

RISK HOMEOSTASIS: A CASE STUDY OF THE ADOPTION OF A SAFETY INNOVATION ON THE LEVEL OF PERCEIVED RISK

Napier, Vic
Pima Community College
vic@vicnapier.com

Findley, Carolyn Sara (Casey)
Auburn University Montgomery
casey.findley@mail.aum.edu

Self, Donald Raymond
Auburn University Montgomery
dself@mail.aum.edu

ABSTRACT

Risk homeostasis theory introduces the concept of perceived risk. Each individual has their own acceptable target level of perceived risk. If his/her perceived risk becomes too great, he/she is take measures to reduce that risk back to an acceptable level. Conversely, if his/her perceived risk is too low, he/she will introduce more risk into the situation in order to raise the level of perceived risk back to the target level. Thus, a homeostatic effect is achieved through the constant adjustment of perceived risk. Safety innovations are often used as a tool to lower the level of perceived risk. However, the individual may not have the ability to stop the lowering of the perceived risk after the introduction of a safety innovation. So with a safety innovation, the perceived risk often becomes too low, and the individual will make corrective measures by introducing increased risk, a concept referred to as accident migration. The effects of risk homeostasis are observable in a wide variety of settings. In skydiving, the introduction of a safety innovation, the Cypres Automatic Activation Device (AAD) promoted a decrease in “no pull/low pull fatalities.” During this period, there was an increase in “open canopy fatalities,” while the aggregate number of skydiving fatalities remained relatively stable. This paper will further establish that risk homeostasis theory can explain the shift in types of skydiving fatalities during the adoption of the AAD during an eight year adoption period. Data for this study comes from the following sources; United States Parachute Association, Skydive.net, and SSK Industries (AAD manufacturer). Implications for manufacturers and distributors of equipment used in extreme sports are presented.

INTRODUCTION

During 1990 through 2000, technical improvements in sport skydiving resulted in a dramatic decrease in skydiving fatalities related failure to activate a parachute. During the same time, there was a dramatic increase in the number fatalities related to landing. Total annual fatalities remained about the same during this period. Although a connection between these trends has been

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suspected for some time, a relationship between the two trends has never been the topic of academic research. This paper establishes a relationship between the introduction of a safety innovation, the Cypres Automatic Activation Device (AAD) and a simultaneous decrease in “no pull/low pull fatalities” and increase in “open canopy fatalities,” while the aggregate number of skydiving fatalities remains relatively stable. This paper will further establish that risk homeostasis theory can explain the shift in types of skydiving fatalities during the adoption of the Cypres Automatic Activation Device (AAD).

The Cypres is a very popular brand of Automatic Activation Device (AAD), which was introduced in 1991. Cypres stands for “Cybernetic Parachute Release System.” It is a safety device that is designed to deploy the reserve parachute if a skydiver goes through a preset altitude at a speed that would indicate that his or her main parachute was not deployed.

LITERATURE REVIEW

Skydiving, sensation seeking, and risk homeostasis have been the subject of in both the academic and popular media settings. However, very little research specifically links the three, which are intrinsically related.

Zuckerman (1994) defined sensation seeking as “the seeking of varied, novel, complex, and intense sensations and experiences and the willingness to take physical, social, legal, and financial risks for the sake of such experience,” and called those with this personality type “sensation seekers.” Farley (1986) referred to this risk taking personality as the “Type T.” Both of these terms describe an individual who is thrill seeking, sensation seeking, and risk taking (Farley, 1986; Roberts, 1994). Sensation seeking can be described by a series of continuums. Those at one end of the continuum are most happy living very calm, predictable lives, while those at the other end of the continuum constantly look for novelty and excitement. This trait can be expressed in positive and negative ways, as well as mental and physical ways (Self and Findley, 2007). Extreme sports, like skydiving are an example of a positive, physical expression of sensation seeking.

