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Dynamic Processes in Risk Perception

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Abstract

This article examines how public concern about different social problems changes over time in response to fluctuations in problem severity. Examining time series of concern and objective severity for nine different problems, both graphically and econometrically, we address three main questions. First, how closely does concern track fluctuations in problem severity? Second, what psychological processes mediate the relationship between concern and problem severity? Finally, what factor(s) distinguish between problems for which tracking is accurate and inaccurate?

The accuracy of public perceptions of risks has been the focus of recent controversy. On one side of the debate, several economists have argued that the formation and updating of risk perceptions are generally compatible with Bayes' rule (Viscusi, 1985; Viscusi and O'Connor, 1984). On the other, behavioral decision theorists argue that risk perceptions often violate Baye's rule and are only imperfectly correlated with objective measures of risk (see, e.g., Vlek and Stallen, 1980; Slovic, Fischhoff and Lichtenstein, 1982). They argue that psychological factors such as *voluntariness* (Starr, 1969), *dread*, and *familiarity* (Slovic, et al., 1982) drive a wedge between objective and subjective risk.

Whatever its conclusion, virtually all research on risk perception has been cross-sectional. The accuracy of perceptions has been measured by the correlation, across risks, of perceived risk and objective measures of problem severity such as fatality rates. While some research has compared risk perceptions at two points in time—e.g., before and after policy interventions (e.g., Viscusi and O'Connor, 1984) or catastrophic events (e.g., Smith and Michaels, 1987)—there has been no research on the dynamic response of risk perceptions to changes in problem levels over multiple time periods.

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This article addresses this gap by analyzing time series data on public concern and the objective severity of a wide spectrum of problems. These include AIDS, crime, drunken driving, herpes, inflation, polio, teenage suicide, and unemployment. The research has several goals. First, it seeks to assess how *accurately* risk perceptions track objective changes in risk over time. Just as earlier work has estimated the correlation of concern and objective problem severity across different sources of risk, here accuracy is measured by the degree to which risk perceptions track objective risks as they fluctuate over time. Second, we attempt to determine what psychological factors, if any, mediate the dynamic relationship between subjective and objective risk. As an example, people could *adapt* over time (Helson, 1964) to an existing level of a problem so that perceived riskiness would decline even if an objective threat remained constant. Third, we examine a risk perception phenomenon, analogous to stock market fads, which we term *panic*. Often there appears to be an exaggerated response to an emergent or worsening problem (such as herpes in 1985) followed by a virtual collapse of concern. Below we document several panics and attempt to shed light on why certain types of risks are prone to panics while others are not.

A major finding discussed below is that there is no generally applicable dynamic relationship between perceived and actual risk. Although some types of risks evoke a measured and proportionate response, for others, public concern often exhibits wild fluctuations bearing little or no relationship to variations in the severity of the underlying problem. While it is difficult to determine the ideal level of response to a problem, public responses are often sufficiently extreme in one direction or the other to conclude that concern has overshot or undershot the appropriate level.

Examples of apparently insufficient response include the apathy of politicians, academics, and those who were at risk of contracting AIDS, in the early stages of the disease (Shilts, 1986). The extraordinary lack of vigilance by American Naval officers at Pearl Harbor in 1941 (Janis, 1972) and the surprising apathy of a town in Oklahoma that was warned that it would be consumed by a sink-hole (Janis, 1962) are also examples of insufficient response.

On the overshooting side, one can cite the sudden though brief surge of attention to the problem of disappearing children in the early 1980s. When the panic abated, there was no evidence that there had been any sudden change in the problem prior to or during the panic, nor did the actual severity of the problem in terms of numbers affected bear any relation to the extremity of the response. The herpes scare, also in the early 1980s, is another case in point. Although approximately half the population carries the herpes virus, at the peak of herpes hysteria mothers kept children away from classrooms in which classmates were reported to suffer from the virus. Months later a problem that had merited front-page coverage in the two national news weeklies had virtually disappeared from public consciousness. The massive cancellation of American European vacation plans in the summer of 1986 in response to a single terrorist airport raid also seems to qualify as an example of overreaction.

Although some of these cases of divergence between perceived and actual risk are harmless, in many situations, e.g., when people take or fail to take meliorative actions, or when public policy responds to public concerns, a disproportionate (in either direction)

public response can have significant consequences. Resources may be directed toward eliminating conditions that do not pose objective hazards, while truly threatening situations are ignored.

This distortion of resource allocation can be especially consequential in a dynamic context. The postwar period has seen the emergence of long-term environmental and social hazards caused by worldwide population expansion and industrialization. Acid rain threatens forests and lakes, the ozone layer shows signs of deterioration, coral reefs are deteriorating as oceans become polluted, and rain forests are vanishing. AIDS, drug use, and teenage pregnancy are increasingly pervasive. These problems share pernicious qualities. First, the causal processes typically involve long time lags. For example, chemicals released into the atmosphere can take a decade to interact with the ozone layer. Even if emissions were terminated today, ozone deterioration would continue (Morone and Woodhouse, 1986). Some effects are virtually irreversible as, for example, when aquifers are polluted or rain forests desertized. Second, the problems often involve complex interactions (Perrow, 1984) and feedback components (Sterman, 1989) that can lead to an exponential rate of deterioration if the problem remains unregulated. The effects of feedback can be seen, for example, when AIDS becomes spread by an ever expanding population of asymptomatic carriers, or when the offspring of teenage mothers repeat the pattern. Third, interventions may require time-consuming research, the establishment of bureaucracies, and international cooperation.

Lags in causal processes and policy response, and feedback loops, indicate the need for a timely and measured response. At the same time, the sheer multitude of problems necessitates efficient allocation of scarce resources to the most pressing needs. Divergence between public concern about a problem and its objective severity interferes with the ability of policymakers to respond effectively and efficiently to emerging and developing problems.

In what follows, we first discuss the different measures of concern and objective risk that we employ in the analysis. Next, we assess the accuracy of risk perceptions. Finally, we test for various psychological factors that may affect dynamic responses to risk.

1. Method

1.1. Measuring concern

Tracking public concern over time is problematic. Concern can be measured by a variety of proxy variables, each with its own advantages and limitations. Perhaps the most objective measures of concern are the *meliorative actions* taken in response to a hazard. For example, bathhouse attendance could be used as a proxy for gay concern with AIDS (although we were unable to obtain the data). However, for most hazards—e.g., disease, pollution, crime, and government budget deficits—either there is no behavioral response or it is very difficult to measure. As an example of the former problem, people may be

worried about government budget deficits, but there is little they can do to mitigate the impact (presumably adverse) of these deficits. Similarly, assessing fear of crime by measuring urban outmigration would be problematic. Crime is only one reason why people leave the city; isolating the amount of outmigration caused by crime would be exceedingly difficult.

