993).

The uncertainty of the situation helps to determine our behavior in social-interactions: We will be "nice" to others in a social-interaction only if we feel that others will be "nice" back (Baker & Rachlin, 2001; Chaudhuri, Sopher, & Strand, 2002; Rachlin, Brown, & Baker, 2001). That is, if we feel there is an uncertainty about whether the other person in a social-interaction will reciprocate our kindness, we will not be kind to begin with. The same rule of uncertainty also controls our self-behaviors (Brown & Lovett, 2001). It is as if the presence of uncertainty provides justification (or possibly an excuse) for imprudent behavior (Schweitzer & Hsee, 2002).

In most self-interactions we must choose between long-term and prudent decisions (larger rewards in the long-run, but smaller rewards at the moment) and short-term and imprudent decisions (larger rewards at the present moment, but smaller rewards in the long-run); however, there is bound to be uncertainty on the part of the decision maker. The uncertainty in this type of decision-making generally fits the following pattern: short-term outcomes are often somewhat predictable (though not always), but long-term outcomes are usually less predictable. For a smoker contemplating quitting, there is a general level of understanding of the consequences of not smoking today (i.e., withdrawal symptoms, but the severity is unknown). However, the consequences of quitting smoking in the long-run are very uncertain (maybe they will experience better health, maybe not). In an experiment by Bendor, Kramer and Stout (1991), computers were programmed to play against each other in a prisoner's dilemma game. Each computer was programmed with various strategies for play. Levels of cooperation were quite high when playing against a tit-for-tat opponent and when random uncertainty (noise) was added to the tit-for-tat strategy, cooperation by the opponent decreased dramatically. In real life, this type of uncertainty of consequences may also be responsible for decreased levels of prudent decision-making. If this uncertainty (which is inherent in the real world) could be reduced then the number of prudent decisions people make should increase.

When faced with an uncertain world, people must calculate some mental probabilities about the consequences of possible actions. In order to properly assess the future consequences of behavior, decision-makers should ideally look to the past. That is, decision makers should ultimately ask themselves, in the past, when in a similar situation, how many times did I choose option A and how many times did I choose option B and further, what were the outcomes when I did choose A and when I did choose B. Obviously, decision-makers do not do this for a variety of reasons including the amount of (cognitive) effort involved and the fact that their memories are less than perfect. In cases of uncertainty, a decision-maker may operate using some average values which describe the range of possible probabilities involved. Given this possibility, however, if people's memories could be stimulated (through feedback about past actions and consequences), then their ability to estimate probabilities for future choices should improve and thus their prudent decision-making should increase (Harvey & Fischer, 2005; Schweitzer & Hsee, 2002).

I hypothesize that the addition of both Present-Uncertainty and Future- Uncertainty will decrease participants' ability to exhibit prudent decision-making (make correct choices). I also hypothesize that feedback about our past behaviors and the consequences of these behaviors will leave us better able to understand the uncertainty inherent in the decision-making process and thus increase our ability to exhibit prudent decisions (make the right choices). In this experiment, people were asked to make 200 two-option choices in a computer game designed to measure prudent decision-making. The present and future consequences of decisions were made either certain or uncertain by modifying probabilities of outcomes of different aspects of the game. Additionally, following each choice, people were either given No Feedback, feedback about their past behaviors (Behavioral Feedback), or feedback about their past behaviors and the outcomes of those behaviors (Behavioral/Outcome Feedback). These manipulations created a 2 X 2 X 3 (Present-Uncertainty X Future-Uncertainty X Feedback) design. I hypothesize that both Present-Uncertainty and Future-Uncertainty built into the game will decrease people's ability to exhibit prudent decision-making compared to a control condition with no uncertainty (perfect predictability) since increasing uncertainty seems to lead to decreased prudent decision-making in real life situations[1]. I also hypothesize an interaction between Present-Uncertainty and Future-Uncertainty such that the addition of both Present/Future-Uncertainty will decrease

[1] Though uncertainty is being treated as an isolated issue in this paper, it must be noted that uncertainty in this type of decision making process will be a moderator of the predictions that would be made solely using time discounting functions (Frederick, Loewenstein, & O'Donoghue, 2002).

