EXPLORING THE EFFECT OF GROUP POLARISATION ON PERCEIVED INVULNERABILITY IN GENERAL AVIATION PILOTS

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ABSTRACT

Although both perceived invulnerability and group polarisation are well known psychological phenomena, there has not been any research conducted to examine the effect of group polarisation on the level of perceived invulnerability amongst general aviation pilots.

Two studies were conducted to measure the level of perceived invulnerability amongst general aviation pilots and to test whether the level of perceived invulnerability was affected due to group polarisation.

The first study tested 34 pilots. Although the majority of the pilots exhibited perceived invulnerability, there was no evidence suggesting that low level group interaction induced group polarisation leading to an increase in individual's level of perceived invulnerability.

The second study examined 78 pilots. Although the majority of the participants displayed perceived invulnerability, there was no evidence suggesting that high level group interaction resulted in group polarisation leading to an increase in individual's level of perceived invulnerability.

There was no evidence that the two experimental manipulations (low group interaction and high group interaction) differed in effectiveness, as the effect size between studies I and II did not significantly differ.

Although it is of some concern to general aviation safety that the majority of the pilots in both studies exhibited perceived invulnerability, the level of perceived invulnerability does not appear to be increased by a group polarisation effect. The latter finding is consistent with safe operations, having found no evidence that multi-crew operations lead to increased levels of perceived invulnerability. In addition to the implication of the current findings, limitations of the present study, possible areas for further research and recommendations are presented.

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ABBREVIATIONS

ACAS	Airborne Collision Avoidance System
AIDS	Acquired Immune Deficiency Syndrome
AOPA	Aircraft Owner and Pilots Association
ATP	Air Transport Programme
BFR	Biennial Flight Review
CAR	Civil Aviation Rule
FAA	Federal Aviation Authority
GA	General Aviation
GAO	General Accounting Office
HIV	Human Immunodeficiency Virus
ICAO	International Civil Aviation Organisation
IMC	Instrument Meteorological Condition
NTSB	National Transportation Safety Board
PPL	Private Pilot Licence
TCAS	Traffic Alert and Collision Avoidance System
VFR	Visual Flight Rules
VMC	Visual Meteorological Condition

CHAPTER ONE

INTRODUCTION

1.1 Aviation safety

Since man's very first powered flight, it has been clear that there is an element of risk involved in flight. However, during the period of powered flight the reasons for the risk have changed considerably. In the early days risk was essentially due to issues of design, aerodynamics and mechanical failures. The last hundred years of aeronautical design and research in human factors have seen a fundamental change in the cause of risk. Nowadays, the main cause is not the aircraft but the human in the cockpit (Koonce, 1999).

Hobbs (2004) examined 100 aircraft accidents that occurred between 1921 and 1932 in Australia and reported that pilot error contributed significantly more to accidents than mechanical failure. However, despite the presence of human error, it was not identified as a significant scientific discipline in the early days of aviation (Koonce, 1999). This suggests that risk due to human error has been the primary flight safety issue since the early days of aviation (Feggette, 1985; Murray, 1997) although the importance of human error has recently become significant.

It has been noted that the air accident rate has declined as technology has advanced. In particular, a dramatic improvement of overall reliability of aircraft systems was observed when turbojet and turbofan engines were developed and introduced in the late 1950s and early 1960s (Chamber & Nagel, 1985). O'Hare (1999) argued that "the reliability of jet engines compared to reciprocating engines was both directly (fewer engine failures) and indirectly (fewer powerplant problems meant fewer problematic situations for crew to manage) responsible for improved levels of safety" (p. 7).

Although the aviation industry continues to witness a high level of sophistication, air accidents continue to occur. Because of its rapid engineering progress, which has resulted in fewer accidents due to mechanical malfunction, recent attention has diverted to focus predominantly on human factors, which has been the primary flight safety issue since the early days of aviation (Feggette, 1985; Murray, 1997). Pearson (1963) claimed that human factors, pilot error in particular, stemmed from inattention, poor judgement and distraction and it was in this area where the greatest contribution could be made toward the reduction of accident.

It has been suggested that approximately 70–80% of aviation accidents are attributed, at least in part, to human error (Wiegmann & Shappell, 2003). Whilst it may be possible to reduce the current accident rates further, it is unrealistic to expect human induced accidents to be totally eliminated because of the idiosyncrasies of human performance and reasoning. In addition, technological innovations have "radically altered the relationship between systems and their human elements" (Reason, 1997, p. 1) resulting in a new sphere of accidents. According to Sarter and Alexander (2000), the projected growth rate in air traffic during the next decade could lead to an average of one major aircraft accident per week unless the current accident rate is reduced further.

In principle, a possible solution to the human error induced accidents may be to replace the pilots, who are vulnerable to certain forms of error, with a fully automated system that is not susceptible to error. However, despite the current impressive technology, in practice it is almost impossible to design fully automated error-free system that could cope with all types of emergencies (Orasanu, 1993). In addition, Dismukes and Tullo (2000) countered such views, arguing that humans have the unique capability to analyse incomplete or conflicting information from diverse sources and to assess novel situations and devise appropriate solutions in a way that current technology is not.

It is therefore somewhat ironic that the cognitive processes that make humans such good pilots may equally make them vulnerable to certain forms of error, which is why the accident record repeatedly demonstrates that at least three out of four accidents involve performance error made by apparently healthy and appropriately qualified individuals (ICAO, 2005).

In potentially high-loss endeavours such as airline operations, Degani and Wiener (1997) argue that it is essential to have a detailed set of procedures in order to successfully operate complex human-machine systems. This is indeed the case, as the majority of operational decisions by pilots in airline environment are predetermined in standard operating procedures; failure to comply with such procedures may result in a disciplinary action.

Despite the usefulness of standard operating procedures, logically not all situations have corresponding procedures to satisfy the outcome, as some situations that arise will be novel, in the sense they have never happened before (This is analogous to the frequent criticism of inductive reasoning, discussed by Gilbey & Hill, [2008].).

Alternatively, there may be instances where the situation may be differently perceived by flight crew and consequently the flight crew may respond in a sub optimal manner. In addition, when an option selection decision (this is to select one option from among a set of alternatives, Orasanu, [1993]) is faced, any psychological factors (e.g., perceived invulnerability) that arise during a decision making process could further degrade the quality of decision.

Thus, it seems reasonable that a better understanding of the underlying causes of pilot error and poor judgement is required in order to improve aviation safety by accurately detecting and appropriately managing errors. Dismukes and Tullo (2000) suggested that both airlines and the regulatory authorities should redirect evaluation of crew performance away from counting errors and expecting performance to be error-free to the detection of errors and managing of the consequences of such errors. In addition, Besco (1992) argued that because few pilot errors were the consequence of skill deficiencies, the entire industry needed to focus on knowledge and attitude to improve pilot performance.

For many years, it was assumed that good judgement was an inevitable by-product of flying experience. However, the data that Bureau of Air Safety Investigation (1996) has accumulated indicates that "the errors of judgement are made by experienced and less-experienced pilots alike" (p. 5). Therefore, airlines around the world have devoted many resources on human factors training. Consequently human factors training, in particular Crew Resource Management, Line Operation Safety Audit and Threat and Error Management, became a significant aspect of the airline training syllabus in order to reduce crew related accident (Simpson & Wiggins, 1999).

Sarter and Alexander (2000) pointed out that the overall safety of the system could be determined by the performance of the weakest link. The weakest link has been often referred to the single pilot, low-technology, less rigorously trained pilots in general aviation, rather than multi-crew, high technology, expensively trained pilots in air transport environment (Strictly speaking, however, this may actually be due to 'cherry-picking' of the highest ability trainees for air transport from the pool of would-be pilots, as opposed to an effect explained by the two different career strands).

According to the report from Bureau of Transportation Statistics (2007), in the United States, the accident rate for general aviation in 2006 was 6.64 accidents per 100,000 flight hours, whereas the accident rate for air transport operation was 0.15 accidents per 100,000 flight hours. This indicated that the accident rate for general aviation was 44 times greater than the accident rate for air transport operation. These vast differences in accident rate have been found to be consistent for many years (Bureau of Transportation Statistics, 2007).

Despite the higher accident rate for general aviation, accidents involving air transport operation appear to receive greater media attention. At least in part, this is likely to be due to the number of toll involved per accident. It is however noteworthy that the fatality rate for general aviation was almost seven times greater than the fatality for the scheduled air transport operation for period from 1977 to 1994 (Wyczalek, 1997). O'Hare (1999) explained that although the losses in general aviation (e.g., human and economic) may be as great, if not greater, as the losses in air transport environment, the main focus by the regulators and public has almost exclusively been on the toll arising from air transport crashes. This may be because deaths arising from general aviation crashes are spread in ones or twos and consequently, ignored as they receive less attention from the media.

Hunter (1999) stated that virtually all airline pilots were once general aviation pilots at one stage of their carrier. Indeed, when they commenced their flight training, they were considered as general aviation pilots. It therefore seems reasonable to assume that attitudes learnt in general aviation have an enduring effect; that is, the attitude learnt is likely carried over to airline transport environment (Hunter, 1999). This implies that more focus on human performance analysis and human errors are needed at general aviation level.

1.2 Aviation safety in general aviation

As Hunter (1999) described, general aviation is composed of pilots with a wide variety of experience and a wide range of aircraft type. General aviation can be broadly described as all aviation operations, excluding those of commercial airlines and military aviation. General aviation encompasses a wide variety of activities that include, but are not limited to, business flying, agricultural aviation, personal flying for pleasure or sports, and flying by flight-training institutions (Kumar, DeRemer, & Marshall, 2005). In addition, there are various categories of aircraft used in general aviation operations, including single engine and multi engine piston aircraft, turboprops, turbojets, helicopters, gliders and experimental aircraft (GAO, 2004).

According to the General Accounting Office (GAO) (2004), the majority of general aviation hours flown fell into three distinctive categories of flying activities: recreational, business, and corporate flying. Recreational flying related to the use of aircraft for pleasure or personal transportation, accounted for 40.8% of the total general aviation hours. Business flying related to the use of aircraft in connection with the pilot's occupation or private business, accounted for 12.2% of the total general aviation hours. Corporate flying related to the use of aircraft owned or leased by a corporation or business flown by professional pilots, also accounted for 12.2% of the total general aviation hours.

According to the Aircraft Owner and Pilots Association (AOPA) (2002), recreational flying accounted for the largest single type of operations and also the largest accident rate (67.3%) in 2000. This accident rate, mainly due to human error (e.g., pilot error) for recreational flying, has been observed for many years, although there has been an increased recognition of the importance of human factors in pilot performance in general aviation and consequently human factors training has been incorporated in the pilot training syllabus (O'Hare, 1999).

Wiegmann et al. (2005) analysed data over an 11-year period from 1990 to 2000 and found no change in the proportion of accidents that were either mainly or partly due to the unsafe acts of pilots. Likewise, Li, Baker, Grabowski and Rebok (2001) found that 85% of the general aviation crashes may have been caused by pilot error and the percentage of probable cause has not been changed since 1942. This finding may be due to the wide diversity of flight activities, aircraft and pilot populations that made it especially difficult to improve the safety in general aviation (Li & Baker, 1999). Alternatively, because of limited opportunity of human factors training in general aviation, the general aviation pilots tend to be more vulnerable to human errors than airline pilots (Wiggins, 1999).