Meliorative actions are also a relatively insensitive measure of concern. Given time constraints, people are unlikely to respond actively to a hazard until concern reaches a relatively high level, so action measures are probably only appropriate for hazards that are seen as severe. A final disadvantage of action measures is that they may be affected by a variety of factors—e.g., the ease of taking action—other than the subjective severity of the problem. For example, whether a homeowner tests for radon will depend on the ease and cost of testing as well as the level of concern about radon poisoning.

An alternative measure of risk perception is *self-reports* of concern collected in public opinion polls. Opinion polls are more sensitive than behavioral response, and they measure concern more directly. However, polls too are problematic. First, people are unlikely to put as much thought into deciding how to respond to a poll as they do in deciding whether to take meliorative action. Second, repeated surveys of concern for a particular risk are extremely rare, and even when questions about a specific hazard are collected repeatedly, question wording and sampling procedures often change from one questionnaire administration to the next, complicating the task of separating actual change in concern over time from other sources of response variation (see, e.g., Bell, 1960). Data on risk perceptions for the *same group of subjects* sampled repeatedly is virtually nonexistent.

A final proxy for public concern is the number of articles appearing over time on a topic in a given set of newspapers or periodicals. This has the advantage of being a relatively consistent measure over time, and is also more sensitive to changes in concern than meliorative action. However, it is also the most indirect measure. Indeed, media coverage is probably an important determinant, as well as a measure, of concern (Combs and Slovic, 1979).

The measures of concern and problem severity that we used are listed in table 1. As is evident from the table, we employed all three types of measures of concern: meliorative action, public opinion polls, and newspaper article counts. Where possible, we collected multiple measures of concern, and used different measures to cross-validate one another. For example, while our main measure of concern for crime was the percent of respondents to the National Opinion Research Center's General Social Survey who reported that they were afraid to walk alone at night (FEAR), we also collected data on the percent of respondents to the same poll who believed that spending on crime prevention should be increased (SPEND). These measures are highly correlated ($r = .64, p < .005$). Figure 1 illustrates a similarly close relationship between three measures of concern for drunken driving: net MADD (Mothers Against Drunk Driving) chapters formed (the number formed minus the number disbanded),[1] news articles, and periodical articles. In general, different measures of concern were highly correlated and yielded similar results when included in the time series analyses.

Table 1. Data sources

Problem name	Concern	Severity
AIDS	National new articles (National Newspaper Index)	Diagnosed cases (U.S. Dept. of Health and Human Services)
Crime	% respondents afraid to walk at night (NORC General Social Survey)	Violent crime rates (FBI Uniform Crime Reports)
Drunken driving	# of MADD groups founded − # MADD groups disbanded (Center for the study of youth development)	% auto fatalities caused by drunken drivers (U.S. Dept. of Health Human Services)
Herpes	National news articles (National Newspaper Index)	Number of new cases reported (National Disease Therapeutic Index)
Inflation	% citing inflation as most important problem (Gallup)	Inflation rate (Statistical Abstract of the United States)
Unemployment	Most important problem (Gallup)	Unemployment rate (Statistical Abstract of The United States)
Polio	New York Times news articles (New York Times Index)	New York State cases (National Foundation for Infantile Paralysis)
Teenage suicide	National news articles (National Newspaper Index)	Teenage suicide rates (National Center for Health Statistics)
Teenage illegitimacy	New York Times news articles (New York Times Index)	Births to unmarried teenagers (Statistical Abstract of the United States)

1.2. Measuring problem severity

Problem severity, although more straightforward than concern, is also problematic for several reasons. First, the best measure of problem severity is sometimes unclear. For medical problems (e.g., AIDS, herpes, and polio), and for teenage suicides and illegitimacy, number of fatalities or cases are probably fairly good proxies for severity, and have been used extensively in earlier research. The economic variables are also relatively straightforward, although there are different measures of inflation and unemployment that could be employed. Crime is more problematic, since it is unclear what types of

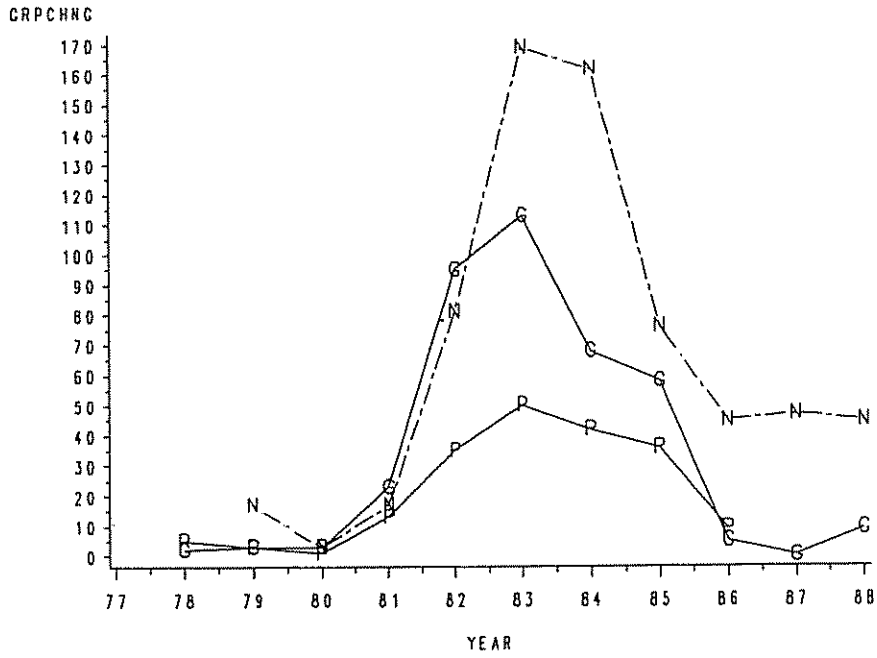

Figure 1. Three measures of concern about drunken driving: Net MADD groups founded (G), news articles (N), and periodical articles (P).

crimes should be included (e.g., only felonies? only crimes against persons?). We chose the latter because it seemed to correspond more closely to the type of offenses that Americans fear most (see Stinchcombe et al., 1980). Unfortunately, for some types of problems that seem to display interesting dynamic patterns of concern (e.g., drug abuse and nuclear power), there are no valid measures of problem severity; several problems were excluded from our study for this reason.

A second difficulty with measuring problem severity is that, for many problems, the actual accuracy of the data itself is unclear. For example, in the National Disease Therapeutic Index, the incidence of herpes is measured by scanning doctors' records for newly diagnosed cases. Such a method is vulnerable to selection effects in terms of what types of people seek medical treatment for herpes, and sampling bias in terms of the geographical location and specialization of the sampled doctors. However, these problems should not pose a serious challenge as long as they are consistent over time; we are concerned not with the absolute incidence of herpes (as in cross-sectional analyses), but with relative fluctuations over time.