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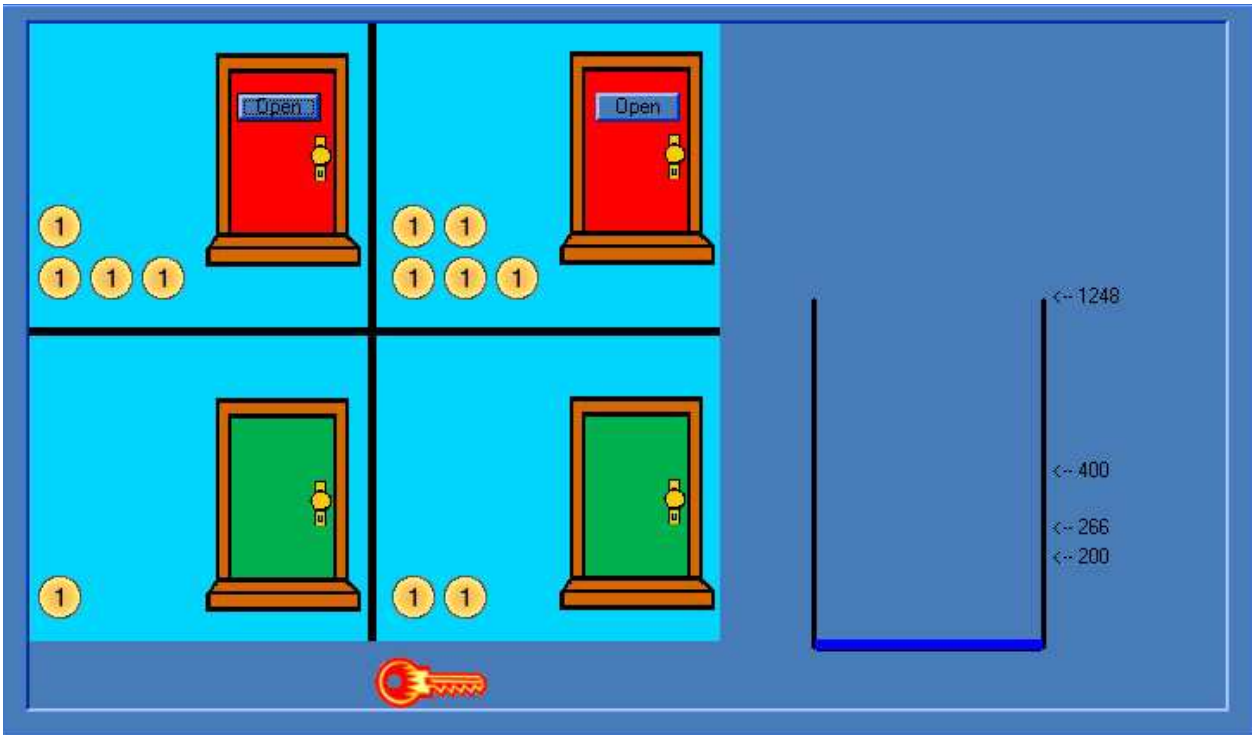

Figure 1: A single player choice game with short-term and long-term consequences. In this game, the top doors are red and the bottom doors are green.

prudent decision-making further than either type of uncertainty alone. Further, I hypothesize that as the amount of feedback increases (No Feedback, Behavioral Feedback, Behavioral/Outcome Feedback) people's ability to exhibit prudent decisions will also rise due to feedback's ability to remind people about past behaviors and/or consequences, thus helping them to better understand probability.

2 Method

2.1 Participants

Three-hundred undergraduate volunteers (166 females and 134 males) from an undergraduate participant pool at Missouri State University participated in this experiment. All participants were treated in accordance with the ethical standards of the American Psychological Association.

2.2 Apparatus and procedure

Participants made decisions between the options in a game containing short-term and long term consequences by pressing buttons on the screens using a standard two-button mouse. The computer game was written using Microsoft Visual Basic.

Prior to experimentation, informed consent was given and all responses were kept fully confidential. Participants were first asked a series of demographic questions and a series of questions designed to assess behavioral self-control (ability to make prudent decisions in the real world) from external sources (including things such as smoking and alcohol consumption behavior). It was through the use of these types of questions that the procedure to be described was validated in earlier research. At the conclusion of the game participants were asked to estimate the probabilities of various aspects of the game (keys and points to be described).

