Article

Cost Discrepancy, Signaling, and Risk Taking

Jim Lemon

Abstract: *If risk taking is in some measure a signal to others by the person taking risks, the model of "costly signaling" predicts that the more the apparent cost of the risk to others exceeds the perceived cost of the risk to the risk taker, the more attractive that risk will be as a signal. One hundred and twelve visitors to youth "drop-in" centers estimated the costs ("dangers") of four behaviors as presented to them and the costs that they perceived for themselves. The four behaviors were chosen to plausibly signal different characteristics about the risk taker and also to have different magnitudes and probabilities of cost. Cost discrepancy, the excess of presented over perceived risk, was associated with intention to smoke in females. It is concluded that costly signaling seems to operate in behaviors with low magnitudes but high probabilities of cost. Other behaviors with this risk profile may also be associated with costly signaling.*

The propensity to take risks in adolescence is widely recognized as a major factor contributing to health liabilities, some of which may have lifelong consequences. Additionally, risk-taking behavior is a frequent source of conflict between adolescents and those responsible for their development and well being (Crockett & Peterson, 1993). A variety of health promotion programs aimed at reducing adolescent risk-taking behavior have been conducted, often with little effect (Fromme & Brown, 2000). The emphasis in many of these programs has been upon dramatic consequences (e.g., serious injury or death) of such risks. Although these consequences may occur and are of serious concern to the guardians of adolescents, they may be less significant to the adolescents themselves. Limited experience (Halpern-Felsher et al., 2001; Weinstein, 1989), a tendency to underestimate the probability of occurrence of negative events (Taylor & Brown, 1988) and perhaps even failing to consider the costs (Halpern-Felsher & Cauffman, 2001), may result in different perceptions of risk behaviors by adolescents.

Definitions of the word "risk" emphasize the costs of risk taking. For some risks, such as Russian roulette with a six chamber revolver, the magnitude and probability of cost are easily quantified (Luce & Raiffa, 1989). For more commonly attempted risks, both the magnitude and probability of cost are far less certain. However, the supposed costs of risk taking are routinely presented in the media and by concerned individuals. Without attempting to determine the accuracy of these presentations, what might be the effect of discrepancies between the presented costs and the costs estimated by the adolescent risk taker upon their risk taking?

One aspect of the analysis of risk taking has been strongly influenced by recent developments in animal behavior. Zahavi and Zahavi (1997) proposed the Handicap Principle as an explanation for what appeared to be gratuitously risky behavior in animals, such as "stotting" (jumping in place) by gazelles in the presence of a predator. It is generally accepted that such behaviors act as signals of quality, in this case informing the predator that the gazelle is likely to escape. Such displays, while exacting a cost from the actor, do appear to divert predation onto other, presumably less fit, prey (Zahavi & Zahavi, 1997). "Costly signaling" has become accepted as a model of many risky behaviors, advertising individual quality to conspecifics as well as predators (Grafen, 1990; Leal, 1999).

The application of this model to human behavior is straightforward, with the major difference that humans have a wide variety of costly signals that they may choose to display in different combinations. Involvement in mountaineering, skateboard stunting, or skydiving places individuals at some risk which they accept as a demonstration of their superiority. It has often been observed that risky rituals in primitive societies (National Geographic, 1976) bear a striking similarity to the risky behavior of adolescents in more advanced societies. Risky behaviors thus fit into the general class of costly signals, their performance imposing direct costs as well as the possibility of reduced survival.

To the extent that behavioral displays are unrelated to underlying fitness, individuals may be able to advertise a level of fitness that they do not possess. The simulation of costly signals can survive at equilibrium in populations (Johnstone & Grafen, 1993). Indeed, as long as the simulated signal increases the overall reproductive success of the individual, it will remain a viable strategy (Candolin, 1999).