Even when we are able to measure problem severity with a high degree of accuracy, it is often unclear whether the public possessed equally accurate information at the time when subjects are recorded in our data sets. Any observed dynamic response to fluctuating risks reflects two casual linkages: between the perceived and actual problem level, and between concern and the perceived level. The relative impact of each of these

linkages is, in practice, difficult to disentangle. For some problems, such as polio, unemployment and inflation, data about problem severity are available rapidly. In such cases, we would expect that any discrepancies between concern and objective problem level would result from imperfections in the link between concern and problem perception. For other problems, such as herpes and crime, data about problem severity are available only after considerable delays. In these cases, we would expect the link between perceived and objective severity to play a more prominent role.

A final difficulty relating to measuring problem severity is that risks may affect different segments of the population differently. An extreme problem for one segment (e.g., AIDS for homosexuals and drug users) may be far less of a problem for other groups. As long as the proportion of the various groups in the population is relatively stable over time, however, this is unlikely to pose a serious problem for time series analyses, where the focus is on changes over time rather than absolute levels. It is a severe pitfall for cross-sectional analysis, where a disproportionate sampling of homosexuals could, for example, lead a researcher to exaggerate the risk of AIDS.

Our response to these difficulties was comparable to that towards measuring concern. Where it was possible, we obtained multiple measures of problem severity. For example, we measured AIDS severity both by numbers of diagnosed cases and by deaths; the two series are so qualitatively similar that we only present the latter. In the case of polio, we were able to obtain monthly data on polio cases in New York City from January 1911 to December 1915, on New York State cases from January 1915 to December 1929, and yearly data on New York State cases from 1915 through 1954. Given the difference in populations and periods, the estimation results for the three samples were remarkably similar. For simplicity, we only report the regression results from the New York State monthly sample, and plots from the New York State yearly sample. However, the congruence of polio results using different time series and different measures of problem severity increases our confidence in the robustness of our findings.

2. Results

2.1. Accuracy of risk perceptions

The accuracy of risk perceptions was assessed in two ways. First, it was measured by the simple bivariate correlation between concern and problem level and between change in concern and change in problem level. Second, it was assessed qualitatively by examining time series plots of concern and problem levels. The correlation results are presented in table 2. The correlations between levels of concern and problem level are intended as a measure of overall tracking "in the large"; is concern generally high when the problem is relatively severe and low when the problem is relatively mild? As evident from the table, concern levels generally track problem levels fairly accurately in the large, although there

Table 2. Correlations between concern and problem severity

Problem name	Levels	Changes	*n* of cases
AIDS	.78	N.A.*	8
Crime	.86	.27	21
Drunken driving	.55	.16	10
Herpes	−.047	−.23	94
Inflation	.87	.59	30
Unemployment	.87	.72	30
Polio	.38	.28	156
Teenage suicide	.46	.11	22
Teenage illegitimacy	.26	.06	47
Means	.55	.25	

*Insufficient period-by-period observations of actual rate.

is substantial variation between problems. The average adjusted correlation for the nine different problems was .55; six of the nine correlations are significant at the .05 level. Correlations between change in concern and change in problem level measure the accuracy of period-by-period tracking—tracking "in the small." Correlations between the change variables are significantly lower than those between levels; the mean correlation is .25, and only the two economic variables showed a period-by-period correlation above .5. Apparently, concern tracks problem levels much more closely in the large than in the small.

Figures 2a–2i graph concern and a measure of objective problem level for AIDS, crime, drunken driving, herpes, inflation, unemployment, polio (yearly), teenage suicide, and teenage illegitimacy, respectively. In each case, the objective level of concern has been rescaled by an affine transformation that minimizes the sum of squared errors between the two plots. As would be expected from the high correlations for crime, inflation, unemployment, and to a lesser extent polio, concern tracks the objective levels of these problems fairly closely. Net number of new MADD groups founded also seems to track drunken driving fatalities quite closely, although during the early 1980s, the formation of new MADD groups seemed to lag behind the rise in fatalities by an interval of one or two years.

How one evaluates the responsiveness of AIDS concern depends on how one interprets the data. The general trend of AIDS concern follows diagnosed cases fairly closely, but there are several brief but very sharp departures of concern from the trend of cases. These include an increase from 3 to 145 articles per month over a five-month period in 1985, and a decline from 123 to 7 articles over the first four months of 1988.

The other risks display far less evidence of close tracking, whether viewed in the large or in the small. Concern for herpes appears completely unrelated to the level of the problem as measured by newly diagnosed cases. Indeed, a brief but substantial surge of worry about herpes occurred in 1983 at a time when new cases, if anything, were at a low point. Although it is possible that the surge of concern about herpes may have led to an increase in meliorative actions, and a subsequent suppression of the rate of infection, such reverse casual processes cannot explain why the surge of concern occurred in the first place.

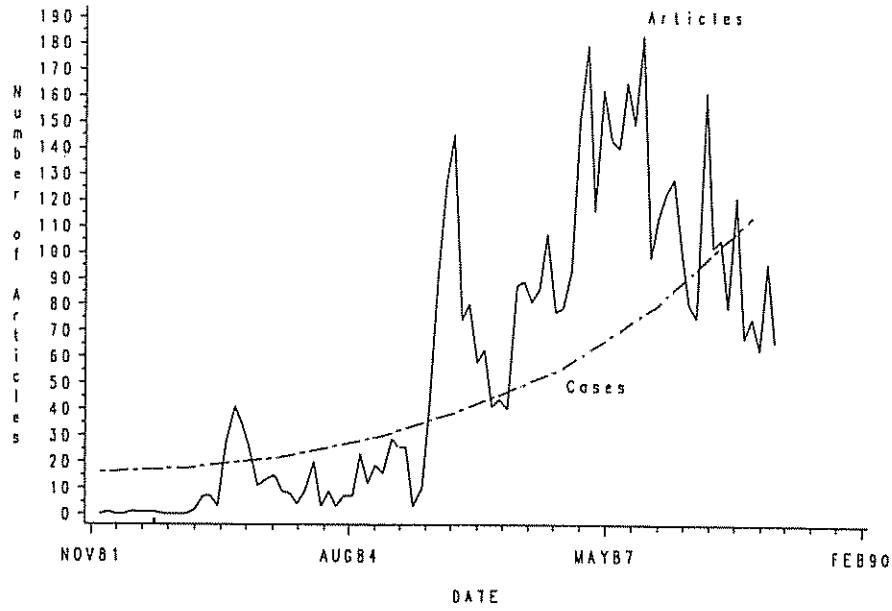

Figure 2a. AIDS: Cases and articles.