General Rules of the Game. During the main portion of the experiment, participants played a computer game which was designed to simulate the decisions containing short-term and long-term consequences we make every day and was similar to a single player prisoner's dilemma game played against a dummy player using a tit-for-tat strategy (Bendor, Kramer & Stout, 1991). Participants were asked to make a series of decisions involving keys and doors on the game board shown in Figure 1. The rules of the game shown are quite simple.

1. Participants are given a red key to begin the game.

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2. Red keys open red doors and green keys open green doors (the top two doors are red, the bottom two doors are green).
3. When a door is opened, the key which was used is given up.
4. When a door is opened, the participant may receive the points shown and he/she will receive a new key (red or green).
5. The game will be reset and more choices will be made using the new key received (the game will be played many times).
6. The goal is to make as many points as possible.

If the participant possesses the red key, he/she can choose between 4 points and 5 points. If the participant possesses a green key, he/she can choose between 1 point and 2 points. Using this basic paradigm, four different versions were created (Control, Present-Uncertain, Future-Uncertain, and Present/Future-Uncertain). Each participant saw only one of these versions.

Control Version. In the control version of this game, behavior was deterministic. That is, choice for the smaller option (1 or 4) always yielded a red key which could be used on the next trial, and choice for the larger option (2 or 5) always yielded a green key. These new keys appeared only after participants had made a choice using the old key. On every individual trial, it was better to choose the larger points (better short-term consequences), but it was MUCH better in the long-run to have red keys which could only be obtained by choosing the smaller points (better long-term consequences). These two goals are not compatible. The solution to this game is quite simple: Always choose the red door with the smaller number of points, always receive 4 points (which is pretty good!) and always receive a red key (which is very good). Successful participants must bypass the temptation of short-term consequences during every single trial. Prudent decision-making is measured in this game as the percent of trials (there are 200 total) in which participants choose the left-side doors (both have the smaller present points, but yield the red key).

Present-Uncertain and Future-Uncertain Versions. In the control version of the game, from 1 to 5 points was received after every choice (present or short-term consequences) and red keys were given for every left side choice and green keys were given for every right side choice (future or long-term consequences). In order to make a Present-Uncertain version, the points were made uncertain (not always received). In order to make a Future-Uncertain version, the keys were made uncertain (not always the same color for the same choice). The computer program had correction factors built into the probability generating mechanism such that the obtained probabilities reflected programmed probabilities both locally (extreme strings were eliminated) and globally (obtained probabilities were kept within 5% of the programmed probabilities).

As described earlier, upon choosing the top left door in the control version of the game participants always received 4 points (5 points after choosing top right, 1 point after bottom left, 2 points bottom right). In the Present-Uncertain version of the game, 5 points were showing in each of the left boxes and 7 points were showing in each of the right boxes. Upon choosing the top left door in the Present-Uncertain version, there was an 80% chance that the player would receive the 5 points and a 20% chance that a message would appear which read, "Sorry, you do not receive any points this time". This led to an average payout of 4 points (5 *.80) for each top left choice. Upon choosing the top right door in the Present-Uncertain version, there was a 71.43% chance that the player would receive the 7 points and a 28.57% chance that the sorry message would appear (average 5 points). Upon choosing the bottom left door there was a 20% chance that the player would receive the 5 points (average 1 point). Upon choosing the bottom right door there was a 28.57% chance that the player would receive the 7 points (average 2 points). The average payouts were exactly the same as the control version (that is, the expected value of each of the choices was held constant between the Control and Uncertain-Present version).

As described already, the participant did not know which key would be received until *after* a choice had been made. When opening a door on the left side, participants playing the Future-Uncertain version received the red key 75% of the time (and therefore, a green key 25% of the time). The probability of receiving a green key after choosing a door on the right side was also 75% (with a 25% chance of receiving a red key). This manipulation of keys led to expected values in the Control and Future-Uncertain groups which were not constant.