Simpson and Wiggins (1999) argued that although human factors education has become a significant aspect of the airline training syllabus, it was often a relatively neglected component in the general aviation environment. Indeed, to date there is only a limited number of formal on-going human factors training in general aviation. O'Hare (1999) argued although it was understandable that analysis of the human performance has been mainly focusing on air transport environment because of primarily large number of passengers carried and the global economic significance, it was now time to re-direct some portions of the effort to general aviation.

The issue about maintaining the adequate knowledge and skills required to operate an aircraft safely amongst recreational pilots in particular has not gone unnoticed. Ritchie (1988) argued that because the majority of pilots in general aviation do not operate as full-time professional pilots, a large number of general aviation pilots are faced with the challenge of achieving and maintaining adequate flying skills. According to Hunter (1999), the "lack of practice of flight skills, particularly procedural and decision-making skills, acts to curtail human performance" (p. 28).

Similarly, O'Hare and Chalmers (1999) found that the lowest median annual flying hours were Private Pilot Licence (PPL) holders (22 hours) and micro-light pilots (23 hours). Such low annual flying hours raised serious questions about the ability of most pilots to maintain the range of skills required to operate an aircraft safely in compliance with the legal certification requirements, although O'Hare (1999) argued that "the lack of recent flight experience does not itself constitute a risk factor for accident involvement" (p. 270).

According to New Zealand's Civil Aviation Rule (CAR) part 61 (2007), there is no minimum flying hours required to maintain currency of licence for Visual Flight Rule (VFR) pilots in general aviation. As long as a pilot complies with requirements such as medical requirement, recent flight experience and completion of Biennial Flight Review (BFR) every 2 years, the holder of pilot licence can continue to exercise the privileges applicable for the type of licence. These requirements do not appear to address human factors education, the area that Simpson and Wiggins (1999) considered so imperative.

Civil Aviation Authority of New Zealand (2001) claimed that the standardisation of BFR was constrained by the low number of completion of the review and the absence of a common syllabus. The Civil Aviation Authority of the United Kingdom (1997) also agreed that the requirement for the PPL revalidation were inadequate. "In a recent open letter to GA pilots in the New England region, Director R. E. Whittington said that some sources say that…the BFR is a quick ride around the pattern and a sign-off in the logbook for 2 more years of haphazard flying…a properly conducted BFR will help improve pilot judgement and flying proficiency" (Koonce, 2002, p. 190).

It seems reasonable to assume that the likeliness of accident involvement increases with time since the most recent BFR was conducted, as flying skill may degrade unless hours are regularly flown. However, actual data suggested that the shorter the period since the most recent BFR, the higher the number of general aviation accidents that occurred. Figure 1 shows that general aviation pilots who recently completed BFR were involved in more accidents than pilots who completed BFR less recently. Koonce (2002) explained that this counter-intuitive relationship may be due to pilots who recently completed BFR engaging in more frequent flying with greater self-confidence than the pilots who completed their BFR less recently.

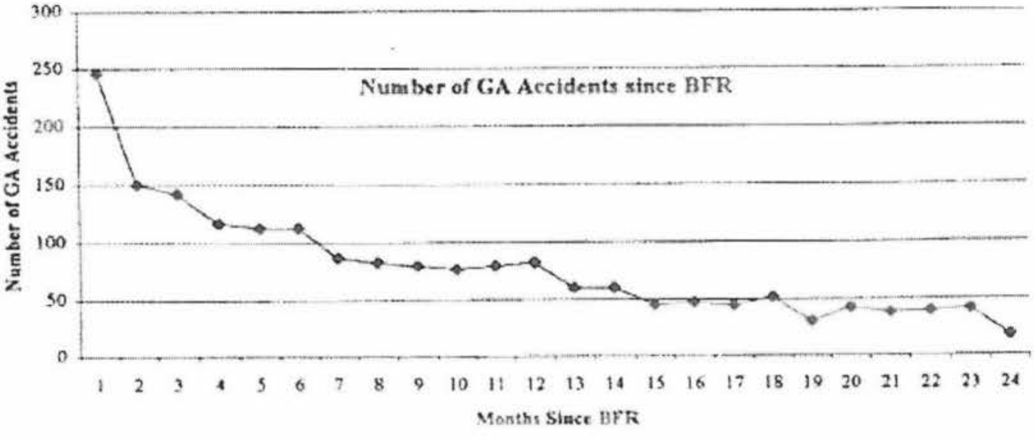

Figure 1. Number of general aviation accidents since Biennial Flight Review
Source: Koonce (2002)

Likewise, Booze (1977) found that the likeliness of accident involvement increased as one had greater recent exposure to the flight environment in general aviation. The likeliness of accident involvement was 10 times more for pilots with 101-200 flight hours in the last six months than those with 0-10 flight hours in the same period.

Logically, exposure is a prerequisite to incur risk. Li (1994) explained that likeliness of risk and accident involvement was a function of the exposure. Li (1994) further argued that frequent exposure to flying environment may result in tendency of overconfidence although, in contrast, Wetmore and Lu (2005b) argued that obtaining more flight experience could reduce the likelihood that a pilot would display overconfidence because better weather assessment in flight, for instance, may be a function of flying experience. However, numerous studies (e.g., Goh & Wiegmann, 2001; O'Hare & Smitheram, 1995; Wilson & Fallshore, 2001) claimed that although a pilot may have assessed the weather accurately, it was personal overconfidence that encouraged pilot to continue. In addition, both anecdotal and accident data suggested that pilot's willingness to encounter more challenging flight regimes was a function of experience, perhaps due to the acceptance of increased risk (Salvatore, Stearns, Huntley & Mengert, 1986).

Both O'Hare (1990) and Booze (1977) agreed that in general aviation, younger pilots were significantly more likely to be involved in accidents than older pilots. One reason could be that younger pilots were more likely to engage in more flying activities than older pilots. O'Hare (1990) combined the effect of age and recent flight experience on the accident involvement and suggested that younger pilots with relatively higher recent flight experience were more likely involved in the accidents. A similar finding was observed with younger pilots with more total flight time (Booze, 1977). In addition, younger pilots rated themselves as more likely to take risk and had high scores on a measure of personal invulnerability despite being aware of the risk involved (O'Hare, 1999), although the level of optimism was found to be a function of age (Borges & Dutton, 1976).

According to Federal Aviation Authority (2002), most general aviation pilots believe they are safer, possess greater flying skill, are less likely to take risks in flight, and are less likely than their peers to experience an aircraft accident; that is, they perceive themselves invulnerable to an aircraft accident. Logically, if the attribute is normally distributed, approximately half of the pilots holding such belief must be wrong (Gilbey, Fifield & Gibson, 2006). Thus, perceived invulnerability has been the focus of many investigations as these beliefs are considered to be widespread and they are easily observed in daily life.

1.3 Perceived invulnerability

Gilbey, Fifield and Rogers (2006) observed that it is imperative to perceive risk accurately, as subsequent behaviour is determined by the perception of risk involved. For instance, if people wrongly perceived the risk of behaviour to be lower than it actually was, they were more likely to exhibit such behaviour (e.g., Burger & Burns, 1988). This type of inaccurate perception of risk has been called perceived invulnerability (Breheny & Stephens, 2004), unrealistic optimism (Weinstein, 1980), optimistic bias (Weinstein, 1980), illusion of unique invulnerability (Perloff, 1987) and positive illusion (Taylor & Brown, 1988). This thesis will use the term 'perceived invulnerability'.

Research has suggested that people generally believe that they are less likely than their peers to experience such negative events (Weinstein, 1980). Studies concerning vehicle accidents (e.g., Holt, 2007; Svenson, 1981) found that many drivers believed themselves to be more competent and in control than they actually are, thus there was strong tendency to believe their chance of being involved in accidents was less than average. Study concerning smoking related illness found a similar tendency; that is, although current smokers admitted that they were more susceptible to smoking related illness than non-smokers, they perceived themselves less vulnerable to smoking related health risk than other smokers (McCoy et al., 1992). Similarly, Apanovitch, Salovey and Merson (1998) discovered that majority of college students considered themselves invulnerable to Acquired Immune Deficiency Syndrome (AIDS), although 85% understood the means of Human Immunodeficiency Virus (HIV) transmission and 25% personally knew someone with AIDS.

Contrary to research highlighting the negative side of perceived invulnerability, other researches have exposed the positive side of perceived invulnerability. Regan, Gosselink, Hubsch and Ulsh (1975) claimed that because of a need for high self-esteem and the need of psychological well-being, people might inflate self-assessments of their own ability. As a consequence, a positively biased view of one's future accompanied a variety of psychological benefits such as self-reports of happiness and contentment, increased motivation and persistence, and ultimately better performance and greater success (Taylor & Brown, 1988). In addition, the study on the implication of dispositional optimism for physical well-being suggested that "compared to pessimists, optimists seemed to show fewer signs of intra-operative complications and to evidence a faster rate of recovery" (Scheier & Carver, 1987, p. 179).

Numerous studies (e.g., Hoorens, 1996; Pulford & Colman, 1996) have demonstrated that people's general perception toward most situations is not accurate; that is, people tend to believe negative events are less likely than average to occur, yet positive events are more likely than average to occur. The likely causes of emergence of perceived invulnerability may include egocentrism accounts, singular vulnerability judgement and bias in a self-serving manner. Egocentrism accounts arise when self-serving information is believed to be more strongly related to the comparative judgement than other-relevant information (Chambers & Windschitl, 2004). Singular vulnerability judgement arises when people believe that probability of occurrence is based on individual or case specific information rather than base-rate (e.g., perceived relative frequency) information (Klar, Medding, & Sarel, 1996). Bias in a self-serving manner arises when people believe that their own attributes are more likely than other attributes to facilitate desired outcomes and to hinder feared outcomes (Kunda, 1987).

In aviation, the phenomenon of perceived invulnerability has been studied with the view to minimise risk-taking attitude in pilot judgements. For instance, Berlin et al, (1982) introduced invulnerability as one of five hazardous thought patterns (also including anti-authority, impulsivity, macho and resignation). Since then, these five hazardous thought patterns have been adopted into virtually every pilot decision making training syllabus to teach the pilots how to recognise and take a countermeasure whenever any of these hazardous thought patterns were encountered in order to minimise the number of irrational pilot judgements.

Although efforts have been made to minimise the tendency of these hazardous attitudes, evidence suggests that perceived invulnerability, in particular, remains widespread and persistent in aviation. For instance, Lester and Bombaci (1984) argued that perceived invulnerability may be the most common hazardous attitude. Their study showed that 43% of the subjects displayed invulnerability, 20% displayed impulsivity, and 14% displayed macho attitudes. Subsequent research (Lester & Collony, 1987) found a similar pattern of results: Invulnerability (39%), Impulsivity (24%) and Macho (19%).

According to Wetmore and Lu (2006), perceived invulnerability was the most common hazardous attitude displayed by the accident pilots resulting in substantially higher risk factors per accident flight.

The report produced by Federal Aviation Authority (FAA, 2002) suggested that most general aviation pilots believe they possessed greater flying skill and were less likely than their peers to experience an aircraft accident. Similarly, Gilbey, Fifield and Gibson (2006) argued that comparative optimistic assessments of potentially risky situations were widespread and persistent in aviation and thus might affect safety related decisions. Interestingly, however, Gilbey, Fifield and Rogers (2006) found the effect of perceived invulnerability was negligible among air traffic controllers, particularly toward aviation specific negative events. Air traffic controllers appeared to be less susceptible to perceived invulnerability in air traffic control related matters.