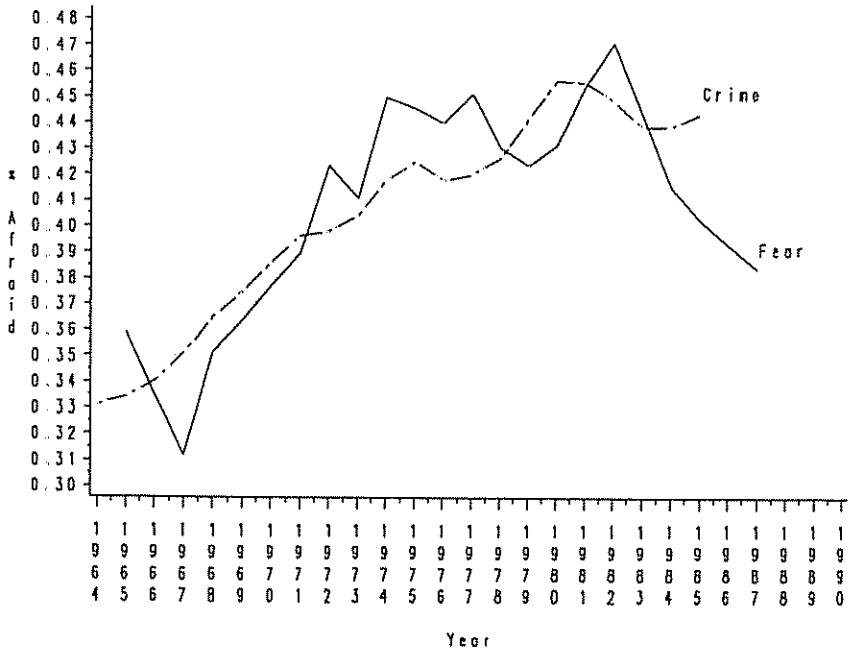

Figure 2b. Crime: Violent crime rates and reported fear.

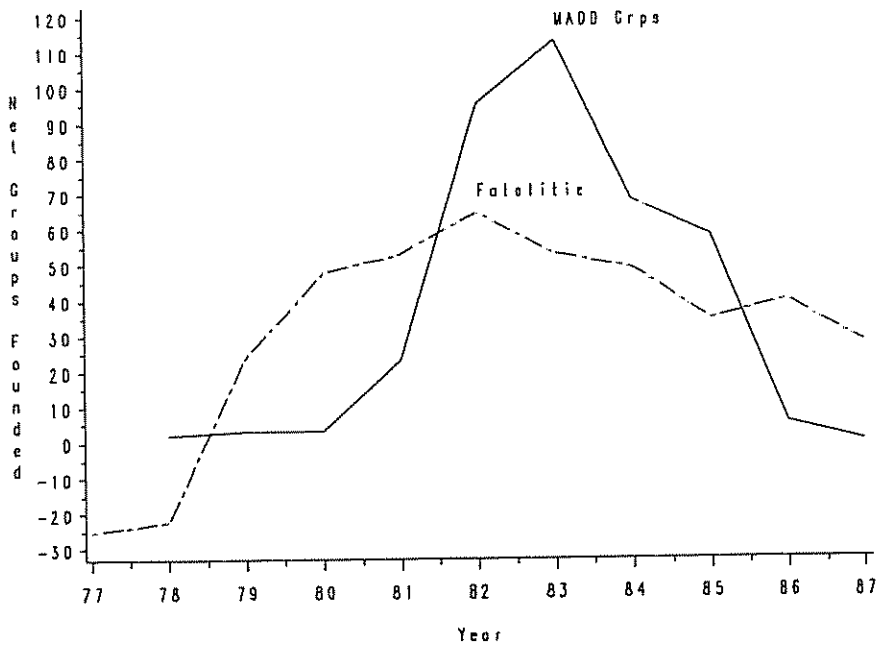

Figure 2c. Drunken driving: Percent road fatalities from drunken driving and net MADD groups formed

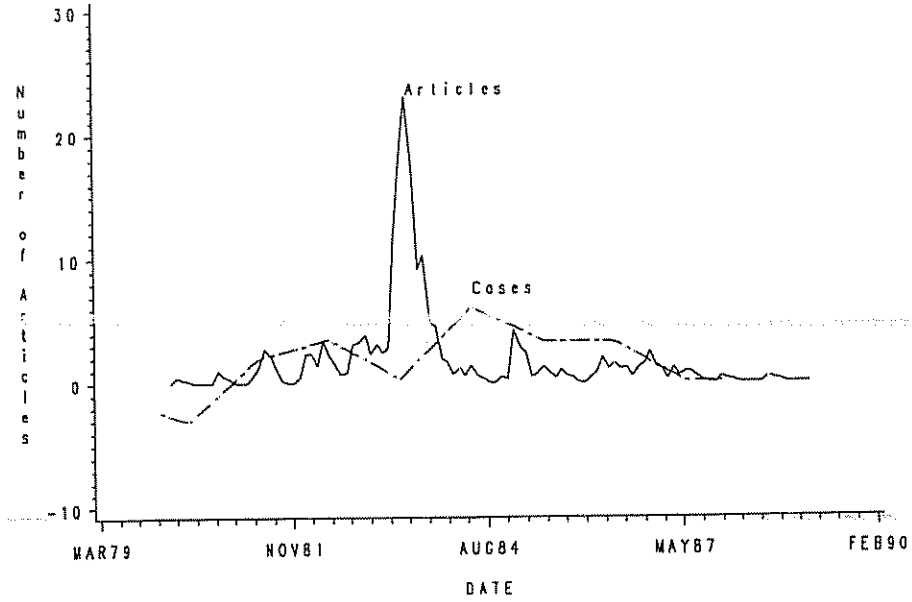

Figure 2d. Herpes: Cases and news articles.