Adding Feedback. Following each trial, a text box appeared on the screen. This text box contained different things for each of the feedback conditions. For the No Feedback versions of the game, the text box simply contained the words, "Click OK to continue" and 1 s later, a button appeared which would present the next trial. For the Behavioral Feedback version, the text box contained the following "You picked the Top Left/Top Right/Bottom Left/Bottom Right door X times". This line only contained the door just chosen and X was replaced with the number of times the door had been chosen up to that point in the experiment. This text was again followed 1 s later by a button which, when clicked, presented the next trial. For the Behavioral/Outcome Feedback version, the text box contained the same words as

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the Behavioral Feedback, but also contained the following ". . . .and received the red key X times and the green key Y times". Again, this was followed 1 s later by a button which continued the game. Participants received only one type of feedback throughout the game.

3 Results and discussion

3.1 Control group and basic comparisons

Control Group. Overall, the control group (No-Uncertainty and No-Feedback) exhibited prudent decision-making (control by long-term rather than immediate consequences) by choosing doors on the left side of the game on nearly every trial ($M = 94.7\%$). This prudent decision-making increased as the game progressed ($M = 85.6\%$ during trials 1–50; $M = 96.4\%$ during trials 51-100; $M = 98\%$ during trials 101–150; and $M = 98.8$trials 151–200). As can be seen, with no uncertainty and no feedback, the game is quite easy for participants to "solve", that is, participants are driven by long-term consequences quite readily in the face of a perfectly predictable situation.[2]

Basic Comparisons with No Feedback. A one-way between subjects ANOVA run on participants in the four different conditions, testing only those participants who received No Feedback, revealed that these groups significantly differed, $F(3, 96) = 165.67$, $p < .001$, $MS = 1.49$. A priori contrasts revealed that the No-Uncertainty group (94.7%) exhibited significantly higher levels of prudent decision-making than the Present-Uncertainty group (48.2%), $t(96) = 14.98$, $p < .001$, or the Future-Uncertainty group (55.1%), $t(96) = 17.55$, $p < .001$. Additionally, the Present/Future-Uncertainty group (40.5%) exhibited significantly lower levels of prudent decision-making than the average of the Present-Uncertainty and Future-Uncertainty groups, $t(96) = -4.81$, $p < .001$. These findings support the basic predictions that the addition of present or future uncertainty will decrease prudent decision-making and that the addition of both types of uncertainty will decrease prudent decision making even further.

[2] The correlation between participants' reported ACT (American College Test) composite score and overall performance in the game was not significant, $r(25) = .304$. Also, the correlation between performance on the game and scores from a survey designed to assess impulsiveness was not significant, $r(25) = -.291$. These two findings, though not significant, suggest that, though the game is one which relies on past academic success, it clearly also is a measure of impulsiveness. However, as the correlation between the measure of impulsiveness and ACT composite score indicates impulsiveness and past academic success would seem to go hand in hand ($r(25) = -.424$, $p < .05$).

Table 1: Results from 2 X 2 X 3 (Present-Uncertainty X Future-Uncertainty X Feedback) Omnibus ANOVA

	Statistic			
Source	*df*	*MS*	*F*	*p*
Uncertain Present (UP)	1	5.271	554.95	.000
Uncertain Future (UF)	1	2.614	275.25	.000
Feedback (F)	2	0.203	21.38	.000
UP X UF	1	0.698	73.53	.000
UP X F	2	0.038	3.97	.020
UF X F	2	0.054	5.65	.004
UP X UF X F	2	0.090	9.46	.000
Error	288	0.009		

3.2 Experimental groups

A 2 X 2 X 3 (Present-Uncertainty X Future-Uncertainty X Feedback) between-subjects analysis of variance on the amount of prudent decisions exhibited by the participants in the game was performed. As can be seen in Table 1, every effect was significant, most notably the interaction of Present-Uncertainty X Future-Uncertainty, $F(1, 288) = 73.53$, $p < .001$. Because of this interaction, separate analyses were performed for each combination of present and future uncertainty (No-Uncertainty, Present-Uncertainty, Future-Uncertainty, and Present/Future-Uncertainty). A summary of the findings of these analyses can be seen in Figure 2 which displays prudent decision-making during the final Fifty-trial block of the experiment.