Psychologically, sensation seekers can be identified through the Sensation Seeking Scale, Form V (SSS-V). The SSS-V has four subscales; thrill and adventure seeking (TAS), experience seeking (ES), disinhibition (Dis), and boredom susceptibility (BS). Thrill and adventure seeking (TAS) refers to the desire to engage in extreme sports and/or dangerous activities. Experience Seeking (ES) is the desire to seek novel experiences through travel and unconventional friends and lifestyles. Disinhibition (Dis) refers to a lack of inhibited social behavior involving promiscuity and substance use. Boredom Susceptibility (BS) describes distaste for repetitive, or routine, work and/or people. (Zuckerman, Kuhlman, Jorjeman, Teta, and Kraft, 1993).

There are several biological/chemical characteristics that are commonly found in sensation seekers. Sensations seekers are most likely to be male and between the ages of 16 and 24. However, there are many sensation seekers who are female and/or in a different age range. Sensation seeking tends to decline slowly with age, which parallels a decline in testosterone levels (Farley, 1986; Roberts, 1994; Zuckerman, 1994).

Zuckerman has also found a genetic link for sensation seeking. Sensation seekers have an elongated version of the DRD4 gene, which regulates the production of dopamine and affects pleasure and emotion (Alvear, 1999; Roberts, 1994; Toufexis, 1996, Zuckerman, 2000).

Many researchers have conducted studies that link sensation seeking and extreme sports, specifically skydiving (Fitzpatrick, 1999; Poretz, 2003; Roberts, 1994; Self, Henry, Findley and Reilly, 2007; USA Today, 2003; Weiss, 1987; and Zuckerman, 2000).

Semmens and Kresich (1988) lay out the early history of risk homeostasis theory. Evidence for risk homeostasis theory begins with Peltzman's economic model of behavior surrounding improvements in traffic safety. He cited a North Carolina accident survey that indicated automobiles with particular safety equipment were 40 percent more likely to be involved in accidents. This and similar results convinced Peltzman that human behavior interacts with safety improvements in subtle and powerful ways. Peltzman felt safety is only one of a number of competing goals that people bring to risky activities. Convenience, comfort, excitement and status are examples of some of the needs that compete with safety. From an economic prospective, individuals might choose to trade an increase in safety for speed or economy.

Peltzman's economic model eventually evolved into the risk homeostasis theory. This theory, which was developed by Wilde (1984), predicts that when external forces increase risk beyond acceptable levels people will alter their behavior to decrease risk to an acceptable level. However, when risk decreases below optimal levels people will behave in ways that satisfy competing needs, with the need for safety being only one of many. The main differences between people are their individual levels of acceptable perceived risk, or target risk. Sensation seekers, specifically extreme sports participants may have higher levels of target risk than their low sensation seeker counterparts.

Most of the evidence for risk homeostasis comes from traffic safety statistics. Hoffer, Milner and Peterson (1995), in a study of Virginia traffic accidents in the early 1990s, found that driver side airbags contributed to driver behaviors that increased accidents and fatalities. Semmens and Kreisich (1988), point out that in spite of the introduction of many safety devices just as large a proportion of the US population gets killed in traffic accidents now as in 1925. Although the fatality rate per mile of travel has gone down, the aggregate number of traffic related fatalities has remained relatively stable. They also found pedestrians are twice as likely to be killed in a painted crosswalk as in an unmarked one.

Risk homeostasis has been observed in a variety of settings. Sagan (1997), and Stetzer and Hofmann (1996) have illustrated the theory of risk homeostasis on large organizations such as NASA, but they haven't examined the character or habits of the individuals involved. Breslin, Sobell, Capell, and Vakili (1999) applied risk homeostasis theory in explaining the effects of alcohol on gambling.

The effects of risk homeostasis have been applied to several extreme sports. Shealy (1999) used risk homeostasis theory to explain the relationships between helmets and skiing. Levine and Gorman (1994) also surveyed skiers' perceptions of danger following skiing deaths. Several researchers have observed the effects of risk homeostasis in their review of whitewater kayaking safety and fatality rates (Harrison, 1998; Kesselhiem, 1999, Potomac, 2004).