It has been reported that one of the most significant causes of general aviation fatalities is the continuation of the flight under visual flight rules (VFR) into deteriorating weather. As the flight progresses into the deteriorating weather, there will be an inevitable degradation of visual cues such as speed, distance, orientation and the attitude of the aircraft upon which the pilots under VFR are highly dependent. According to National Transportation Safety Board (NTSB, 2007), fatality in accidents involving VFR flights into instrument meteorological condition (IMC) is significantly greater than the fatality of accidents involving VFR flights in visual meteorological condition (VMC)

(Such a significant difference in fatality may indicate that accidents in IMC were far more severe than the accidents in VMC).

As a result, the Federal Aviation Authority has been encouraging pilots to acquire instrument rating and maintain the required proficiency in order to maximise the chance of pilots to cope with VFR into IMC situations without incident or accident (Hunter, 1999). However, it is interesting to note that Civil Aviation Authority of United Kingdom (1997) found 45% of pilots who had a controlled flight into terrain accident held a current instrument rating. This finding suggests that holding a current instrument rating may falsely perceive one's true flying ability, thus increasing the likelihood of continuation into adverse weather.

O'Hare and Smitheram (1995) argued that although a pilot may assess a given situation accurately, they may not realise the risks involved in continuing with the flight due to personal overconfidence and excessive optimism. In other words, a pilot's overconfidence in his or her own ability may encourage continuation with the flight because of an unrealistically optimistic belief about being able to avoid harm through personal control of the flight (Goh & Wiegmann, 2001). Wilson and Fallshore (2001) also found a similar tendency, whereby pilots under VFR were overly optimistic regarding their chances of experiencing the flights under VFR into IMC, and are overconfident in their ability to both avoid and successfully fly out of IMC. In addition, younger pilots, in particular, rated themselves as more likely to take risk and had high scores on a measure of personal invulnerability despite being aware of the risk involved (O'Hare, 1999).

Several studies (see, e.g., Hunter, 1999; Ritchie, 1988) have expressed concern about general aviation pilots, in particular, recreational pilots, not maintaining adequate flying skills required for the licence and/or rating held. Although aircraft handling and control was cited as the most cause or contributing factors that resulted in accidents, those accidents may well include pilots' incorrect decision to continue into the deteriorating weather and consequently lost the control due to visual cues being degraded and eventually obliterated. Thus, the proportion of the accidents that may potentially include perceived invulnerability may be greater than reported.

There is debate as to whether perceived invulnerability is a function of experience or otherwise. Gilbey, Fifield, and Gibson's (2006) preliminary findings showed that pilots who had attained their PPL were significantly more optimistic than those who had flown solo and those who had not yet flown solo group, indicating that an achievement of "milestones" in training, such as the attainment of a PPL, may be associated with an increase in comparative optimism. O'Hare (1990) highlighted that a successful pilot needed to possess confidence in one's ability to control the aircraft in all flight regimes. An unfortunate by-product may include a degree of overconfidence in one's skill and judgment and an unrealistic optimism about the chances of avoiding harm through personal control. Likewise, Kern (1998) supported that perceived invulnerability is a function of experience; that is, the more experience the pilots had in the air, the more invulnerable the pilots may perceive themselves to be.

Thus, it appeared that the feeling of perceived invulnerability from typical accident causes may be a function of experience rather than age (O'Hare, 1990) although, interestingly, younger pilots had high scores on a measure of personal invulnerability despite being aware of the risk involved (O'Hare, 1999). Such findings were also consistent with study conducted by Wichman and Ball (1983) who argued that aviators with more experience and exposure developed stronger self-biases, such as self-confidence and ego. In addition, Booze (1977) identified that overconfidence and lack of vigilance by high time pilots have been cited as possible contributors to the accidents, perhaps due to a beneficial effect accrued with greater cumulative flight experience turning to be a risk factor.

Koonce (2002) argued that the feeling of overconfidence tends to be slightly lower during the period of skill development and with experience a pilot's confidence level is generally expected to remain slightly below the skill level. However, it is consistent with Gilbey, Fifield and Gibson's (2006) preliminary finding that for a period of time, after obtaining a licence, a pilot's confidence level is momentarily higher than the skill level and as a consequence, a serious incident or accident is more likely to occur during this period. Typically, the highlighted period is approximately six months since the commencement of pilot training.

Telfer (1989) identified that student pilots initially perceive that their judgement could be defective and as a result, they tended to be more cautious. However, after accumulating flying hours over approximately six months, they were less prepared and unwilling to admit that their judgement could be defective as shown in Figure 2. Although Figure 2 demonstrates that self-confidence increases with acquirement of piloting skills, Koonce (2002) argued that the pilot's confidence level is expected to be below the piloting skill as more experience is gained.

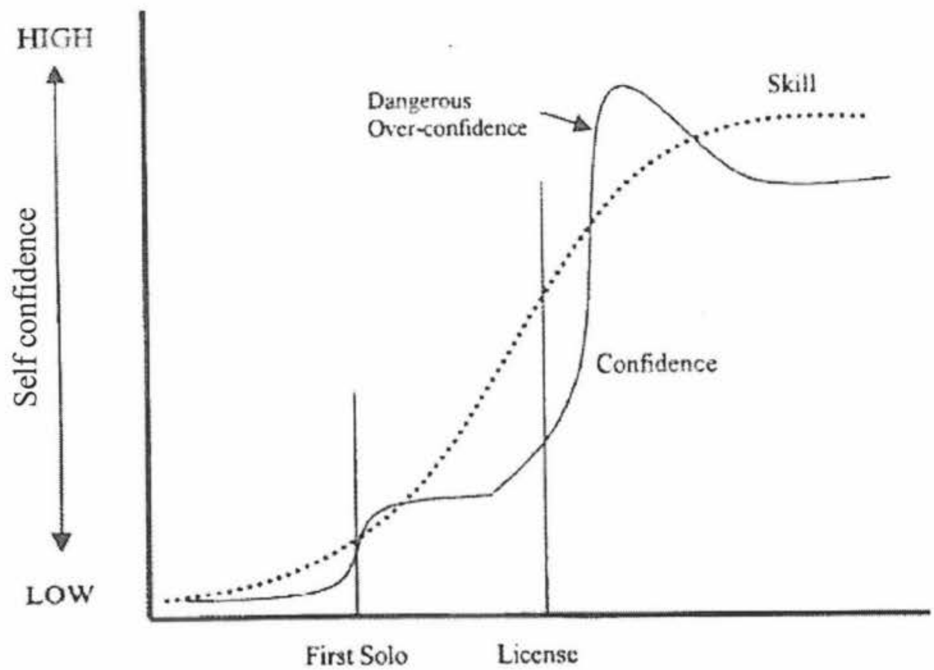

Figure 2. The relationship between pilot experience and self-confidence

Source: Koonce (2002)

Previous studies have found no evidence suggesting a relationship between experience and self-illusions such as perceived invulnerability. For instance, Goh and Wiegmann (2001) argued that although pilots who chose to continue the flights into the deteriorating weather displayed greater confidence in their own piloting ability and more optimistic view on the possible consequences, there was no evidence of differences in experience and training between the groups of pilots who chose to continue or divert; that is, pilots in both groups had similar flight hours and level of certifications. Thus, it may be that the differences in self-judgment on skill and ability appeared to reflect differences in self-awareness of meta-cognitive estimates of one's own ability.

Contrary to their earlier position, Goh and Wiegmann (2002) argued that the loss of situational awareness that precipitated flight initiated under VMC continuing into IMC may be due to a lack of experience interpreting real-time weather by low-time. Their analysis showed that almost 24% of the pilots involved in the accidents due to the VFR flights into IMC may not have realised that the weather had deteriorated, suggesting that they did not intentionally fly into IMC. This finding supports Wetmore and Lu's (2005b) argument that the accurate assessment of the visibility may be a function of flying experience, thus the tendency to continue the flights under VFR into deteriorating weather was likely to reduce as a pilot gained more experience.

Although obtaining a higher level of pilot licence and more flight experience would seem to reduce the likelihood of exhibiting perceived invulnerability (Wetmore & Lu, 2005b), the findings suggest otherwise. Continuation of VFR flights into IMC due to inaccurate assessment of the actual visibility may be a product of greater willingness to take risks and overconfidence in flight skills, rather than lack of experience.

Telfer (1989) identified that at the beginning of the training, student pilots recognised that their judgment could be a source of danger to themselves and others, thus cautious decisions were generally made. However, after accumulating flying hours over 6 months or so, they were less prepared and unwilling to agree that their judgment could be defective. This finding led to the conclusion that this perceptual shift might be indicative of an optimistic view of their perceived invulnerability and may be the reason for the fairly universally well known high accident rate for pilots with 100–300 total flying hours.

In contrary to Telfer's (1989) finding, O'Hare and Chalmers (1999) argued that there was no evidence of an increased risk of accident involvement during the 100–200 or 100–300 hours total time periods. Rather, their data indicated that trend of accident involvement during the 100–200 or 100–300 hours total time periods were slightly opposite to Telfer's (1989) finding.

It is generally accepted that it is virtually impossible to stop perceived invulnerability from developing and affecting one's decision making (Jensen, 1995). One reason for this may be that there is a certain plausibility to the notion that if a pilot is still flying after, for instance, thirty years, then they are invulnerable insofar as their skill level has stopped them being in an accident or incident (A. Gilbey, personal communication, February, 2008). Nevertheless, prolonged influence of perceived invulnerability would develop a loss of respect of dangerous situation and this type of attitude trait would result in a serious incident or accident (Koonce, 2002). Thus, an awareness of this hazardous attitude may help to develop a more positive and rational approach toward flying decision (Jensen, 1995).

For instance, landing with undercarriage retracted without any malfunction in the undercarriage system is rare but still occurs. In aviation, there is a well-known saying for the pilots who fly aircraft with retractable undercarriage:

> *"There are two types of pilots flying aeroplane with retractable undercarriage. One who landed with undercarriage up and ones who will land with the undercarriage up"* (Deakin, para 1, 2004).

The implication is that the chances of landing with undercarriage retracted are always present regardless of training and/or experience thus the pilots need to be aware of the possibility of encountering the negative side of perceived invulnerability.

Ken (1998) stated that hazardous attitudes, including perceived invulnerability, were only hazardous if they are allowed to manifest themselves in people's behaviour. Thus, by taking time to understand hazardous attitudes, and by actively searching for any indication of them in pilots' flying activities, although it is unrealistically optimistic to think that they can be abolished, they can nevertheless be managed.

Although self illusions, by definition have primarily been explored at the level of the individuals, there is good reason to explore them also from a social perspective, in particular, from a perspective of small group interaction. Campbell and Bagshaw (2001) stated that if the individual members of a group already held an opinion about a particular course of action, the opinion of the group as a whole would be stronger. This is a form of polarisation of attitude.

Thus, if each flight crew in multi crew environment possessed a certain level of perceived invulnerability, which was known to exist to some extent in everyone, their level of perceived invulnerability may increase through a group polarisation and consequently, the chances of perceiving risk inaccurately or taking unnecessary risk or combination of both were anticipated to be greater.

1.4 Group Polarisation

As a general practice, important decisions are usually made by groups as opposed to individuals. The common belief that a decision made by more than one person is deemed to be a better decision originates from the popular notion that groups are less likely to make errors than individuals (Baron & Byrne, 2000). Group decisions are also believed to be more cautious and less daring than individual decisions (Myer & Lamm, 1976).