Grafen's (1990) analysis of costly signaling included a "strategic choice" option which has become important in the analysis of this type of be-

havior and is particularly appropriate for costly signaling in humans. In this option, the signaler evaluates the costs associated with particular behaviors, estimates his/her own level of fitness, and tries to optimize the return from costly signaling by choosing behaviors and levels of risk within these behaviors that will produce the most effective signals with the least cost to the individual.

In other words, if one wishes to send a deceptive signal of fitness by engaging in risk taking, it is wise to choose a risk-taking behavior with the largest excess of apparent cost over the perceived actual cost. One factor affecting this is that humans tend to rate the probability of negative events occurring to themselves as lower than occurring to others (Weinstein & Klein, 1995) even in high-risk situations (Middleton, Harris & Surman, 1996). This provides a ready-made difference even if the receiver (R - who rates the probability slightly higher for the other person) has the same overall appreciation of the risk as the signaler (S - who rates it lower for himself/herself).

Additionally, participation in risk-taking behaviors is associated with lower estimates of the costs of those behaviors (Benthin, Slovic & Severson, 1993). To the extent that S has a lower estimate of the cost than a nonparticipant R, the behavior will be attractive as a deceptive signal. Beyond this, the well-known tendency of authorities to exaggerate the costs of socially disapproved behaviors provides an additional excess of apparent cost when signaling to Rs who accept the inflated cost estimates presented to them. It is clear that a number of factors can produce cost discrepancy.

Personal characteristics such as courage, strength, hardiness, skill, and luck are valued universally. As mentioned above, the first four appear to be closely related to costly signaling in animals, while the last is certainly important to humans (Smith, Wiseman, Harris, & Joiner, 1996). Engaging successfully in a risky activity such as skateboard stunting would signal strength and skill, while purchasing a winning lottery ticket would be accepted as a signal of luck by many.

Consider cigarette smoking as a risk behavior. If the smoker is using smoking as a signal of quality, it is almost certainly signaling hardiness. In contrast, speeding while driving would appear to signal skill, and perhaps luck. Engaging in unsafe sex might signal a reliance on the presumed luck of avoiding pregnancy or disease. Finally, defying risks in general might signal courage. If cost discrepancy interacts with what quality is signaled, it should differentially affect risk taking on that basis.

Another way of analyzing risk behaviors is to examine the magnitude of cost and the probability. Smoking and getting drunk have a low cost per occurrence, but a high probability of cost. That is to say, they represent an incremental risk. Speeding while driving or engaging in unsafe sex exposes one to high costs, but at a much lower probability per occurrence. It is also possible that the magnitude and probability of cost interact with cost discrepancy in risk-taking decisions.

The present study sought estimates of presented and perceived risks, intention to perform and recent performance of smoking, getting drunk, engaging in unsafe sex, and speeding while driving. The intended subjects were from 16 to 20 years of age, sampled from populations likely to engage in risk-taking behaviors.

Method

Participants

One hundred and twelve (112) visitors to youth "drop-in" centers in the Sydney metropolitan area participated in the study. These centers are intended to provide an alternative to "hanging out" in public places, especially for students in the hours after school and unemployed youth. They typically offer amusements, instruction in various subjects, counseling, and support for young people in difficulty.

Instrument

The questionnaire was anonymous. It first requested the age, sex, and educational attainment (as years of school completed) of the respondent. The survey then asked for information about four behaviors—tobacco smoking, getting drunk, having unsafe sex, and speeding while driving. These behaviors were selected to provide both contrasting signals of fitness as discussed above and differing probabilities and magnitudes of cost. For each behavior, the respondent was asked to record, on five point semantic differential scales, how dangerous that behavior was as presented to them by their acquaintances and by the media, their own estimate of how dangerous it was to themselves, and how likely they were to perform that behavior in the near future. They were also asked whether they had performed that behavior in the past month in a Yes/No format.