Skydiving has also been the subject of previous research on risk perception. Griffith and Hart (2005) found, in a comparison of skydivers to non-skydivers, that the skydivers had lower levels of death anxiety, which lends itself to higher levels of target risk. Celsi, Rose, and Leigh (1993) found skydivers to accept significantly higher levels of risk. Finally, Laurendeau and van Brunschot (2006) observed how more experienced skydivers monitor the risk perceptions of the beginning skydivers in their subcultures.

HYPOTHESIS

This paper is comparing two groups of dead skydivers; those who died from "Open Canopy Fatalities" and those who died from other causes.

H1: Accident records will show that when fatal skydiving accidents in one category decline, there will be an increase in fatal skydiving accidents in a different category.

METHODOLOGY

This is a comparative study of existing data, measuring relationships between the following data: 1) Total annual US skydiving related fatalities, 1989 through 1998; 2) Total annual US parachute landing related fatalities, 1989 through 1998; 3) Total annual US Cypres activation's, 1989 through 1998; 4) Cypres US annual sales, 1989 through 1998; 5) The age and number of jumps of victims of fatal skydiving accidents.

Data on skydiving fatalities for the years 1989 through 1998 was supplied by United States Parachute Association (USPA). This data consists of the "official" numbers that identify the age and number of jumps of the accident victims and equipment involved.

Data from an online database at Skydive.net, which was also used in this study, is more detailed than the USPA data. Gross totals of fatalities, age and jump number have matched USPA numbers for the last five years.

Data on Cypres activation was supplied by SSK Industries, the US distributor for AirTec, the German manufacturer of Cypres AADs. Until 1998, any Cypres that was activated had to be sent to the factory for inspection and calibration. This resulted in highly accurate data on each Cypres activation.

Skydivers refer to dangerous fast turns made at low altitudes as "Hook Turns". The USPA uses a definition to define low turns that result in death or injury as a turn made under canopy so close to the ground that the jumper does not return to straight and level flight before impact. This definition does not cover situations in which a jumper may have an open and controllable canopy, but fails to make any control inputs at landing, and as a result flies straight into the ground at 40 mph with fatal consequences.

If the data source indicates that a fatal accident involved an open and controllable canopy it is treated as an "Open Canopy Fatality". "No pull/low pull " indicates that either no parachutes were deployed before impact, or were deployed too late to avoid fatal injuries. "Other" means that the jumper died as a result of some other cause besides Open Canopy Fatality or no pull/low pull.

RESULTS

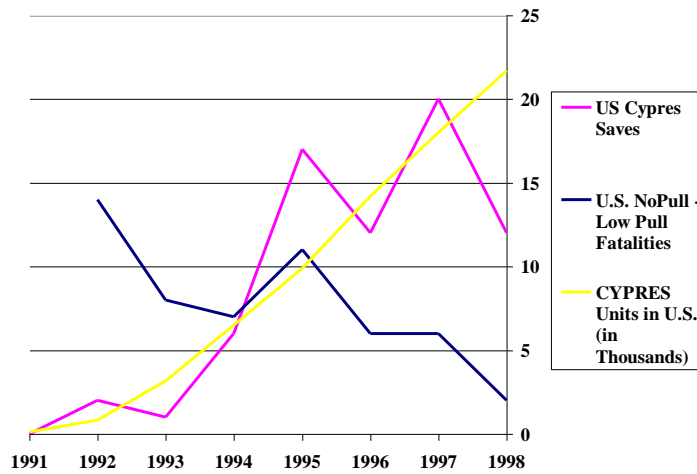
H1: Accident records will show that when fatal skydiving accidents in one category decline, there will be an increase in fatal skydiving accidents in a different category.

The first issue addressed was whether the increasing popularity of Cypres AAD's resulted in a decrease in "No pull/low pull fatalities." Using USPA and SSK data, it becomes apparent that shifts in the circumstances surrounding fatal accidents began occurring in the early 1990s. SSK data shows an obvious inverse relationship between "No pull/low pull fatalities" and Cypres saves from 1991 to 1998. Cypres sales figures also increase proportionally to Cypres saves.