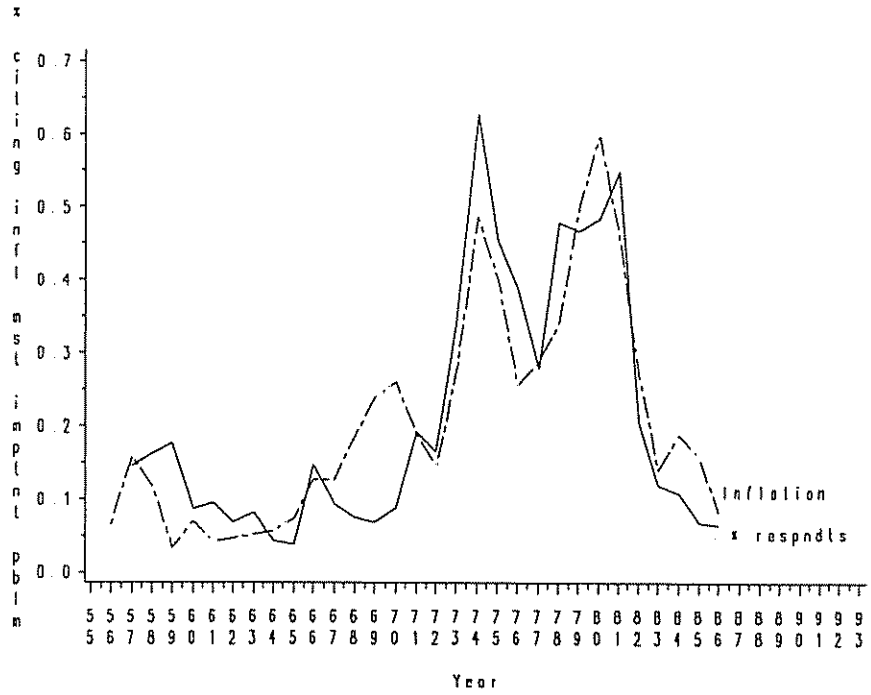

Figure 2e Inflation: Levels and polled concern.

Teenage suicide and teenage illegitimacy display similar patterns. News articles on teenage suicide were relatively consistent from 1972 through 1982, as suicide rates increased by 28%; news articles then increased tenfold between 1982 and 1984, a period during which actual suicides increased by only 3%. News articles on teenage illegitimacy rose fivefold between 1965 and 1972, and then dropped back to the original level in 1974. During this interval, the rate of illegitimacy did not depart noticeably from its trend. Again, public concern for teenage suicide and illegitimacy may have prevented both problems from subsequently intensifying more than they otherwise would have; but the negative feedback effect of concern on the problem cannot explain the initial increase in concern. In any case, there is no evidence that the surge of concern did, in fact, have a negative impact on the problem itself.

In sum, for certain problems (crime, inflation, unemployment) public concern does track problem severity with a relatively high degree of accuracy, while for other problems (e.g., polio, drunken driving, and AIDS) the fit is less perfect. Moreover, for a variety of problems there appear to be brief surges of concern unrelated to any observable change in problem severity. We now turn to the question of why such divergences occur.

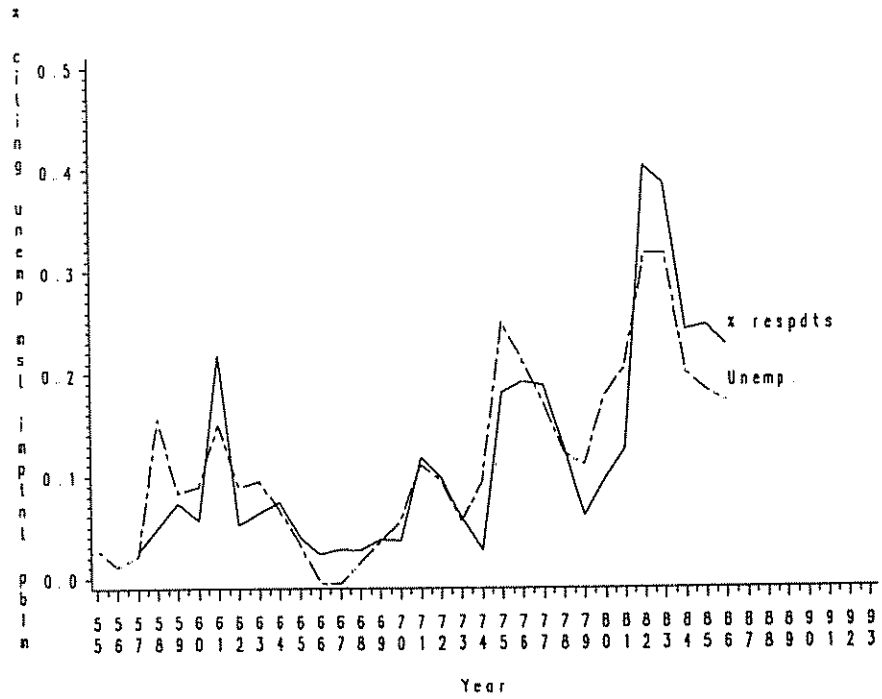

Figure 2f. Unemployment: Levels and polled concern.

2.2. *Dynamic processes affecting public concern*

Based on *a priori* psychological considerations, we tested for the operation of two dynamic processes that could mediate the relationship between objective risks and risk perceptions: adaptation and surprise.

2.2.1. Adaptation. Psychologists have long noted that people adapt to ongoing stimuli. Adaptation is observed in virtually all sensory systems. In vision, if an unchanging stimulus pattern is projected on the retina, the perception of the pattern will fade over a period of seconds (Pritchard, 1961). Adaptation also mediates the effectiveness of reinforcement. For example, electric shock has a reduced impact when subjects have preadapted to a low-level shock (Adamson, Henke, and Donovan, 1969) through previous administrations. The concept of adaptation—and the allied *reference point* concept—has also influenced research on motivation (McClelland, Atkinson, Clark, and Lowell, 1953), decision making under uncertainty (Markowitz, 1952; Kahneman and Tversky, 1979), intertemporal choice (Loewenstein, 1988; Loewenstein and Prelec, 1989), and marketing (Oliver, 1980).

Applied to risk perception, adaptation implies that earlier experience with a hazard will decrease later concern. As an example, adaptation may underlie the dynamic public

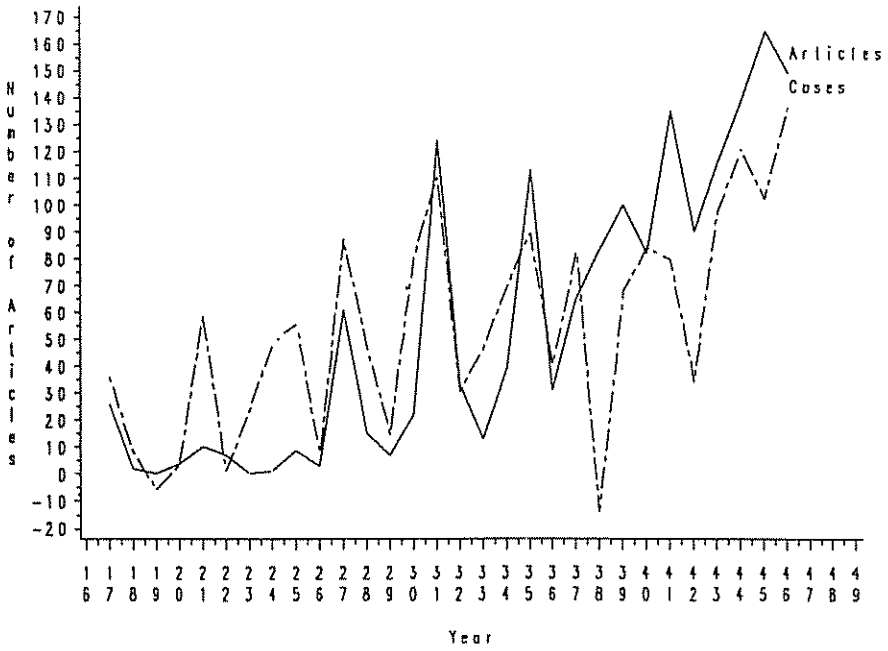

Figure 2g. Polio: Cases and news articles.