Initially, it was conjectured that group discussion would generally lead to compromise between more extreme preferences of individual members and produce more moderate decisions (Cason & Mui, 1997). For instance, it was believed that a board of directors comprised of a number of people with varying views on the future direction of their company would compromise around a so called 'middle road' (Brown, 2000).

Contrary to the popular notion that groups were more cautious and less daring than individuals (Myers & Lamm, 1976), an experiment by Stoner (1961) utilising choice-dilemmas questionnaire found that group decisions were riskier than individual decisions. This finding was initially termed as the 'risky shift' and inspired numerous studies of group risking taking mainly because it contradicted some prevailing theory of conformity and normalisation held at that time (Ellis & Fisher, 1994).

Many studies conducted in several different communities and countries replicated Stoner's (1961) observation. For instance, the comparison of an individual's decisions between pre and post group interaction indicated that more risky decision was eventuated with the presence of group interaction (Wallach, Kogan, & Bem, 1962). It is noteworthy that although a prolonged discussion within the group would more likely cause group polarisation phenomenon to be present, a brief period of discussion followed by individual responses also produced a shift in the group's average position (Myer & Lamm, 1976).

Although many studies found evidence of a 'risky shift', some studies found evidence of a 'cautious shift' (Forsyth, 1999). Further research clarified that items which elicited relatively risky initial tendencies generally elicited further shift toward the risky extreme after discussion, whereas items with relatively cautious initial means were more likely to elicit further shift in the cautious direction (Myers & Lamm, 1976; Teger & Pruitt, 1967). In view of this observation, further research described this phenomenon as 'group polarisation' (Moscovici & Zavalloni, 1969).

Vaughan and Hogg (2005) described group polarisation as when a decision is made in group, the decision is more extreme than the mean of individual member's initial positions, in the direction already favoured by that mean. For instance, a group of people who were inclined to favour capital punishment would likely produce stronger favouritism for capital punishment after discussion.

Jones and Roelofsma (2000) claimed that the potential for the presence of group polarisation is often confined to relatively important decision, implying that the presence of group polarisation is not widespread. In contrast, numerous studies (see, e.g., Isenberg, 1986; McCauley & Segal, 1987; Myers & Lamm, 1976) suggested that group polarisation phenomenon had proved to be remarkably general and robust, having been obtained in a wide variety of domains including jury decision, making gambling decision, estimates of autokinetic movements, terrorism and judgement of physical attraction.

Thus, Brown (2000) claimed that there are strong grounds to believe that polarised attitude is a pervasive consequence of group interaction (in particular, when the initial view of the individual group members was in the same direction [Jones & Roelofsma, 2000].), although, interestingly, the validity of the existence of group polarisation on real decision making group would be in question because of the nature of studies. This is because almost all the studies, which examined the existence of group polarisation, were conducted in laboratory settings with ad hoc [artificially create] groups in which the outcome was almost always hypothetical (Brown, 2000). Thus it is possible that group polarisation in real life may not be as pervasive as numerous studies suggest.

Indeed, when research has been conducted using real decision making groups, group polarisation was not as evident. Semin and Glendon (1973) argued that experimental studies, which examined the presence of group polarisation, were often limited by the amount of information and lack of a specific reference system thus group polarisation phenomenon was often present. In contrast, when the study was conducted on real decision making group, such as a staff evaluation committee, with large amounts of information available and a specific reference system, no group polarisation phenomenon was observed.

Contrary to Semin and Glendon's (1973) findings, Spector, Cohen and Penner (1976) found that task reality was not deemed to be a significant influential factor on the direction of group choice shifts (e.g., group polarisation phenomenon) when the effect of real versus hypothetical risk on group choice shifts was examined. Instead, it was the content of the decision task itself that determined the direction of group choice shift.

Semin and Glendon (1973) argued that it might be the differences in nature between the groups that determined the presence of group polarisation phenomenon. The structural properties of established group and ad hoc [artificially created] group were clearly different: The former was considered to be permanent whereas the latter was considered to be temporary.

Brown (2000) found no group polarisation in the established group (e.g., permanent) because such group was more likely to develop an internal structure, adopt conventional procedures and establish norms about the decision issues, all of which might inhibit any polarisation effect from appearing. In contrast, McCauley and Segal (1987) observed that terrorist groups became more extreme gradually over a period of time because not only the average opinion of the group became more extreme, but the average individual also became more extreme.

On the other hand, Brown (2000) observed group polarisation in judges' decision because their existence was considered as temporary as such existence as a group often disbanded after a single trial. This observation indicates that the group polarisation phenomenon tends to more likely occur in the early stages of group's life, although the generality of group polarisation phenomenon to the real world was in question (Semin & Glendon, 1973).

There has been a plethora of research conducted to identify the underlying mechanism of group polarisation and provide logical explications of how group polarisation occurs. For instance, Social comparison theory (Sanders & Baron, 1977), Persuasive argument theory (Burnstein & Vinokur, 1977) and Social decision scheme theory (Davis, 1973).

The key concept in the social comparison theory is on the self presentational or self enhancement motives that are stimulated by comparisons with others (Brown, 2000). This theory was based on the description by Festinger (1954) who described social comparison as the natural tendency to compare amongst us to determine whether one's view on a particular social reality was correct or not. Because of this tendency, it was often observed that there was a change in one's attitude so as to hold views closer to those of others (Baron & Byrne, 2000).

For instance, during discussion, each individual had a tendency to evaluate the accuracy of own position on the issue by comparing it with others. After the discussion each individual endeavoured to make a favourable impression within the group. Once two motives are combined, individual's initial position is found to be polarised (Forsyth, 1999). In addition, Myer (1978) highlighted that mere exposure of other's responses, without discussion or any other treatment, would tend to match the observed responses or to exceed them in the socially preferred direction.

Brown (2000) explained that the most important factor underlined in the social comparison theory was to possess the knowledge of other group members' positions relative to the dominant social values in question. Therefore, group polarisation was expected to be observed as long as one knew other's preferences without discussion. Teger and Pruitt's (1967) study observed the 'risky shift' with mere information exchange condition.

In contrast, the key concept in the persuasive argument theory is the exchange of information and arguments that preceded the collective decision (Brown, 2000). Burnstein and Vinokur (1977) argued that when the preponderance of arguments favoured a particular alternative, the average prior attitude reflected the direction and magnitude of this preponderance. Further thought or discussion would then lead to polarisation toward the alternative that was initially considered better or more arguments.

Zuber, Crott and Werner (1992) explained that persuasive argument theory was dependent upon three essential factors: validity, redundancy and degree of familiarity. When an argument was valid, the less it had in common with other arguments, the less familiar it was to group members before the discussion, the more persuasive it would be. Thus, group polarisation was expected to take place in the direction of the opinion shared by the majority.

Although both social comparison theory and persuasive argument theory suggested that group interaction could affect decision making, the mechanisms through which this occurred were different. Whilst social comparison theory emphasised that when interacting with others, group members concentrated on gathering information to determine what was socially desirable, persuasive argument theory postulated that people were influenced by the number of persuasiveness of pro and con arguments (Cason & Mui, 1997).

Burnstein and Vinokur (1977) argued that persuasive argument theory by itself was an adequate explanation of polarisation, although, interestingly, Burnstein and Vinokur (1975) acknowledged that small shifts in choice occurred even without discussion when individuals merely know each other's preference, supporting an interpersonal comparison explanation of group induced shifts in choice. Thus, Burnstein and Vinokur (1977) stated that from a broader theoretical perspective, the relationship between persuasive arguments theory and social comparison theory might be conceptualised as one in which persuasive argument was considered to be a cogent theory.

On the other hand, Sander and Baron (1977) argued that the social comparison theory and persuasive argument theory were not mutually exclusive. Instead, both might be processed in a complementary manner, with persuasive arguments facilitating the shifts motivated by social comparison.

In comparing the merits of the social comparison theory to those of the merits of the social comparison theory, the effects of persuasive argument theory on group polarisation were found to be stronger (Brown, 2000). An earlier study showed that although a group polarisation was expected with mere-receipt of information, more enhanced group polarisation was resulted after active discussion suggesting that persuasive argument theory was stronger on producing group polarisation phenomenon (Myer & Lamm, 1976). Similarly, Isenberg (1986) reviewed 21 studies on group polarisation phenomenon and suggested that social comparison theory and persuasive argument theory could occur in combination to produce polarisation phenomenon although the effect of the persuasive argument theory tended to be stronger.

In contrast, Goethals and Zanna (1979) argued that although the influence of persuasive argument theory on group polarisation could not be completely excluded, the influence of social comparison theory on group polarisation was substantial. Similarly, Cason and Mui (1997) operationalised social comparison theory and persuasive argument theory in the context of dictator game, and found that there was a strong evidence against persuasive argument theory and more consistent with social comparison theory.

Unlike social comparison and persuasive argument theories, social decision scheme theory was developed as a general analytic framework to predict the group decisions on the basis of the pre-discussion preferences and the applied aggregation rule (Zuber et al., 1992). This particular theory focused on how individual decisions were aggregated into a group decision, whereas the social comparison theory and persuasive argument theory primarily focused on the changes in individual preferences after discussion (Zuber et al., 1992).

Although each theory (e.g., social comparison theory, persuasive argument theory and social decision scheme theory) by itself was able to explain the underlying mechanism on group polarisation to the certain extent, each theory was insufficient to completely explicate the mechanism underlying group polarisation. Rather it was considered that all three theories were present to certain degree when group polarisation phenomenon was present in the real world. Although their relative weights may vary from situation to situation, it was considered unlikely that any one particular theory solely operated to the complete exclusion of the others (Brown, 2000).

There is another group phenomenon that is similar to group polarisation. It is known as group think and Clemen and Winker (1999) claimed that groupthink is an extreme example of group polarisation. This groupthink phenomenon was said to often occur when members hid or discounted information in order to preserve group cohesiveness (Janis, 1982 cited in Choo, 2005) although several studies have found that cohesiveness is not an important antecedent condition of groupthink (Whyte, 1989).

Although groupthink phenomenon could be arguably considered similar to group polarisation phenomenon, the outcome of those phenomena is different. Group polarisation is the enhancement of the point of view initially dominant within the group after discussion, whereas groupthink is a practice of concurrence seeking; that is, exercise to come to the consensus from the initial preferences of its members (Whyte, 1989). Beesley (2003) argued that "the desire to conform prevents people from expressing critical or novel ideas and in such a group, amiability and morale take precedence over judgement" (p. 94).

Whyte (1989) argued that groupthink phenomenon was a weak explication as to why group may make excessively risky decision as several studies (e.g., Davis & Stasson, 1988) have identified that group decisions were often riskier. Whyte (1989) stated that although the tendency of conformity by the group and the convergence of group members' views on a particular option could be explained by groupthink, it was almost impossible to discern the option to which such a tendency would be directed.

On the other hand, group polarisation could "provide leverage with which to discern and predict what the dominant initial preference within the group will be and what will happen to it during the course of group interaction" (Whyte, 1989, p.51). Thus, if the dominant initial preference within the group was considered risky, then the result of the course of group interaction would be riskier. Similarly, if each individual within the group exhibits a certain level of perceived invulnerability, then the course of group polarisation would result in increased level of perceived invulnerability.

1.5 Increased perceived invulnerability within a group

As aircraft grew more complex and the limitations and fallibility of pilots more evident, provision was made for a co-pilot to provide support for the pilot to reduce individual workload and increase the quality of decision making (Helmreich & Foushee, 1993).