Procedure

Coordinators of youth "drop in" centers in the Sydney metropolitan area were contacted by telephone and asked if they would be willing to participate in a study about adolescent risk taking. All centers contacted expressed interest and an interview with each coodinator was arranged. The purpose and procedure of the study was explained to the coordinator. If the coordinator decided to be involved in the study, either the coordinator or a superior signed a form expressing their agreement. A box of questionnaires including instructions and a sheet to record decliners and exclusions was left with the coordinator. The coordinator and other youth workers involved were asked to mention to visitors between the ages of 16 and 20 that the survey was being conducted, and invite them to participate if they wished. Exclusion criteria were: inability to read/write English, known psychiatric diagnosis, or intoxication. Coordinators were requested to note exclusions and decliners in order to determine if either might be biasing the sample. The centers were contacted periodically by telephone and when the coordinator felt that they were unlikely to collect more surveys, the box containing completed and unused surveys was retrieved by the investigator.

Results

Sixteen out of 17 centers contacted agreed to participate. One center was dropped when an interview with the coordinator could not be arranged. Centers recruited from 0 to 24 participants each, with a mean of 7.5 respondents per center, over periods ranging from three weeks to six months.

Although it was requested that participation be restricted to persons between the ages of 16 and 20, reported ages ranged from 13 to 45 with a mean of 18.4 years. Sixty-nine percent (69%) of re-

spondents were within the requested age range. The analyses summarized in Tables 1-4 were conducted on the data from the subjects who were 20 years or younger, as this was the group relevant to the study. The results for all subjects were essentially the same, except for two associations of danger ratings with unsafe sex. Forty-three females, 57 males, and six of unspecified sex completed the questionnaire satisfactorily. The mean age of females (18.9) was slightly higher than that of males (18.1) as was their educational attainment (11 *vs.* 10.7 years). Exclusions and decliners were poorly recorded, but the sex ratio of respondents was within coordinators' estimates of the sex ratio of visitors.

Analysis of Rating, Intention, and Performance

A cost discrepancy score was calculated by subtracting the perceived danger from the presented danger rating. The higher this score, the more the respondent estimated the presented danger as inflated with regard to him- or herself. Linear modeling was used to test the relationship of the ratings to intention to perform the behavior. Logistic regression was used to test the relationship of ratings to actual performance. For each behavioral intention and performance, three relationships were to be tested: presented danger, perceived danger, and cost discrepancy. Therefore, a Bonferroni adjusted critical $p <= 0.017$ was used for each test. If more than one rating was a significant predictor when tested separately, these were entered into a stepwise selection based on the Akaike Information Criterion (Sakamoto, Ishiguro, & Kitagawa,1986) to determine the best fitting model. As cost discrepancy was a linear combination of presented and perceived danger, if all three were significant separately, only cost discrepancy and the best predictor of the other two were tested together.

In the following analyses, age and years of schooling were tested for association with intention and performance on all variables. No significant associations were found. No significant differences were found between males and females for the ratings of presented danger, perceived danger, cost discrepancy, or frequencies of performing the risk behaviors.

Tobacco Smoking

The presented dangers of tobacco smoking were reported as quite high, although 75% of respondents reported smoking in the past month. On a scale ranging from 1 to 5, with endpoints of "Not at all" and "Extremely" the mean score was 4.1. Despite the high ratings of presented danger of tobacco smoking, there was no significant relationship of presented danger to intention to smoke, either overall or by males and females separately. However, the respondents estimated the danger to themselves as somewhat lower with a mean of 3.7. The best predictor of intention to smoke for all respondents was lower perceived danger rating (Table 1). There were no significant predictors of intention to smoke among males, but cost discrepancy was the best predictor among females (Table 1). Interestingly, none of the ratings were significantly associated with reported smoking in the past month, overall, or for each sex separately.