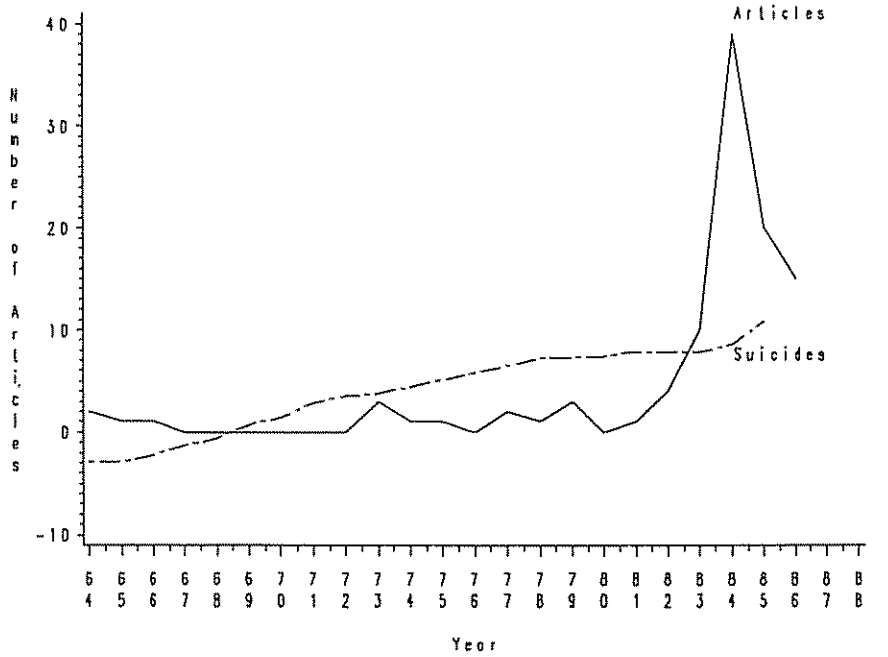

Figure 2h. Teenage suicide: Rates and articles.

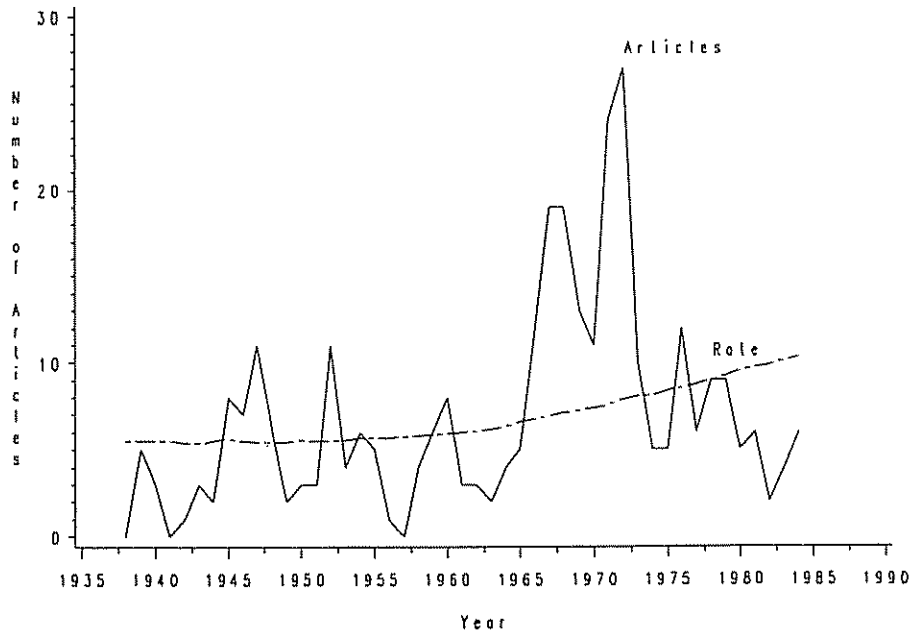

Figure 2i. Teenage illegitimacy: Rates and articles.

response to United States budget deficits; after years of increasing deficits elicited increasing levels of concern, a reduction in the deficit's rate of growth led to a significant reduction of public concern, even though the deficit remained at historically high levels (Rohatyn, 1988).

If C_t represents concern, and P_t represents the objective level of a problem, both at time t, then we can test for adaptation by estimating the equation

$$C_t = a_0 + a_1 P_t + a_2 P_{t-1} + \epsilon_t. \tag{1}$$

Adaptation would imply a negative value for a_2; a higher prior level of the problem would decrease concern for any given current level. Equation 1 can also be rewritten as

$$C_t = b_0 + b_1 P_t + b_2 (P_t - P_{t-1}) + \epsilon_t, \tag{2}$$

where $b_1 = a_1 + a_2$, and $b_2 = -a_2$. Although technically equivalent, equation (2) can be interpreted as stating that people are concerned with the current level of a problem and its rate of change.

There is, however, a problem with forms (1) and (2). Most hazards do not follow a random walk, but are trended. Hence, past levels of a problem provide information concerning the direction and magnitude of future changes. For virtually all problems we examined (see below), for any given level of P_t, a higher value of $P_t - P_{t-1}$ implies a higher level of P_{t+1}. Thus, if people are concerned not only about the current level but also

about future levels, we would expect the estimate of adaptation (a_2) in equation (1) to be biased downward.

2.2.2. Surprise. Closely related to adaptation is the notion of surprise. Surprise occurs when events deviate from prior expectations. Research has demonstrated several consequences of expectation disconfirmation. People are more likely to engage in causal attributions concerning unexpected events (Hastie, 1984; Einhorn and Hogarth, 1986). They are more likely to recall behaviors incongruent with preconceptions (Srull, 1981; Hastie and Kumar, 1979). Consumer satisfaction with purchases depends, in part, on discrepancies between predicted and actual affect associated with product usage (Oliver and Linda, 1981), and between anticipated and actual performance (Churchill and Surprenant, 1982).