The inverse trends of decreasing no pull/low pull accidents and increasing Cypres saves gives strong support to the contention that Cypres units are responsible for the change in aspects of risk in sport skydiving.

<i>Year</i>	<i>CYPRES in U.S. (in Thousands)</i>	<i>US Cypres Saves</i>	<i>U.S. No Pull - Low Pull Fatalities</i>
1998	21.7	12	0
1997	17.99	20	2
1996	14.19	12	6
1995	9.89	17	6
1994	6.49	6	11
1993	3.17	1	7
1992	0.83	2	8
1991	0.11	0	14

Cypres Saves vs LPNP Fatalities

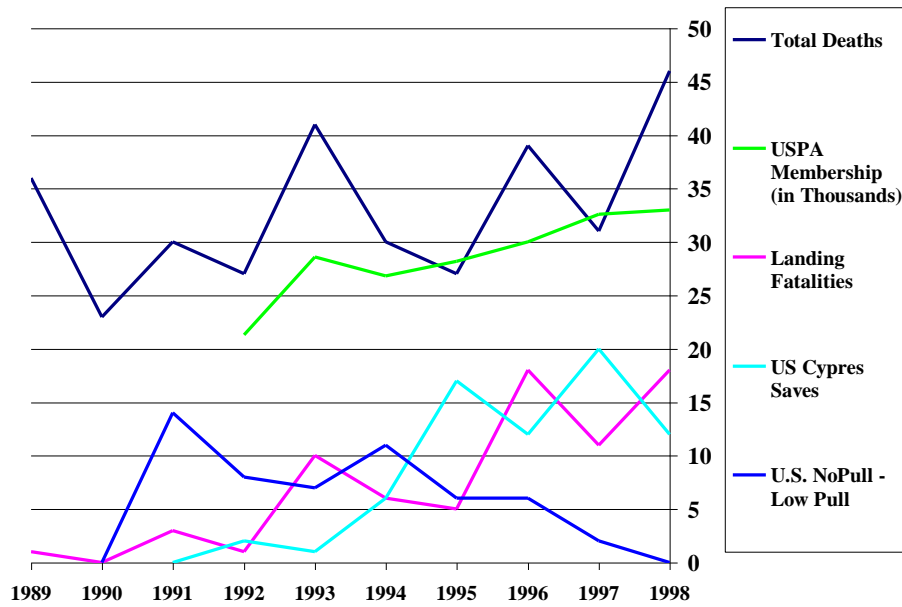


While the SSK data clearly shows a decrease in the number and rate of no pull/low pull fatalities; USPA data shows an increase in fatalities associated with landing. Throughout the 1990s landing accidents accounted for a steadily larger portion of total skydiving related deaths. By 1998 landing accidents had had increased form a very small percentage of fatal accidents to the single leading cause, claiming 36 lives, and accounting for 39% of all fatal accidents.

<i>Year</i>	<i>Total Deaths</i>	<i>Landing Fatalities as a Percentage of Total Deaths</i>	<i>Landing Fatalities</i>
1998	46	39%	18
1997	31	35%	11
1996	39	46%	18
1995	27	19%	5
1994	30	20%	6
1993	41	24%	10
1992	27	4%	1
1991	30	10%	3
1990	23	0%	0
1989	36	3%	1