Getting Drunk

The presented dangers of getting drunk were rated as considerably less than tobacco smoking at a mean of 3.3. Sixty percent of respondents reported having been drunk in the past month. Again, estimates of the dangers of getting drunk for the respondent were lower, at a mean of 2.8. The best predictors of intention to get drunk were lower presented and perceived danger ratings for all respondents (Table 2). However, the best predictor for males was presented danger rating, while for females it was perceived danger rating (Table 2). Similarly, while perceived danger rating was the best predictor of having gotten drunk in the past month for all respondents, the best predictor for males was again presented danger rating, and for females, perceived danger rating (Table 2).

Unsafe Sex

The presented dangers of having unsafe sex were reported as even higher than those for smoking at 4.2. Only 27% of respondents reported having unsafe sex during the past month. Perceived dangers were lower at 3.8, leading to the smallest mean cost discrepancy for any behavior. There were no significant differences between males and females. There were no associations of danger ratings with intention to have unsafe sex (Table 3). Turning to performance, only a significant association of lower presented danger rating with reported unsafe sex in the past month for males was found (Table 3).

Speeding While Driving

The presented dangers of speeding while driving achieved a rating of 4.2, while the perceived dangers were rated at 3.6, producing the highest mean discrepancy score. As before, there were no significant differences in ratings between males and females. Twenty nine percent of the respondents reported speeding in the past month. The presented dangers of speeding were related to intention to speed overall and intention to speed for females, but not for males (Table 4). No associations were found between perceived dangers of speeding and intention. While there was a significant relationship between cost discrepancy scores and intention to speed for females when tested separately, it was in the direction of lower intention to speed when the perceived danger ratings were less than the presented danger ratings, and did not achieve significance when tested with presented danger rating (Table 4). No significant associations of ratings with reported speeding in the past month were found.

Discussion

For every behavior, a positive mean discrepancy score indicated that respondents estimated the dangers of that behavior to themselves as less than those presented to them. This is not unexpected, as previous studies have demonstrated that people generally estimate the probability of occurrence of undesired events for themselves as less than actuarial estimates (Weinstein, 1984) and as lower than the probability for others (Weinstein & Klein, 1995). However, the intention and performance of a risky behavior are generally expected to be related to the dangers of that behavior, whether those presented to the person, or the person's own estimates.

Table 1

Intention and performance of tobacco smoking by sex.

	Predictor(s)	Significance
Intention to smoke—overall	Perceived danger	F[1,80] = 7.43, p = 0.0079
Intention to smoke—males	-	-
Intention to smoke—females	Cost discrepancy	F[1,33] = 10.3, p = 0.003
Smoked in past month—overall	-	-
Smoked in past month—males	-	-
Smoked in past month—females	-	-

Note: Statistics in this and succeeding tables are those associated with the coefficient(s) of interest in the linear model (F) or logistic regression model (z).

Table 2

Intention and performance of getting drunk by sex.

	Predictor(s)	Significance
Intention to get drunk—overall	Presented danger	F[1,79] = 39.7, p < 0.0001
	Perceived danger	F[1,79] = 12.0, p = 0.0008
Intention to get drunk—males	Presented danger	F[1,44] = 31.2, p < 0.0001
Intention to get drunk—females	Perceived danger	F[1,33] = 21.7, p < 0.0001
Drunk in past month—overall	Perceived danger	z = -4.3, p < 0.0001
Drunk in past month—males	Presented danger	z = -3.24, p = 0.001
Drunk in past month—females	Perceived danger	z = -2.74, p = 0.006

Table 3

Intention and performance of unsafe sex by sex.

	Predictor(s)	Significance
Intention to have unsafe sex—overall	-	-
Intention to have unsafe sex —males	-	-
Intention to have unsafe sex—females	-	-
Had unsafe sex in past month—overall	-	-
Had unsafe sex in past month—males	Presented danger	z = -2.56, p = 0.01
Had unsafe sex in past month—females	-	-

Table 4

Intention and performance of speeding by sex.