At a more theoretical level, several prominent theories of emotion (see, e.g., Mandler, 1980; Simon, 1967) view emotions as a response to disconfirmed expectations. Finally, Bell's "disappointment theory" (1985) explains various expected utility anomalies by positing that utility for payoffs depends in part on the discrepancy between outcomes and prior expectations. Payoffs that fall below expectancies engender "disappointment," while payoffs above expectancies cause "elation."

If surprise plays a role in risk perception, we would expect concern to be a decreasing function of prior expectations. The impact of surprise can therefore be examined by incorporating a measure of *expected* problem level in the regression equations as in equation (3).

$$C_t = b_0 + b_1 P_t + b_2(P_t - P_{t-1}) + b_3 E_{t-1}(P_t) + \epsilon_t. \tag{3}$$

If surprise has the postulated effect, we should observe a negative coefficient on the expectation term.

2.2.3. Findings. To test for the operation of adaptation and surprise, we ran regressions of the form (3) on polio, unemployment, and inflation, the three problems for which we had sufficient data on concern, problem levels, and expectations. We ran a regression of form (2) for crime, since we were unable to obtain a usable forecast of crime. To correct for significant positive serial correlation, we estimated all four equations using the two-step full transform method (Harvey, 1981). The results are shown in table 3.

As a forecast of inflation, we used the Livingston one-year-ahead forecasts of inflation collected quarterly from professional economic forecasters. Our estimates of expected

Table 3. Estimation of simple regression model (corrected for autocorrelation)

	(Constant)	(P_t)	($P_t - P_{t-1}$)	$E_{t-1}(P_t)$	R^2	*n* of cases
Violent crime (fear)	29 (11.0)	.00028 (4.8)	−.00040 (−1.9)		62	21
Polio (monthly, New York State)	−.16 (−.32)	.015 (2.5)	−.0049 (−1.2)	.0019 (.27)	12	144
Inflation	.031 (.61)	.047 (6.7)	−.013 (−1.4)	−.020 (−1.0)	67	30
Unemployment	−.20 (−3.3)	.19 (4.0)	−.055 (−2.9)	−.133 (−2.7)	83	19

t-statistics are in parentheses.

R^2 regression does not include variance accounted for by autocorrelation.

unemployment were taken from a quarterly NBER (National Bureau of Economic Research) survey conducted by Victor Zarnowitz in which economists report forecasts of a wide range of economic variables. Forecasts of polio were made by taking the average polio rate from the previous year and adjusting for the month by a constant estimated from historical data. Correlations between forecasts and realizations, and between change in forecasts and change in realization, are presented in Table 4, and are generally quite high. The one exception is change in inflation versus change in expected inflation, which displays a negative correlation.

Not surprisingly, for all four problems concern is positively and significantly related to the current level of the problem (see table 3). However, contrary to the adaptation hypothesis, the sign of the change term is negative in each case. The expectation term is negative for inflation and unemployment, significantly so for the latter, but is positive and nonsignificant for polio. Thus, we seem to observe weak evidence for a surprise effect.

What can account for the failure to observe adaptation? Rather than adapting to existing levels of a problem, it appears that concern is not immediately fully aroused by an increase in the level of a problem, but bubbles up slowly. Such a delayed response could be designated *partial adjustment*. At least two mechanisms could account for this phenomenon.

First, partial adjustment may reflect a lag in the compilation of reporting of information about risks. Information about hazards such as crime and disease fatalities takes time to collect and disseminate. If this effect were sufficiently pronounced, one could observe a positive value for b_2, even if adaptation does occur.

Second, people may expect positive changes in time series to be followed by mean-reverting adjustments. Research on intuitive extrapolation (Andreassen and Kraus, 1987) has shown that people often expect random variables to regress toward prior levels. The well-known *gambler's fallacy* reflects the general belief that random sequences alternate more often than they actually do. The fact that people expect an unfavorable change to be followed by a favorable adjustment could explain why, given a particular current problem level, they tend to be less concerned if the problem has recently worsened.

The expectation of mean reversion may also be due to experience with error-prone data, where extreme shifts are often caused by measurement error. When interpreting data on hazard levels, individuals are faced with the classic signal-detection task of differentiating fundamental changes from short-term fluctuations and random error. The greater measurement error is, the larger is the number of observations people should require to draw conclusions about changes in hazard levels. Hence, in the short run, expectations may be regressive.

Finally, it is possible that partial adjustment is a short-term phenomenon, while adaptation is a longer-term process. In early periods, concern could gradually grow due to one or more of the reasons discussed above. However, in later periods people might adapt to

Table 4. Correlations between forecasts and realizations

Problem name	Levels	Changes	*n* of cases
Inflation	.39	−.35	32
Unemployment	.97	.86	19
Polio	.80	.77	144

the problem, producing a decline in concern. If this were the case, then we would expect concern following the introduction of a new risk to follow an inverted U-shaped trajectory. Although this pattern is difficult to observe econometrically, since the actual duration of the lags is unknown, there are some cases of public responses to risk that do appear to fit this pattern. The establishment of MADD chapters, depicted in figure 2b, did not accelerate until several years after fatalities started to climb, and then continued to increase briefly after fatalities peaked in 1984 (see McCarthy, Wolfson, Baker, and Mosakowski, 1988). Longer time series on a wide range of risks would allow us to ascertain whether this pattern is a common one.

2.2.4. Panic. Finally, we turn to those problems (herpes, teenage suicide and illegitimacy, and AIDS) that display extreme fluctuations in concern that do not correspond to changes in the level of the problem. These problems seem to present evidence of what could be termed *panic* in dynamic risk perception.

Tales of public panics occur throughout recorded history. During the French revolution, for example, a "great fear" (grande peur) extended throughout the French countryside. In village after village, rumors of brigands, dragoons, or vagrants caused peasants to arm themselves and led to mass uprisings (Lefebvre, 1973). In the 1950s, a not dissimilar fear of communism and communists swept the American public and their politicians (Caute, 1978). Most recently, impressed by the volatility of financial markets, economists have proposed formal definitions of panic, and have attempted to understand why panics occur (Smith, Suchanek, and Williams, 1986; Camerer, 1989).

Applied to risk perception, panic refers to a situation in which public concern for a problem temporarily rises to a level either out of proportion to the problem's objective magnitude, or out of line with prior and future levels of concern. Panics are difficult to identify econometrically, because no good criteria exists that define exactly what pattern of residuals qualifies as a panic. Nevertheless, by the sheer magnitude of the phenomena, the risks mentioned earlier—herpes, AIDS, and teenage suicide and illegitimacy—do seem to have features suggestive of panic. For each, there are sudden surges of concern that are unrelated to or vastly out of proportion to changes in the underlying problem. And in each case, at its peak, concern is radically out of line with earlier and later levels.