No-Uncertainty Groups. As can be seen in Figure 3, at least initially, the addition of Behavioral Feedback and Behavioral/Outcome Feedback actually hurt these participants' ability to exhibit prudent decisions (perhaps the task was so easy that the feedback confused them). However, these initial differences seen during the first and second fifty trials virtually disappeared as the experiment progressed. A 3 X 4 (Feedback X Fifty-Trial Block) mixed-factor analysis of variance was performed on the proportion of the responses which were made on the left side of the game board (prudent decision) for the groups with No-Uncertainty (see Table 2).

One-way analyses of variance were performed on the mistakes that participants made in estimating the key and point outcomes. Mistakes in estimation for points were measured by the absolute difference between the actual percent of times the points were received from a door and the estimated percent of time points were received from a door was calculated for each of the four doors separately. These differences were simply averaged together to create a measure of error in predicting points. A mea-

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Table 2: Results from 3 X 4 (feedback x fifty-trial block) ANOVA's.

	Statistic			
Source	*df*	*MS*	*F*	*p*
No Uncertainty				
Feedback	2	0.038	3.94	.023
Fifty-Trial Block	3	0.606	138.90	.000
Feedback X Fifty-Trial Block	6	0.017	4.01	.001
Error (Fifty)	216	0.004		
Error (Feedback)	72	0.010		
Present-Uncertainty				
Feedback	2	0.138	2.75	.070
Fifty-Trial Block	3	0.234	17.23	.000
Feedback X Fifty-Trial Block	6	0.014	1.00	.425
Error (Fifty)	216	0.014		
Error (Feedback)	72	0.050		
Future-Uncertainty				
Feedback	2	0.657	10.71	.000
Fifty-Trial Block	3	0.824	38.34	.000
Feedback X Fifty-Trial Block	6	0.028	1.32	.251
Error (Fifty)	216	0.022		
Error (Feedback)	72	0.061		
Present/Future-Uncertainty				
Feedback	2	0.240	12.68	.000
Fifty-Trial Block	3	0.016	1.72	.164
Feedback X Fifty-Trial Block	6	0.026	2.72	.014
Error (Fifty)	216	0.009		
Error (Feedback)	72	0.019		

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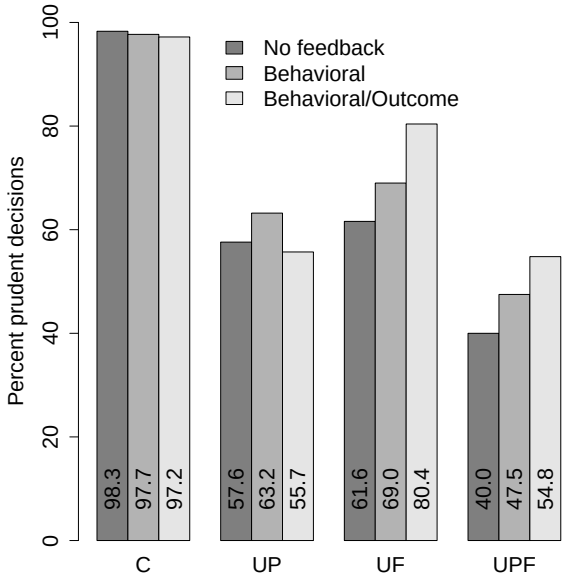

Figure 2: Prudent decision-making exhibited by the Control (C), Uncertain-Present (UP), Uncertain-Future (UF), and Uncertain-Present/Future (UPF) groups during the final Fifty-trial block of the experiment. Numbers shown are the means.