	Predictor(s)	Significance
Intention to speed—overall	Presented danger	F[1,78] = -3.17, p = 0.002
Intention to sspeed—males	-	-
Intention to speed—females	Presented danger	F[1,33] = -3.1, p = 0.004
Sped in past month—overall	-	-
Sped in past month—males	-	-
Sped in past month—females	-	-

With regard to tobacco smoking, there was no evidence that intention to smoke was related to presented dangers, and the best predictor of intention for females was the cost discrepancy score. Actual performance was unrelated to both presented and perceived dangers. In contrast, presented and perceived dangers were strongly related to both intention and performance in getting drunk. In both intention and performance, males appeared to rely more on presented danger, while females looked to perceived danger. The difference between these two behaviors, here characterized as having costs of low magnitude but high probability, is striking. It is probable that getting drunk is not assessed solely on the basis of its direct physical costs, but includes the possibility of collateral costs associated with the drunken state, such as violence or accidents.

In behaviors characterized as having high costs, but low probability of cost, a different picture emerges. For speeding while driving, presented dangers were inversely related to intention to perform these behaviors for all respondents and females. McKenna, Stanier and Lewis (1991) found that females' estimates of their driving skill were generally less overoptimistic than those of males. In contrast, there was no significant predictor of intention to have unsafe sex or speed among males, and only a single inverse relationship of presented danger ratings to performance of unsafe sex.

Smoking seems to be a good model of the incremental cost risk behavior. While males did not apparently utilize cost discrepancy in their risk assessment of smoking, females did so. As females may derive additional perceived benefits from the calming and appetite suppressing effects of nicotine, these factors may differentially affect their risk assessment of smoking.

It appears that getting drunk was not perceived primarily as an incremental cost behavior. The context of heavy drinking may be an important factor in assessing the dangers of such behavior. It is well recognized that in such contexts, violence and accidents are more common. It is likely that the direct physiological effects of heavy drinking are outweighed by the associated dangers, making it unsuitable to test the relationship of magnitude and probability of cost on risk assessment in the adolescent. One relationship that was initially expected, that of cost discrepancy scores to getting drunk in males, was not observed. While males were expected to assess getting drunk in terms of their estimates of how well they could withstand the effects of alcohol compared to the general perception of these effects, it was not observed in this sample.

The conclusion drawn from the present study is that adolescents may well incorporate costly signaling in their risk taking, and in the case of intention to smoke, females may use estimates of presented and perceived dangers of these behaviors in ways that are consistent with "strategic choice" in the costly signaling model (Grafen, 1990). Turning to whether the quality signaled or the magnitude/probability of cost interacts more strongly with cost discrepancy, there is some evidence that magnitude/probability may be more important, as the only strong relationship of cost discrepancy was with intention to smoke. If hardiness as a quality had been more important, getting drunk would be expected to exhibit a relationship with cost discrepancy, despite the presence of lower probability costs such as violence or accident. Other incremental cost behaviors such as voluntary poor diet might also be influenced by costly signaling. In contrast, costly signaling does not appear to explain either intention or performance in high cost/low probability risk taking in adolescents.

The effect of cost discrepancy on smoking may have some bearing on anti-smoking campaigns. To the extent that these widen the gap between the presented and perceived costs, such campaigns may actually make smoking more attractive as a costly signal. Particularly important might be the extent to which anti-smoking campaigns emphasize dramatic but relatively uncommon health dangers, as it would be predicted that the less adolescents had actually encountered such outcomes, the more likely they would be to discount the probability of their occurrence (Weinstein, 1989).

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Acknowledgements

The author wishes to acknowledge the valuable assistance of the participating youth "drop in" centers and their staff.

Author

Jim Lemon, Ph.D., is a research psychologist with the Health Psychology Unit, University of Technology, Sydney, Australia. As a research psychologist, he has worked in the drug and alcohol field and is currently working in health psychology. He also has been involved with computerized human performance testing throughout his career. At present, he is concentrating on decision making,particularly with regard to taking risks. jim.lemon@uts.edu.au