As intuitively plausible as the provision of a second pilot may appear, the literature on group polarisation suggests there may be instances where this could lead to less safe behaviour. Specifically, research into group problem-solving and decision-making suggests that group were worse than individuals when solving the same problems because total cognitive resources available in group are often less than total of individual cognitive resource (Orasaun & Salas, 1993). In addition, research has also suggested that groups were more likely to adopt extreme positions than individuals when making a decision alone because of the group polarisation phenomenon (Baron & Byrne, 2000). Davis and Stasson (1988) claimed that polarised attitude was dependent upon the nature of the tasks, although task reality was not found to be a strong influence on group polarisation phenomenon (Spector et al., 1976).

Buehler, Messervey and Griffin (2005) conducted a study to test for optimistic bias in individual prediction and collaborative prediction. The study found that although there was an optimistic bias for both individual and collaborative predictions, the collaborative prediction was significantly more optimistic than individual prediction. Hinsz, Tandale and Vollrath (1997) explained that when individual members within a group processed information where individuals already held an optimistic bias, the group often accentuated this tendency, resulting in more optimistically biased decision.

Buehler et al. (2005) argued that more pronounced optimism within the group context may be because of diffusion of individual accountability and any negative consequences for being optimistic when in group. Feldman and Rosen (1978) highlighted that individuals acting alone, held more responsibility for behaviour leading to negative consequences when compared to individuals within the group. This is because individuals acting alone had sole responsibility for the negative outcomes of the actions taken, whereas individuals within the group shared in the culpability for the negative outcomes of the group's actions. Consequently, the reduced perception of responsibility on negative consequences would be resulted when individuals were in group.

It was found that heightened optimistic bias in group may be caused by overconfidence (Buehler et al., 2005). Stephenson, Clark and Wade (1986) found that two person groups were abundantly more confident about the accuracy of their answers to questions than were individuals. Likewise, Heath and Gonzalez (1995) reported that individuals' interaction within a group resulted in heightened confidence in their decisions because during interaction, each individual was forced to organise and elaborate their case better in favour of their decisions. As a consequence, individuals exhibited an increase in one's confidence on the decision after interaction with others, particularly when the initial view of the individual group members was in the same direction (Jones & Roelofsma, 2000).

Overall, research appears to show that the level of perceived invulnerability and confidence level tend to increase when individuals are in group. This type of group behaviour may be due to the presence of group polarisation. The possibility that perceived invulnerability could be increased by group polarisation potentially has implications for aviation safety, particularly in the area of general aviation. Specifically, pilots who exhibit perceived invulnerability as individuals may exhibit increased levels of perceived invulnerability when they are in a group situation.

1.6 Defining the research problem

Studies (e.g., Gilbey, Fifield, & Rogers, 2006; Pulford & Colman, 1996) have suggested that perceived invulnerability has a tendency to influence the degree of accuracy on the risk perception. Negative events, in particular, needed to be accurately perceived as there are strong possibilities to underestimate the risk involved. Wetmore and Lu (2006) found that perceived invulnerability was the most common hazardous attitude displayed by the accident pilots and consequently, risk factor per accident flight has substantially increased.

Several studies (Buehler et al., 2005; Hinsz et al., 1997) suggested that individuals in group tend to be more optimistic than individuals alone. In addition, two person groups exhibited more confidence than were individuals (Stephenson et al., 1986). The implication would be that the individual's level of perceived invulnerability would likely be amplified in a group.

One explanation on increased level of optimism or confidence when in a group may include the presence of group polarisation phenomenon (Buehler et al., 2005). Several studies (Isenberg, 1986; Myers & Lamm, 1976) suggested that group polarisation phenomenon is remarkably general and robust. The potential for a group polarisation effect to increase perceived invulnerability could have implications for aviation safety. As such, it is important to explore the question, "does group polarisation affect perceived invulnerability in a two pilot environment?"

To test this research question, two studies will be conducted in this thesis to explore the implication of group polarisation affecting the level of perceived invulnerability amongst pilots in general aviation. The extant theories of perceived invulnerability (Breheny & Stephens, 2004) and group polarisation (Moscovici & Zavalloni, 1969) will provide framework to guide the current research.

The first study will measure the individual's level of perceived invulnerability and test whether a group polarisation effect would lead to an increase in the participant's level of perceived invulnerability. An experimental condition (e.g., presence of a passenger who is not directly involved in flight and with whom limited exchange of information [low interaction] occurs between a pilot and passenger) was created to test effect of group polarisation.

The rationale for this experimental condition was because most general aviation aircraft are flown by a single pilot often with additional person (e.g., passenger) on board. Although an additional person is present in the cockpit, active group interaction between a pilot and additional person is not always present. This situation is tested using a questionnaire based experiment. As such, the following three hypotheses will be tested.

H_1: Pilots flying alone will demonstrate perceived invulnerability toward a range of aviation related behaviours and events.

H_2: Pilots flying in the presence of additional person, with whom there is limited discussion of flying related matter, will demonstrate perceived invulnerability toward a range of aviation related behaviours and events.

H_3: The level of perceived invulnerability measured in the presence of additional person condition will be significantly higher than the level of perceived invulnerability measured in the pilot alone condition due to the presence of group polarisation.

The second study will also measure the individual's level of perceived invulnerability and test whether a group polarisation effect would lead to an increase in the participant's level of perceived invulnerability. An experimental condition (e.g., presence of another pilot on board and no restriction on the group interaction [high interaction]) was created to test effect of group polarisation.

The rationale for this experimental condition was because although the most general aviation aircraft are flown by a single pilot, there are numerous occasions where two or more qualified pilots travel together particularly during their training to higher licence and/or rating. In addition, several studies (e.g., Burnstein & Vinokur, 1977; Myer & Lamm, 1976) suggested that group polarisation phenomenon is stronger when the discussion was allowed. The following four hypotheses will be tested.

H_4: Pilots flying alone will demonstrate perceived invulnerability toward a range of aviation related behaviours and events.

H_5: Pilots flying in the presence of additional person, with whom there is no limit on discussion of flying related matter, will demonstrate perceived invulnerability toward a range of aviation related behaviours and events.

H_6: The level of perceived invulnerability measured in the presence of additional person condition will be significantly higher than the level of perceived invulnerability measured in the pilot alone condition due to the presence of group polarisation.

H_7: The level of polarised perceived invulnerability will be significantly higher when there is no limit on discussion of flying related matter than when discussion is limited.

CHAPTER TWO

Study I: Exploring the effect of group polarisation on perceived invulnerability (low interaction)

2.1 Aim

The aims of the present study are: i) to measure general aviation pilot's level of perceived invulnerability; and ii) to test whether a group polarisation effect, due to the presence of a passenger who is not directly involved in the flight and with whom limited exchange of information occurred (low interaction), would lead to an increase in the pilot's level of perceived invulnerability.

2.2 Method

2.2.1 Design overview

The rationale for the present study is that in general aviation aircraft are often flown by a single pilot, but an additional person would join a pilot for the flight. Although active group interaction between a pilot and the additional person may be quite limited in nature, previous research has shown that group polarisation could be observed without the presence of any lengthy discussion (see, e.g., Myer, 1978; Teger & Pruitt, 1967). As such, the current study tests whether group polarisation increases the level of perceived invulnerability in aviation where group interaction is restricted (e.g., low interaction between a pilot and a passenger).

The present study adapts the questionnaire and method originally used by Gilbey, Fifield and Gibson (2006) to measure perceived invulnerability. For the purpose of the current study, Gilbey, Fifield and Gibson's (2006) questionnaire was split into two parts to enable a within-subjects design to be used. The participants completed the first part alone in order to determine participants' level of perceived invulnerability. The second part was subjected to experimental manipulation (e.g., presence of a passenger who is not directly involved in flight and with whom limited exchange of information [low interaction] occurs between a pilot and passenger) to create a group polarisation effect. The degree to which group polarisation occurs is quantified by the difference in effect size due to the experimental manipulation (second part) compared to that found for the control condition (first part). For instance, if the mean perceived invulnerability score of the second half of the questions is greater than that of the first half, then this difference would be taken as evidence that group polarisation occurred.

2.2.2 Participants

Thirty eight participants were invited to participate in this study, of whom 34 (89%) participants agreed to participate. Participants were second and third year undergraduate students enrolled in a university, Air Transport Pilot degree programme. There were six female and 28 male participants whose ages ranged from 18 to 32 years (mean age = 21.38, $SD = 2.61$); 61.8% held a private pilot licence ($n = 21$) and 38.2% held a commercial pilot licence ($n = 13$). The total flight experience of participants ranged from 140 hours to 290 hours ($M = 180.40$, $SD = 34.53$).

2.2.3 Materials

The questionnaire used in the present study comprised 20 items, each of which tapped a different aspect of perceived invulnerability. Initially, 18 items from a questionnaire used by Gilbey, Fifield and Gibson's (2006) study were planned to be adopted. However, two of the original items were considered to be unsuitable for the potential participants in the present study. Consequently, 16 items used by Gilbey, Fifield and Gibson (2006) were adopted into the questionnaire used in the present study. Two of the original items, which were considered to be inappropriate, were i) forgetting to select undercarriage up and ii) failing my medical.

Firstly, although forgetting to select undercarriage up measures perceived invulnerability, the potential participants for the present study would be unlikely to have flown an aircraft with retractable undercarriage. Thus this item was not included in the questionnaire as true reflection of one's perceived invulnerability on this item was in question.

Secondly, although failing medical check measures perceived invulnerability, this particular item was considered to be a general negative question, rather than an aviation negative question in specific. Thus this item was not included in the questionnaire as the design of the questionnaire was to measure perceived invulnerability in aviation.

The 16 remaining items are listed in descending order of the effect size (i.e., size of difference from the neutral position of average) as reported by Gilbey, Fifield and Gibson (personal communication, 2007) and they are presented in Table 1.

Table 1. Mean difference from average and standard deviation

Items	Mean difference from 4 (SD)
Compared to other university ATP students my age, my chances of ...in the future are:*	
An 'embarrassing (e.g., wing-touch) incident whilst taxiing	5.33 (1.48)
Causing injury or death whilst flying	5.31 (1.36)
Accidental controlled flight into terrain	5.24 (1.05)
Problems whilst flying due to bad fuel management**	5.21 (1.25)
Being the cause of a near-miss	4.98 (1.38)
Getting lost whilst flying	4.98 (1.30)
Unplanned stall	4.76 (1.21)
Taxiing in the wrong place	4.76 (1.19)
Unknowingly breaching controlled airspace	4.76 (1.32)
Completing a manoeuvre with inappropriate or wrong flap settings	4.70 (1.61)
An unplanned heavy landing	4.67 (1.05)
Misinterpreting or failing to notice instrument readings	4.55 (1.21)
Descending too quickly***	4.31 (1.48)

In flight engine failure	4.31	(.84)
Deviating from an assigned altitude	4.28	(1.33)
In flight bird strike	4.26	(1.01)

* The wording was changed to '*Compared to other pilots of similar age and experience, my chances of ... in the future are*': in current questionnaire

** The wording was changed to '*Either fuel starvation or fuel exhaustion whilst flying due to poor fuel management*' in this research questionnaire

*** The wording was changed to '*Descending too quickly, resulting in passenger discomfort*' in this research questionnaire

The 16 items were divided into two separate questionnaires by allocating alternate items in Table 1 in descending order of effect size to each half of the split questionnaire. In principle, this method should result in split-halves with comparable overall mean effect size.

In order to have 20 items in total, four additional items, based on the researcher's own experience were added to the original questionnaire (two to each half). The four additional items are presented in Table 2.