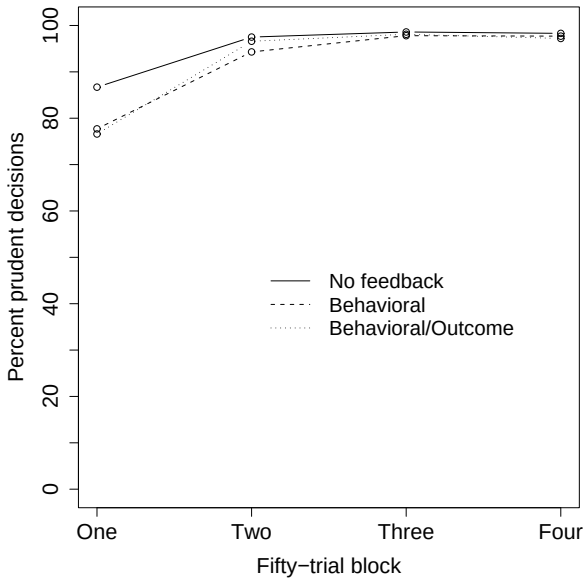

Figure 3: Prudent decision-making exhibited by the No-Uncertainty groups across Fifty-Trial Blocks of the experiment.

sure of error in predicting keys was calculated in a similar manner. There was no difference in errors in estimating points between the different feedback groups. Similarly, there was no difference in errors estimating keys between the different feedback groups. This lack of findings is not particularly surprising or enlightening since the majority of participants in the No-Uncertainty groups were perfectly accurate in estimating both keys and doors (they were all at unity for these groups).

Present-Uncertainty Groups. As can be seen in Figure 4, there is a general rise in prudent decision-making throughout the experiment for all groups. Behavioral Feedback is generally higher than No Feedback which is generally higher than Behavioral/Outcome Feedback. A 3 X 4 (Feedback X Fifty-Trial Block) mixed-factor analysis of variance was performed on the proportion of the responses which were made on the left side of the game board (prudent decisions) for the groups with Present-Uncertainty (see Table 2). The overall number of prudent decisions made by people receiving No Feedback (48.2%), Behavioral Feedback (55.7%), and Behavioral/Outcome Feedback (51.8%) did not significantly differ. The number of prudent decisions across the Fifty-Trial Blocks of the experiment (45.3%, 50.6%, 52.8%, 58.8%) significantly differed. A trend analysis revealed a significant linear trend, $F(1,\ 72) = 32.07$, $p < .001$. Though it appears as though neither type of feedback is enough to increase prudent decisions when the short-term consequences of our actions are uncertain (Present-Uncertain), considerable experience (by the final Fifty-Trial Block) can increase prudent decision-making.

One-way analyses of variance were performed on the mistakes that participants made in estimating the key and point outcomes. There was no difference in errors in estimating points or keys between the different feedback groups. This finding is somewhat expected given the results from the prudent decision making described above (namely that feedback did not seem to effect prudent decision-making for the Present-Uncertainty groups). The addition of feedback did not seem to benefit the participants' understanding of the contingencies present.

Future-Uncertainty Groups. As shown in Figure 5, the number of prudent decisions rose for all groups as the experiment progressed. Also, it can be seen that, other than the first block, the order of the feedback groups from least to most prudent decisions is No Feedback, Behavioral Feedback, Behavioral/Outcome Feedback. A 3 X 4 (Feedback X Fifty-Trial Block) mixed-factor analysis of variance was performed on the proportion of the responses which were made on the left side of the game board (prudent decisions) for the groups with Future-Uncertainty (see Table 2). The overall number of prudent decisions made by people receiving No Feed-

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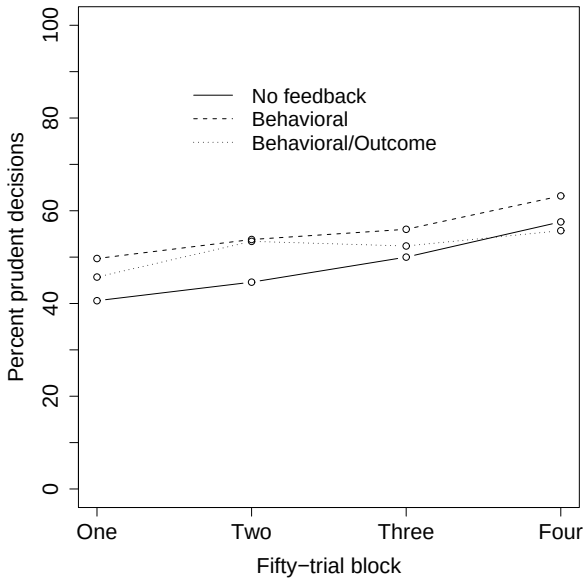

Figure 4: Prudent decision-making exhibited by the Present-Uncertainty groups across Fifty-Trial Blocks of the experiment.