Why do certain risks evoke panic while others do not? To address this question, we must return to the cross-sectional approach that has characterized most work on risk perception. Although cross-sectional research cannot identify panics, which are inherently dynamic in nature, time series research cannot explain why panics occur. Indeed, panics are in part *defined* by the lack of an explanation for an observed surge of public concern (in terms of actual changes in the underlying problem). Ideally, it should be possible through cross-sectional analysis to identify the characteristics of a problem that make it prone to panic. However, given the small number of risks we examined, a true cross-sectional analysis is impossible, and we can only speculate about why some risks temporarily attract disproportionate attention. Clearly, an important avenue for future research is to examine risk perceptions both cross-sectionally and over time using panel data.

Table 5 lists the different risks we examined, classifying them according to the apparent occurrence or nonoccurrence of panic. What characteristics distinguish between the risks listed on the left and right half of the table? Slovic, Fischhoff, and Lichtenstein (1980)

Table 5. Risks by presence or absence of panic

No evidence of panic	Evidence of panic
Polio	AIDS
Crime	Herpes
Inflation	Teenage suicide
Unemployment	Teenage illegitimacy

identified three factors—*dread*, *exposure*, and *familiarity*—that appear to underlie risk perceptions. Problems that are higher in dread and exposure, or are less familiar, are *ceteris paribus* perceived of as riskier. Dread includes components such as whether the problem is potentially catastrophic, fatal, threatening to future generations, not easily reduced, involuntary, and threatening to the rater personally. None of these factors seems to discriminate between the panic-prone and non-panic-prone risks listed in table 5. For example, if anything we would expect crime, inflation, and unemployment to affect most raters more personally than AIDS, teenage suicide and illegitimacy, and to a lesser extent herpes. Exposure refers to the numbers of people exposed, but again this factor does not appear to discriminate between the two categories of risks. Certainly AIDS and teenage suicide are far more localized than crime, inflation or unemployment.

The panic-prone and non-panic-prone risks do, however, seem to differ in familiarity. Familiarity in the Slovic et al. study included observability, knowledge, immediacy of consequences, and familiarity itself. AIDS, herpes, and teenage suicide and illegitimacy are all problems that have only recently reached public consciousness, and policymakers and the public seem equally at a loss for explanations or solutions. Polio, crime, inflation, and unemployment have long been identified as important problems. Herpes and AIDS are also not directly observed by most of the population, and knowledge about causes, incidence, and treatments remains severely restricted. Although it is impossible to derive any hard conclusions from such a small sample of risks, it appears possible that familiarity, as defined by Slovic et al., is a major factor underlying the dynamic response to risks.

Panics, like other social phenomena, have proximate as well as distal causes. Distal causes refer to fundamental and long-term causal factors. Familiarity may constitute such a distal cause of panics. Proximate causes refer to the immediate factors that cause a phenomenon to emerge at a particular time and place. For panics, the proximate cause often seems to be a particularly vivid case or new finding that receives considerable media attention. An illustration of this is the case of AIDS, depicted in figure 2a. In the last months of 1982, with more than 1000 cases of AIDS infection reported, the major newspapers and news magazines published a total of less than two articles per month on the epidemic. In April of 1983, the revelation that AIDS could be transferred through blood transfusions led to a brief media blitz amounting to approximately 225 articles per month (Shilts, 1987, p. 267). After two more years of relatively sparse coverage, media and public concern was once again sparked. The announcement in July, 1985 that Rock Hudson had contracted AIDS led overnight to a 500% increase in the number of news articles on the disease.

Panics may also be initiated by a type of contagion process, either by word of mouth or through the news media. In some cases, a single article in a major periodical can spark a

surge of interest in the media as a whole, even when no evidence exists of an underlying change in the problem itself. This is illustrated by the cases of herpes and teenage suicide depicted in figures 2d and 2h. In retrospect, there were no discernible qualitative shifts in the paths of either of these problems. However, each of them exhibited temporary but powerful surges of concern as manifested by news articles. Although apparently fueled by the media, concern took on far more concrete forms. For example, during the brief media blitz on herpes, many parents would not allow children to attend classes with students who exhibited signs of herpes.

3. Discussion

Our main findings are as follows. First, for a variety of problems, subjective risk perceptions track the objective levels of problems surprisingly closely. Second, there is no evidence of adaptation in dynamic risk perception, at least in the short run. Instead, we observed a phenomenon that we termed *partial adjustment*; instead of adjusting rapidly, or even overshooting, concern seems to bubble up slowly over time in response to an increase in the level of a problem. We noted that this could be explained by risk communication processes involving lags, by the presence of random noise in information about risks, or, closely related, by a popular belief that time series tend to be regressive. Third, we found some evidence that surprise plays a role in dynamic risk perceptions. Fourth, we identified a dynamic pattern of risk perception that we termed *panic*—a temporary elevation of concern above past and future levels that is not explained by a change in objective risks. We speculate that the psychological construct Slovic et al. refer to as *familiarity* may help to discriminate between risks that do and do not evoke such a panic reaction.

Cross-sectional research on risk perception is like a snapshot of a scene. It gives an overall picture, but provides no information about how the scene is evolving over time. Thus a snapshot can present a highly selective or even misleading image if the landscape it depicts is changing over time. Time series research, on the other hand, is like a movie; it provides information about how a scene changes over time, but often fails to present the big picture. In this study, although our main innovation is to examine risks in a dynamic perspective, we have also attempted to introduce a cross-sectional perspective by examining time series for a variety of different problems. Nevertheless, far more work remains to be done both on risk time series and, as mentioned earlier, on panel data.

An important question that would require panel data to address is whether people perceive a relatively constant overall level of risk over time or whether overall risk perceptions also wax and wane. It is possible that people have a roughly fixed amount of concern they can focus on different problems. Indeed it has been argued both in the media (Dionne, 1988), and the academic literature (Scitovsky, 1981), that most people have an optimal level of concern that is greater than zero. Such *single-peaked* preferences (Coombs and Avrunin, 1977) for perceived risk would mean that different risks would be substitutes for one another. On the other hand, it is possible that overall awareness of risk fluctuates over time. The great fear in revolutionary France seems to reflect such an overall heightening of fear.

Notes

1. There is some question whether the net *formation* or *existence* of MADD groups is a better measure of concern about drunken driving. The reason we selected the former is that different MADD groups operate at varying levels of involvement. Many begin with great enthusiasm and then peter out even though they aren't officially disbanded. Thus, the absolute number of groups in existence is a poor proxy for aggregate concern. Beginning a group, however, requires great effort, and is a more reliable indicator of concern. There would of course be a problem if there were so many groups that existing groups prevented new groups from forming. But the total number seems insufficient to cause appreciable "crowding out."

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