Table 2. Four additional items

Compared to other pilots of similar age and experience, my chances of ...in the future are:
Misinterpreting an aerodrome chart of approach plate
Making a mistake(s) on a flight plan
Omitting a checklist item(s)
Misunderstanding an ATC instruction

For all 20 items, participants were asked to judge the likelihood of the event occurring to themselves, compared to pilots of a similar age and experience. The 20 questions were worded as: 'Compared to other pilots of similar age and experience, my chances of (problem) in the future are: almost certain; much above average; above average; a little below average; average for ATP student; a little below average; below average; much below average; never happen.' For the purpose of statistical analysis, numerical values of 'almost certain' = 1, 'much below average' = 2, 'above average' = 3, 'a little below average' = 4, 'average for ATP student' = 5, 'a little below average' = 6, 'below average' = 7, 'much below average' = 8 and 'never happen' = 9 were assigned to each of the potential responses.

If there was no perceived invulnerability then the numerical score would be five. Variation from a numerical score of five would indicate the presence of perceived invulnerability (or vulnerability); for example, a numerical score higher than five would indicate the presence of perceived invulnerability, whereas a numerical score of less than five would indicate the presence of perceived vulnerability. Logically, the greater the deviation from the mean numerical score is, the higher the level of perceived invulnerability (or vulnerability).

There were two types of questionnaires used in the present study. A type A questionnaire may be inspected in Table 3 and also in Appendix A. Type A questionnaire contains part I of the questionnaire as listed in Table 3 first, followed by part II of the questionnaire as listed in Table 3. In contrast, type B questionnaire contains part II of the questionnaire first, followed by part I of the questionnaire. Half of the participants were randomly assigned to complete part I of the questionnaire first (control condition), followed by part II of the questionnaire (experimental condition); that is, these participants completed type A questionnaire. The other half of participants were randomly assigned to complete part II of the questionnaire first (control condition), followed by part I of the questionnaire (experimental condition); that is, these participants completed type B questionnaire. Two types of questionnaires (type A and type B) were used to provide a fully counter-balanced design, whereby half the participants completed part I and then part II (type A questionnaire), whilst the other half of participants completed part II and then part I (type B questionnaire).

Table 3. List of items in two parts (type A questionnaire)

Compared to other pilots of similar age and experience, my chances of...in the future are:
Part I
Embarrassing (e.g., wing-touch) incident whilst taxiing
Unknowingly breaching controlled airspace
Accidental controlled flight into terrain
Unplanned heavy landing
Misinterpreting an aerodrome chart or approach plate*
Descending too quickly, resulting in passenger discomfort
Getting lost whilst flying
Deviating from an assigned altitude
Unplanned stall
Omitting a checklist item(s)*
Part II
Misinterpreting or failing to notice instrument readings
Completing a manoeuvre with inappropriate or wrong flap settings
Either fuel starvation or fuel exhaustion whilst flying due to poor fuel management
Causing injury or death whilst flying
Being the cause of a near-miss
In flight engine failure
Making a mistake(s) on a flight plan*

In flight bird strike

Taxiing to the wrong place

Misunderstanding an ATC instruction*

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* Items not originally used by Gilbey, Fifield, & Gibson (2006)

The first part of the questionnaire was intended to measure each participant's level of perceived invulnerability. The second part was intended to test whether restricted group interaction (e.g., mere exchange of information) would affect the level of perceived invulnerability through group polarisation (That is, whether participants' level of perceived invulnerability would increase due to the experimental manipulation). The counter balance design would ensure that any observed effect would not be an artefact of item content alone.

To ensure that the wording and presentation of items would make sense to participants, once all the questions were appropriately distributed into two parts, three flight instructors ('A' category, 'B' category and 'C' category flight instructors where 'A' category flight instructor represents the most senior flight instructor with generally the most experience), who were independent to this study, were invited to assess and review content of questionnaire, accuracy and relevancy of the questions. No items were identified as being unrealistic or set at a level inappropriate for student pilots.

The complete set of materials (type A questionnaire) used for the present study contains the following sections; a letter of introduction, about participants and two parts of questionnaires and they are presented in Appendix A.

2.2.4 Procedure

All participants in this study were individually approached by the researcher when they were at their flight training centre to attend a lecture, briefing, or practicum (e.g., flight training). One briefing room was reserved for the sole use of the research. When approaching to each individual to participate in the research, the overall purpose of the research was explained and emphasis was made that participation in this study was totally voluntary with a maximum time of 30 minutes and that any data collected would remain anonymous. No remuneration or course credits were offered as incentives to participate in this study. All data was collected over a three day period in late April, 2007.

The experimental hypothesis was not disclosed to participants at the time of participation in order to minimise any biases such as demand characteristics (see, e.g., Orne, 1962 cited in Cozby, 2003) that could present during the data collection. However, the overall purpose of this research was verbally explained to participants in order to obtain their consent to participate. Participants were also asked to refrain from discussing the experiment with any other person for at least one week after the time of their participation so that other potential participants were not prejudiced.

Participants were instructed to read each item in the questionnaire and to choose a response that best reflects each individual's decision on a 9-point Likert-type scale (from 1 for almost certain to 9 for never happened). The first part was completed alone. Participants were instructed to individually advise the researcher once the first part was completed in order to proceed to the second part. Before the participants commenced the second part, the researcher made a statement (see below) and participants were asked to verbally state the reason as to why a particular response was chosen prior to answering each question in the second part.

> "*Before you answer the remaining questions, imagine you are on a cross-country flight as a Pilot-in-Command. Imagine that me and my family will be with you as passengers, although we are purely catching a ride. As you know, I am a qualified flight instructor and I strongly believe that students, including yourself, completing the BAv-ATP course are well above average pilots in every aspect, compared to the pilots trained outside Massey University. Lastly, prior to answering each question, please tell me briefly why you chose a particular option*".

When the researcher listened to the brief statements from each participant, the researcher ensured that neither comment nor facial expression was made whilst the brief statements were being made. Also, the researcher did not take any note on the statements as this might discomfort the participants. To ensure each participant's anonymity, each completed questionnaire was placed inside an unmarked envelope, sealed and placed in a box. As anticipated, although the time taken varied, all participation took less than 30 minutes.

Because this research was considered low risk (as evaluated by a screening question provided by the university ethics committee where the researcher was enrolled as a student), full approval from a Human Ethics Committee was not required. Instead, a low risk notification was completed to be recorded on the low risk database. Acknowledgement of low risk notification is presented in Appendix B.

2.3 Results

All data analyses were carried out using the statistical software package SPSS (version 15.0 for Windows). The level of significance, alpha, was $p \leq .05$ for all statistical analyses and all tests were two-tailed.

The baseline score of the perceived invulnerability for participants was calculated by summing up the individual scores for items 1–10 in the first part of the questionnaire and dividing by 10. This provided the mean score of the perceived invulnerability for participants who were hypothetically flying alone. A mean score of the scale of five would indicate that pilots perceived themselves neither invulnerable nor vulnerable overall. Variation from five would indicate the presence of perceived invulnerability (or vulnerability); that is, higher than five indicates the presence of perceived invulnerability, whereas less than five indicates the presence of perceived vulnerability. Logically, the greater the deviation from the mean numerical score is, the higher the level of perceived invulnerability (or vulnerability). Using the mean score of the first ten items, one-sample *t*-test (two-tailed, test value = 5) showed strong evidence of perceived invulnerability; $t(33) = 6.26$, $p < .05$ (mean difference from five = .82), which indicates that overall, participants perceived themselves as invulnerable to the events covered in items 1–10 of the questionnaire that they completed.

The same analysis was applied to the second half of the questionnaire that participants completed, covering items 11–20. This was the condition in which the researcher was present and a statement was made by the researcher prior to the commencement of second part. In addition, each participant was instructed to briefly state the reason why a particular response was chosen prior to choosing it. This is the experimental condition in which the researcher created an environment as if participants were flying with a passenger, exchanging information. Using the mean score of the ten items in the second part, one-sample t-test (two-tailed, test value = 5) again showed strong evidence of perceived invulnerability; $t(33) = 6.39$, $p < .05$ (mean difference from five = .91), which indicates overall participants perceived themselves as invulnerable to the events covered in items 11–20.

To test whether the level of perceived invulnerability was affected by the experimental manipulation (e.g., whether mere exchange of information induced effect of group polarisation on the level of perceived invulnerability), the mean score of perceived invulnerability for part I of the questionnaire was compared with the mean sore of perceived invulnerability for part II of the questionnaire. Paired samples t-test showed that there was no evidence of a difference due to the experimental manipulation $t(33) = -.88$, $p > 0.05$. The mean difference score for the control condition was 5.82 ($SD = .77$) and the mean difference score for the experimental condition was 5.91 ($SD = .83$).

In addition to the planned comparisons, an *a posteriori* (unplanned) comparison was made to measure whether there was any difference in the level of perceived invulnerability associated with the level of licence held. A between-subjects *t*-test, using mean score of perceived invulnerability as the dependent variable and level of licence as the independent variable, was conducted. Independent samples *t*-test showed no evidence of a difference in level of perceived invulnerability associated with the level of licence held, $t(32) = 1.06$, $p > 0.05$; for participants with a CPL the mean difference score was -.05 ($SD = .62$); for participants with a PPL, the mean difference score was .17 ($SD = .56$).

In addition to exploring the effect of different levels of licence on perceived invulnerability, a further *a posteriori* analysis was conducted to examine participants' responses to each of the 20 individual items*. Table 4 shows the mean difference score, one-sample *t*-statistic, degree of freedom and significance for the 20 individual perceived invulnerability items. Items are listed by scale, and by descending order of effect size within each scale.

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* Because half of the participants completed part I in the control condition and part II in the experimental condition, while the remaining participants completed part II in the controlled condition and part I in the experimental condition, scores for individual items were actually collapsed across both levels of the independent variable. Thus any effect due to experimental manipulation has been apportioned equally across each item.

Table 4. Mean difference from average, one-sample t-statistic, degree of freedom and significance for individual perceived invulnerability items and scale of totals

Items	Mean Difference from neutral (Standard deviation in parentheses)	*t*	df	*p*
Unplanned stall[I]	1.79 (1.32)	7.92	33	<.05
Controlled flight into terrain[I]	1.74 (1.24)	8.17	33	<.05
Causing injury or death whilst flying[II]	1.71 (1.36)	7.31	33	<.05
Poor fuel management[II]	1.68 (1.43)	6.84	33	<.05
Getting lost whilst flying[I]	1.41 (1.31)	6.31	33	<.05
Embarrassing incident whilst taxiing[I]	1.24 (1.33)	5.43	33	<.05
Breaching controlled airspace[I]	1.18 (1.11)	6.16	33	<.05
Manoeuvre with wrong flap setting[II]	1.09 (1.06)	6.01	33	<.05
Causing a near-miss[II]	1.03 (1.24)	4.83	33	<.05
Deviating from altitude[I]	.71 (1.29)	3.19	33	<.05
Taxiing to the wrong place[II]	.68 (1.22)	3.22	33	<.05
Descending too quickly[I]	.56 (1.21)	2.69	33	<.05
Misinterpreting instrument reading[II]	.53 (.96)	3.21	33	<.05
Misinterpreting a chart or plate[I]	.47 (1.08)	2.54	33	<.05
Unplanned heavy landing[I]	.38 (1.21)	1.85	33	>.05

Misunderstanding ATC instruction[II]	.38	1.23	1.81	33	>.05
Having an in-flight engine failure[II]	.26	(.75)	2.06	33	>.05
Omitting a checklist item[I]	.24	(1.39)	.98	33	>.05
Making mistakes on a flight plan[II]	.21	(1.17)	1.02	33	>.05
Having a bird strike[II]	.09	(1.06)	.49	33	>.05

The results presented in Table 4 show that 14 items showed significant perceived invulnerability but six items were perceived as neutral. Participants showed most perceived invulnerability with regard to unplanned stall, followed by controlled flight into terrain. Conversely, participants did not exhibit perceived invulnerability toward events such as making mistakes on a flight plan and having a bird strike.