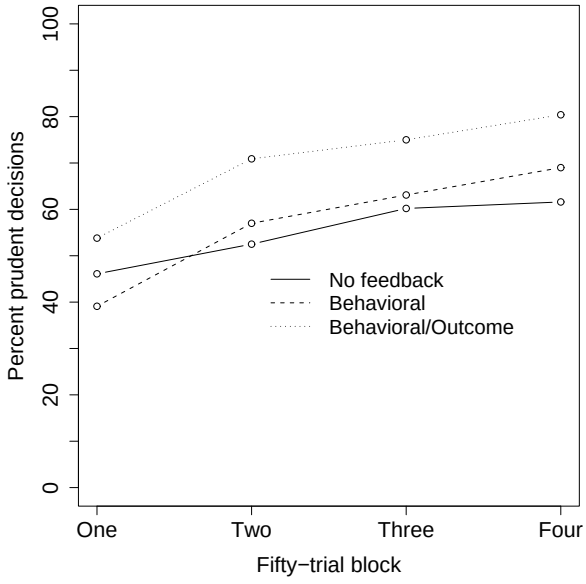

Figure 5: Prudent decision-making exhibited by the Future-Uncertainty groups across Fifty-Trial Blocks of the experiment.

back (55.1%), Behavioral Feedback (57.1%), and Behavioral/Outcome Feedback (70.0%) significantly differed.

A priori contrasts revealed that the addition of Behavioral/Outcome Feedback significantly increased prudent decision-making over No Feedback or Behavioral Feedback, but Behavioral Feedback did not significantly increase prudent decision-making over No Feedback. The number of prudent decisions across the Fifty-Trial blocks of the experiment (46.3%, 60.1%, 66.1%, 70.3%) significantly differed. A trend analysis revealed a significant linear trend, $F(1,\ 72) = 61.71$, $p < .001$. It appears that when the long-term consequences of our actions are uncertain (Future-Uncertain) two conclusions can be drawn. First, we can definitely benefit (prudent decisions increase) from experience and second, feedback must include both past behaviors and outcomes in order to be effective.

One-way analyses of variance were performed on the mistakes that participants made in estimating the key and point outcomes. As expected, there was no significant difference in point errors based on type of feedback. However, the No Feedback (15.1%) and Behavioral Feedback (16.7%) groups made significantly more mistakes in estimating the keys than the Behavioral/Outcome Feedback group (9.6%), $F(2,\ 72) = 4.78$, $p < .05$. The addition of Behavioral/Outcome Feedback seemed to benefit prudent decision making (described in previous paragraph) by increasing participants' understanding of the contingencies present.

Present/Future-Uncertainty Groups. As can be seen in Figure 6, there is virtually no change in prudent decisions across the experiment for either the No Feedback or Behavioral Feedback groups, but there is a rise for the Behavioral/Outcome Feedback group. A 3 X 4 (Feedback X Fifty-Trial Block) mixed-factor analysis of variance was performed on the proportion of the responses which were made on the left side of the game board (prudent decisions) for the groups with Present/Future-Uncertainty (see Table 2). A significant Feedback X Fifty-Trial Block interaction was revealed. When the world is very difficult to predict (Present/Future-Uncertain) prudent decision-making does not seem to rise with experience as had been true in every other group (the No Feedback group's prudent decisions were flat across the experiment). In order to benefit from experience in this case, the experience must include feedback about past behaviors and outcomes (explicit reminders of what's been happening).

One-way analyses of variance were performed on the mistakes that participants made in estimating the key and point outcomes. The No Feedback (22.3%) and Behavioral Feedback (20.3%) groups both made significantly more mistakes in estimating the points than the Behavioral/Outcome Feedback group (15.9%), $F(2,\ 72) = 3.23$, $p < .05$. There was no significant difference in key