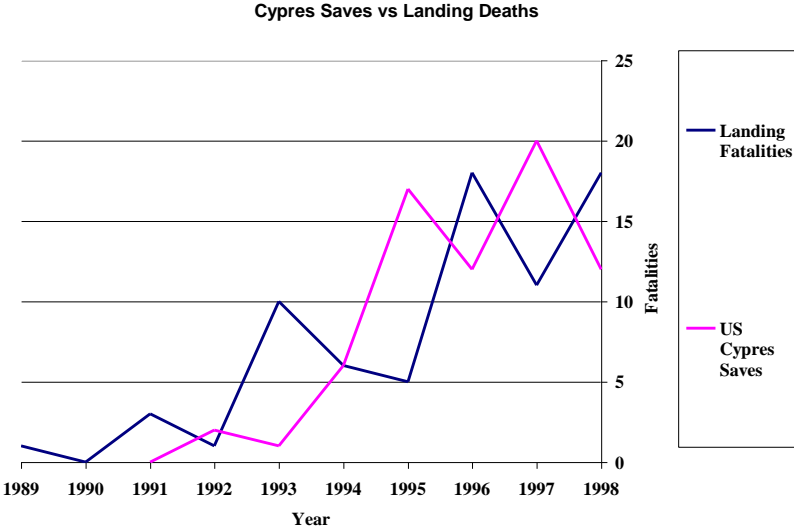
A graphical summary of the data, (Fig 1), shows a distinct direct relationship between Cypres saves and an increase in Open Canopy Fatalities over time that is independent of total fatalities or increasing numbers of jumpers as measured by USPA membership.

Figure 1 Graph Summary



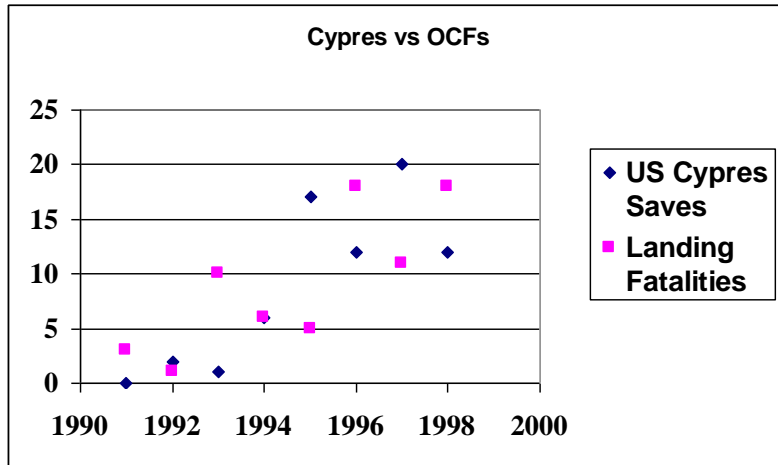
When extraneous data lines are removed the relationship between Cypres saves and Open Canopy Fatalities becomes very apparent. (Fig. 2)

Figure 2 Cypres Saves vs Open Canopy Fatalities



A scatter plot correlating landing fatalities with Cypres saves also shows a distinct relationship between Cypres saves and Open Canopy Fatalities, (Fig. 3).

Figure 3 Cypres Saves vs Open Canopy Fatalities



When presented as raw numerical data the correlation between Cypres saves and Open Canopy Fatalities is equally notable. (Fig. 4)

Figure 4 Correlation between Cypres Saves and OCFs

<i>Year</i>	<i>US Cypres Saves</i>	<i>Landing Fatalities</i>
1998	12	18
1997	20	11
1996	12	18
1995	17	5
1994	6	6
1993	1	10
1992	2	1
1991	0	3
Correlation		0.45

This data shows an unmistakable relationship between the increasing visibility of the Cypres AAD and accidents migrating from “No pull/low pull fatalities” to “Open canopy fatalities.” H1 is accepted.

DISCUSSION

The data presented here shows a very strong relationship between Cypres saves and “Open canopy fatalities.” This relationship occurs exactly as risk homeostasis predicts; skydivers adjust their behaviors to maintain arousal at optimal levels.

Although the graphs are eye catching, correlation does not prove causation. In order to establish causation further research is needed. Perhaps more causal comparative studies in which skydivers are surveyed to determine changes in their attitudes about the impact of Cypres AADs on skydiving risk, compared with corresponding behavioral changes. Determining correlation between these kinds of variables could lead to a determination about how perception of safety influences risk-taking behavior.

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