Of the 14 items which were statistically significant, eight items in part I of the questionnaire showed significant perceived invulnerability and six items in part II of the questionnaire showed significant perceived invulnerability (items are shown in Table 4 as I or II using superscript font) indicating that the two halves were comparable.

Although 14 items were found to detect statistically significant perceived invulnerability, it should be noted that with alpha set at $p \leq .05$ it would be expected that one of the twenty items would be significant at the .05 level, simply by chance; that is, that there would be at least one type I error. Clearly, it cannot be determined which item this may have been, or indeed if type I error in fact had occurred (Some caution may therefore be required in interpreting the results presented in Table 4).

2.4 Interim discussion

The study findings suggested that participants exhibited perceived invulnerability in both the control and the experimental conditions; that is hypothetically flying alone and hypothetically flying with a passenger on board. Thus the first and the second hypotheses were supported. However, the third hypothesis was not supported; that is, there was no evidence that the degree of perceived invulnerability was affected by group polarisation.

The present finding is consistent with Gilbey, Fifield and Gibson's (2006) preliminary finding that the pilots exhibited perceived invulnerability. However, Myer and Lamm's (1976) finding that even a brief period of discussion was enough to produce a polarisation effect was not replicated. The findings suggest although participants exhibited perceived invulnerability in both the control and the experimental conditions the perceived invulnerability did not appear to be accentuated by a group polarisation effect due to the mere presence of another person. The latter finding is considered to be positive finding.

Contrary to Gilbey, Fifield and Gibson's (2006) preliminary finding; that is, achievement of "milestones" in training such as the attainment of a PPL may be associated with an increase in comparative optimism, the present finding suggests no significant differences on the level of perceived invulnerability between the level of perceived invulnerability and the level of pilot's licence.

There are some situations (e.g., flight test or check-ride) where a general aviation pilot is flying with a flight instructor or someone more senior without active group interaction. With regard to aviation safety, the present finding suggests that there was no effect of group polarisation on the level of perceived invulnerability without active group interaction.

A further common situation in general aviation is when one pilot is accompanied by another pilot on a flight (e.g., two PPL holders on a mutual cross-country navigation exercise to complete the CPL syllabus) with perhaps more active group interaction about flying related matters. Previous research (e.g., Isenberg, 1986; Myer, 1978; Teger & Pruitt, 1967) demonstrated that more pronounced group polarisation phenomenon was observed when no restriction on group interaction was imposed. As such, a further study was carried out to explore this different specific situation with different experimental conditions; that is, no restriction on group interaction, in which group polarisation might affect perceived invulnerability.

CHAPTER THREE

Study II: Exploring the effect of group polarisation on perceived invulnerability (high interaction)

3.1 Aim

The aims of the present study are: i) to measure the level of perceived invulnerability in general aviation pilots; ii) to test whether a group polarisation effect, due to the presence of an additional pilot who is involved in the flight and with whom high interaction (e.g., in-depth discussion) occurred, would lead to an increase in the pilot's level of perceived invulnerability; and iii) to test whether the level of polarised perceived invulnerability is higher when there is no restriction imposed on the group interaction (i.e., active discussion) than when group discussion is restricted.

3.2 Method

3.2.1 Design overview

The rationale for the present study was that it is a frequent occurrence in general aviation, particularly in a flight training environment, that aircraft are flown by a single pilot with an additional qualified pilot(s) (e.g., trainee pilots or flight instructor) on board. In this particular circumstance, high group interaction between pilots toward aviation related events might reasonably be expected to occur. Research (e.g., Burnstein & Vinokur, 1977; Isenberg, 1986) has shown that stronger group polarisation phenomenon was observed when high group interaction (e.g., in-depth discussion) was permitted compared to when low group interaction (e.g., mere exchange of information) was permitted within a group. As such, the present study tests whether group polarisation would increase the level of perceived invulnerability in aviation in situations where no restriction on group interaction is imposed (e.g., active discussion takes place). In addition, the present study also tests whether the level of perceived invulnerability increases more when there is no restriction imposed on the group interaction than when group discussion is restricted.

To measure participants' level of perceived invulnerability and to test whether a group polarisation effect would lead to an increase in the participant's level of perceived invulnerability, the questionnaire and method used in study I are repeated in the present study.

3.2.2 Participants

Seventy eight pilots participated in this study. The participants were recruited from seven different flight training organisations in the North Island of New Zealand. The participants and their organisations are anonymous in order to respect privacy and confidentiality.

The participants' experience ranged from a recreational pilot to a highly experienced flight instructor. There were 14 female and 64 male participants whose ages ranged from 18 to 59 years (mean age = 25.94, *SD* = 7.86); 12.8% were student pilots (pilots working towards a PPL) (n =10), 42.3% held a PPL (n = 33) and 44.9% held a CPL (n = 35). Among the holders of a commercial pilot licence, 88.6% held a flight instructor rating (n = 31). The total flight experience of participants ranged from 30 minutes to 5,000 hours (Mean = 662.38 hours, SD = 895.13 hours, Median = 235.00 hours).

3.2.3 Materials

The questionnaire used in the present study was identical to the questionnaire used in study I. For each of the 20 items, participants were asked to judge the likelihood of the event occurring to themselves, compared to pilots of a similar age and experience. The 20 questions were worded as: 'Compared to other pilots of similar age and experience, my changes of (problem) in the future are: almost certain; much above average; above average; a little below average; average for pilots with similar age and experience; a little below average; below average; much below average; never happen'. If there was no perceived invulnerability then numerical score would be five. Any variation from numerical score of five would indicate the presence of perceived invulnerability (or vulnerability); that is, higher than numerical score of five indicates the presence of perceived invulnerability, whereas less than numerical score of five indicates the presence of perceived vulnerability. Logically, the greater the deviation from the mean numerical score is, the higher the level of perceived invulnerability (or vulnerability).

Similar to study I, the current study used two types of questionnaires. A type A questionnaire may be viewed in Table 3, Chapter 2 and also in Appendix A. Type A questionnaire contains part I of the questionnaire as listed in Table 3 first, followed by part II of the questionnaire as listed in Table 3. In contrast, type B questionnaire contains part II of the questionnaire first, followed by part I of the questionnaire. Half of the participants were randomly assigned to complete part I of the questionnaire first (control condition), followed by part II of the questionnaire (experimental condition); that is, these participants completed type A questionnaire. The other half of participants were randomly assigned to complete part II of the questionnaire first (control condition), followed by part I of the questionnaire (experimental condition); that is, these participants completed type B questionnaire. Two types of questionnaires (type A and type B) were used to provide a fully counter-balanced design, whereby half the participants completed part I and then part II (type A questionnaire), whilst the other half of participants completed part II and then part I (type B questionnaire).

The first part of the questionnaire was intended to measure each participant's level of perceived invulnerability. The second part was intended to test whether no restriction imposed on the group interaction (e.g., discussion) would affect the level of perceived invulnerability through group polarisation.

The complete set of materials (type A questionnaire) used for the present study contains the following sections; a letter of introduction, about participants and two parts of questionnaires may be inspected in Appendix A.

3.2.4 Procedure

Invitations to participate in the present study were sent to 11 flight training organisations in the North Island of New Zealand, of which seven organisations agreed to participate (64%). When choosing the flight training organisations, several considerations were made (e.g., geographical location, proximity to where the researcher was located and most importantly, any personal contact the researcher may have). The organisations contacted had advertised in two large aviation publications (New Zealand Aviation News and Pacific Wings) and telecom telephone directory on the internet. As this study was not funded, flight training organisations in the South Island of New Zealand could not be included in the sampling frame. The letter sent to the organisations contained an introduction about the researcher, brief aim of the research, brief description of the procedure, followed by contact details of the researcher. The sample letter may be inspected in Appendix C.

The researcher travelled to each flight training school so that all contact with participants was face-to-face. All participants in this study were individually approached by the researcher to complete the questionnaires although participation was carried out in pairs. When approaching to each individual to participate in the research, the overall purpose of the research was explained and emphasis was made that participation in this study was totally voluntary and any data collected would remain anonymous. Also, it was ensured that the participation would be unlikely to take more than 30 minutes. No remuneration was offered as incentives to participate in this study. All data was collected during July, 2007.

Similarly to Study I, the experimental hypothesis was not disclosed to participants at the time of participation in order to minimise the effect of demand characteristics (Orne, 1962 cited in Cozby, 2003) that could arise during data collection. However, the overall purpose of this research was verbally explained to participants so that the participants could give informed consent to participate. Participants were also asked to refrain from discussing the experiment with any other person for at least one week after the time of their participation so that other potential participants were not prejudiced.

Contrary to study I, this particular study invited a pair of participants to participate at the same time. Participants were instructed to read each item in the questionnaire and to choose a response that best reflects each individual's decision on a 9-point Likert-type scale (from 1 for almost certain to 9 for never happened). The first part of the questionnaire (items 1-10) was completed alone, although a pair of participants was located in the same room, participants were instructed to advise the researcher individually once the first part was completed in order to proceed to the second part. The second half of the questionnaire was completed as a pair in that participants were instructed to discuss their response to each individual item and then to choose a personal response that best reflects their individual decision.

Because this research was considered low risk (as evaluated by a screening question provided by the university ethics committee where the researcher was enrolled as a student), full approval from a Human Ethics Committee was not required. Instead, a low risk notification was completed to be recorded on the low risk database. The letter of acknowledgement from a Human Ethics Committee can be viewed in Appendix B.

3.3 Results

All data analyses were carried out using the statistical software package SPSS (version 15.0 for Windows). The level of significance, alpha, was $p \leq .05$ for all statistical analyses and all tests were two-tailed.

The baseline score of the perceived invulnerability for participants was calculated by summing up the individual scores for items 1–10 in the first part of the questionnaire and dividing by 10. This provided the mean score of the perceived invulnerability for participants who were hypothetically flying alone. A mean score of the scale of five would indicate that pilots perceived themselves neither invulnerable nor vulnerable overall. Variation from numerical score of five would indicate the presence of perceived invulnerability (or vulnerability); that is, higher than numerical score of five indicates the presence of perceived invulnerability, whereas less than numerical score of five indicates the presence of perceived vulnerability. Logically, the greater the deviation from the mean numerical score is, the higher the level of perceived invulnerability (or vulnerability). Using the mean score of the first ten items, one-sample t-test (two-tailed, test value = 5) showed strong evidence of perceived invulnerability; $t(77) = 8.54$, $p < .05$ (mean difference from five = 1.06), which indicates that overall, participants perceived themselves as invulnerable to the events covered in items 1–10 of the questionnaire that they completed.

The same analysis was applied to the second half of the questionnaire that participants completed, covering items 11–20. This was the condition in which a pair of participants discussed their response to each individual item and chose a personal response that best reflected their individual decision. Using the mean score of the ten items in the second part, one-sample *t*-test (two-tailed, test value = 5) again showed strong evidence of perceived invulnerability; $t(77) = 8.92$, $p < .05$ (mean difference from five = .94), which indicates overall participants perceived themselves as invulnerable to the events covered in items 11–20.