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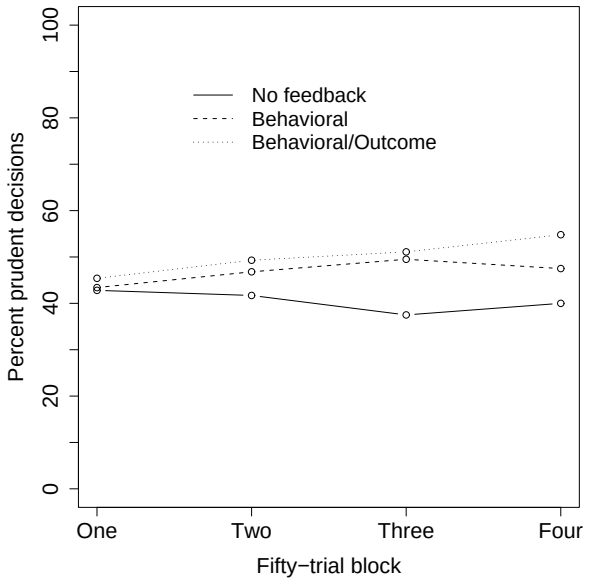

Figure 6: Prudent decision-making exhibited by the Present/Future-Uncertainty groups across Fifty-Trial Blocks of the experiment.

errors based on type of feedback. The addition of Behavioral/Outcome Feedback again seemed to benefit prudent decision making (described in previous paragraph) by increasing participants' understanding of the contingencies present (but this time it is an understanding about the points).

4 General discussion

Except in the Present/Future-Uncertainty with No-Feedback group, there seemed to be a general amount of learning involved in the game. That is, the more opportunities we have to make decisions with both long-term and short-term consequences, the better we become at making them. This general improvement with practice mirrors that seen in real life with age. It seems that as a general statement, when the world contains uncertainty, feedback increases prudent decision-making. The addition of both types of uncertainty decreased prudent decision-making further. Behavioral/Outcome Feedback led to improvements in the participants' ability to predict the uncertainty in the game (contingencies) in several cases and thus increased prudent decision-making.

As predicted, the addition of both present and future uncertainty decreased prudent decision-making with the addition of both types of uncertainty decreasing prudent decision-making even further[3]. Also as predicted, the addition of feedback led to increased levels of prudent decision-making. Contrary to predictions however, the feedback relationship was quite complicated. When there was No-Uncertainty, feedback led to decreased levels of prudent decisions and feedback had its strongest effect when the future was uncertain. When there was No-Uncertainty, perhaps the addition of feedback simply leads to confusion, an otherwise simple problem appears complicated. When the future is uncertain, then it seems as though Behavioral/Outcome Feedback is required before an improvement in prudent decision-making is seen. This outcome seems sensible when one considers the role feedback seems to play in allowing us to accurately keep track of probabilities, thus decrease uncertainty. In order to accurately assess probability, one must not only know past behaviors (the denominator of the probability ratio), but also the outcomes (the numerator).

If the results from this experiment can be generalized, they would imply that people who feel that the consequences of their actions are unpredictable are less likely to make decisions driven by long-term consequences (prudent decisions). Further, if this feeling of uncertainty can be reduced (through feedback) by increasing awareness of the contingencies which operate in the world, then prudent decision-making should increase. This seems to be particularly true when the future is uncertain (it might be argued that the creation of Future-Uncertainty in the present experiment is confounded with average payoff for prudent decision-making). Perhaps people living in poverty look around them and see people working hard, yet barely managing to make it from day to day (that is, the payoffs of prudent behavior are small and hard to detect due to the uncertainty between present behaviors and long-term consequences). They come to believe that the long-term consequences of hard work (a prudent choice) are unpredictable at best, or perhaps even negative. Anything we can do to show people that though the world is uncertain, it is definitely not unpredictable ought to increase their prudent behaviors (or decrease imprudent behaviors as the case may be).

The question for future research then becomes, what else can we do to convince people that uncertain does not equal unpredictable (probabilistic does not equal random)? Giving feedback about our own past behaviors and the consequences can be difficult in many real world situations. For the smoker, the long-term consequences of smoking can not be calculated by looking to their own past. Can feedback about others' behaviors also serve to change our own behaviors and what are the limitations of this influence?

[3] It should be recalled that expected value remained constant from the Control to the Present-Uncertainty condition. However, when changing from the Control to the Future-Uncertainty condition, expected values changed and this change may be responsible for findings.

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