To test whether the level of perceived invulnerability was affected by the experimental manipulation (e.g., whether freely discussing each other induced effect of group polarisation on the level of perceived invulnerability), the mean score of perceived invulnerability for the first ten questions was compared with the mean score of perceived invulnerability for the second ten questions. Paired samples *t*-test showed that there was no evidence of a difference due to the experimental manipulation $t(77) = 1.09$, $p > 0.05$. The mean difference score for the control condition was 6.06 ($SD = 1.09$) and the mean difference score for the experimental condition was 5.94 ($SD = .93$).

To test whether the level of polarised perceived invulnerability was higher when there was no restriction imposed on the group interaction (experimental condition for study II) than when group discussion was restricted (experimental condition for study I) a between-subjects *t*-test, using the differences in mean scores of perceived invulnerability from study I and study II as the dependent variable and study (I or II) as the independent variable, was conducted. Independent samples *t*-test showed no evidence of a difference in the level of polarised perceived invulnerability associated with two different experimental conditions (high group interaction and low group interaction), $t(110) = -1.17$, $p > 0.05$; for participants in study I the mean difference score was -.09 ($SD = .58$); for participants in study II the mean difference score was .11 ($SD = .93$).

In addition to the planned comparison, an *a posteriori* analysis was conducted to test whether there was any difference in the level of perceived invulnerability associated with the level of licence held. To test whether there was a significant difference in the level of perceived invulnerability due to the level of licences held by the participants (e.g., student pilots, PPL and CPL), a between-subject one-way analysis of variance (ANOVA) was performed using mean score of perceived invulnerability as the dependent variable and level of licence as the independent variable. One-way analysis of variance showed no evidence of a difference in the level of perceived invulnerability due to the level of licence held; $F(2, 75) = .35$, $p > .05$; the mean difference score for student pilots was 5.90 ($SD = 1.19$), the mean difference score for participants with PPL was 5.99 (*SD* = 1.00) and the mean difference score for participants with CPL was 6.17 (*SD* = 1.17).

A further *a posteriori* analysis was conducted to measure whether there was any difference in the level of perceived invulnerability with a flight experience. The participants were divided into two groups: experienced pilots and inexperienced pilots. Experienced pilot group consists of the participants who held CPL with either flight instructor rating and/or instrument rating and the flight experience of more than 250 hours. The reason for these criteria was because once pilots commenced working, they were considered as experienced pilots and they needed to be appropriately qualified such as holding CPL with flight instructor rating in order for them to work (R. deMontalk, personal communication, April, 2008). Independent samples *t*-test was performed using mean score of perceived invulnerability as the dependent variable and flight experience as the independent variable. Independent samples *t*-test showed no evidence of a difference in level of perceived invulnerability with the flight experience $t(75) = .61, p > .05$; for experienced pilot group the mean difference score was 6.12 (*SD* = 1.15) and for inexperienced pilot group the mean difference score was 5.96 (*SD* = 1.02).

In addition to exploring the effect of different levels of licence and flight experience, a final *a posteriori* analysis was conducted to test whether there was a greater change in the level of perceived invulnerability in a pilot–pilot group; that is a group composed of two pilots without flight instructor ratings and a pilot–flight instructor group; that is a group composed of a pilot and a flight instructor. First for a pilot–pilot group, the mean score of perceived invulnerability for the first ten items was compared with the mean score of perceived invulnerability for the second ten items using a between-subjects *t*-test. Paired samples *t*-test showed that there was no evidence suggesting a change in the level of perceived invulnerability in a pilot–pilot group, $t(35) = -.77$, $p > 0.05$, the mean score of perceived invulnerability for the first ten items was 6.13 ($SD = 1.11$) and the mean score of perceived invulnerability for the second ten items was 6.23 ($SD = .92$). The same method was used to test whether there was a change in the level of perceived invulnerability in a pilot–flight instructor group. Paired samples *t*-test showed that there was a significant change in the level of perceived invulnerability in a pilot–flight instructor group, $t(21) = 2.08$, $p = 0.05$. The mean score of perceived invulnerability for the first ten items was 5.69 ($SD = .87$) and the mean score of perceived invulnerability for the second ten items was 5.37 ($SD = .55$).

Furthermore, participants' responses to each of the 20 individual items** were also analysed. Table 5 shows the mean difference score, one-sample t-statistic, degree of freedom and significance for the 20 individual perceived invulnerability items. Items are listed by scale, and by descending order of effect size within each scale.

** Because half of the participants completed part I in the control condition and part II in the experimental condition, whilst the remaining participants completed part II in the controlled condition and part I in the experimental condition, scores for individual items were actually collapsed both levels of the independent variable. Thus any effect due to experimental manipulation has been apportioned equally across each item.

Table 5. Mean difference from average, t-statistic, degree of freedom and significance for individual perceived invulnerability items and scale of totals

Questions	Mean Difference from neutral (Standard deviation in parentheses)	*t*	df	*p*
Poor fuel management[II]	2.01 (1.47)	11.91	75	<.05
Unplanned stall[I]	1.88 (1.38)	11.92	75	<.05
Controlled flight into terrain[I]	1.80 (1.47)	10.69	75	<.05
Causing injury or death whilst flying[II]	1.58 (1.53)	8.97	75	<.05
Embarrassing incident whilst taxiing[I]	1.49 (1.54)	8.39	75	<.05
Getting lost whilst flying[I]	1.42 (1.34)	9.25	75	<.05
Causing a near-miss[II]	.97 (1.24)	6.83	75	<.05
Misinterpreting a chart or plate[I]	.96 (1.31)	6.39	75	<.05
Descending too quickly[I]	.93 (1.52)	5.37	75	<.05
Manoeuvre with wrong flap setting[II]	.92 (1.49)	5.41	75	<.05
Breaching controlled airspace[I]	.86 (1.48)	5.05	75	<.05
Misinterpreting instrument reading[II]	.86 (1.40)	5.32	75	<.05
Deviating from altitude[I]	.78 (1.48)	4.59	75	<.05
Unplanned heavy landing[I]	.72 (1.18)	5.33	75	<.05
Omitting a checklist item[I]	.61 (1.75)	3.01	75	<.05
Taxiing to the wrong place[II]	.49 1.81	2.35	75	<.05

Misunderstanding ATC instruction[II]	.41	1.43	2.48	75	<.05
Having an in-flight engine failure[II]	.51	(1.26)	3.55	75	<.05
Making mistakes on a flight plan[II]	.38	(1.88)	1.77	75	>.05
Having a bird strike[II]	.11	(1.56)	.59	75	>.05

The results presented in Table 5 show that 18 items showed significant perceived invulnerability but two items were perceived as neutral. Participants showed most perceived invulnerability with regard to poor fuel management, followed by unplanned stall. Conversely, participants did not exhibit perceived invulnerability toward events such as making mistakes on a flight plan and having a bird strike.

Of the 18 items which were statistically significant, ten items in part I of the questionnaire showed significant perceived invulnerability and eight items in part II of the questionnaire showed significant perceived invulnerability (items are shown in Table 5 as I or II using superscript font) indicating that the two halves were comparable.

Although 18 items were found to detect statistically significant perceived invulnerability, it should be noted that with alpha set at $p \leq .05$ it would be expected that one of the twenty items would be significant at the .05 level, simply by chance. However, it cannot be determined which item this may have been, or indeed if type I error in fact had occurred. Some caution may thus be required in interpreting the results presented in Table 5.

3.4 Interim discussion

The findings suggested that participants exhibited perceived invulnerability in both the control and the experimental conditions; that is hypothetically flying alone and hypothetically flying with an additional pilot on board. Thus the fourth and fifth hypotheses were supported. However, the sixth and seventh hypotheses were not supported; that is, there was no evidence that the degree of perceived invulnerability was affected by group polarisation, or that the level of perceived invulnerability was affected by two different experimental conditions (unlimited group interaction and limited group interaction).

The present finding is consistent with Gilbey, Fifield and Gibson's (2006) preliminary finding that the pilots exhibited perceived invulnerability. However, Teger and Pruitt's (1967) finding suggesting greater polarisation effect to be expected with no restriction on group interaction (e.g., discussion) was not replicated. The findings suggested that although participants exhibited perceived invulnerability in both the control and the experimental conditions, perceived invulnerability did not appear to be accentuated by a group polarisation effect due to active group interaction. The latter finding is considered to be positive finding.

Contrary to Gilbey, Fifield and Gibson's (2006) preliminary finding (the achievement of "milestones" in training such as the attainment of a PPL may be associated with an increase in comparative optimism), the present study found no evidence of differences between the level of perceived invulnerability and the level of pilot's licence. Similarly, there was no evidence of differences in the level of perceived invulnerability between the experienced pilot group and the non-experienced pilot group.

Although it was not an *a priori* (planned) comparison, changes in the level of perceived invulnerability were compared in a pilot-pilot group and a pilot-flight instructor group. The comparison showed that there was no significant change in the level of perceived invulnerability within a pilot–pilot group. In contrast, the comparison within a pilot–flight instructor group showed that there was a significant change in the level of perceived invulnerability. This finding suggests that when an aviation event was discussed with a flight instructor, the level of perceived invulnerability is more likely to be increased, which raises concern as "the flight instructor's performance may have a significant effect on his or her students becoming involved in an accident or becoming a fatality" (Koonce, 2002, p. 31).

CHAPTER FOUR

GENERAL DISCUSSION

4.1 Overview

The central focus of this thesis was to test whether there was change in general aviation pilots' level of perceived invulnerability through a process of group polarisation. In two separate studies (low group interaction and high group interaction), no evidence was found to suggest that perceived invulnerability was increased by group polarisation. There was, however, strong evidence of perceived invulnerability in both the control and the experimental conditions; that is, when hypothetically flying alone and hypothetically flying with an additional pilot or passenger on board.

4.2 Perceived invulnerability

Hypotheses one, two, four, and five predicted that regardless of whether pilots fly alone or in the presence of an additional passenger or pilot, pilots will exhibit perceived invulnerability toward a range of aviation related behaviours and events.

The findings from study I suggested that participants exhibited perceived invulnerability in both the control condition (flying alone) and the experimental condition (flying with another passenger on board) thus the first and the second hypotheses were supported.

The findings from study II also suggested that participants exhibited perceived invulnerability in both the control condition (flying alone) and the experimental condition (flying with another pilot on board) thus the fourth and the fifth hypotheses were supported.

According to the International Civil Aviation Organisation (ICAO, 2005), pilots frequently exhibit a sense of personal invulnerability. Numerous studies (e.g., Chambers & Windschitl, 2004; Gilbey, Fifield & Gibson, 2006) have demonstrated that the feeling of perceived invulnerability, particularly to the negative events, is persistent and widespread in a number of communities, including aviation. This remains a great concern with regard to aviation safety, as perceived invulnerability toward negative events may increase the likelihood of being engaged in such events that could result in accident or incident.

The majority of the participants in the present study rated themselves as invulnerable toward the hypothetical aviation related events affecting them personally. In particular, controlled flight into terrain, airspace infringement and poor fuel management were events that had large effect size.

Firstly, although Civil Aviation Authority of United Kingdom (1997) found that the controlled flight into terrain accident was the single most common form of fatal accident in general aviation flying, the majority of the participants in the present study rated themselves as invulnerable toward controlled flight into terrain event. Overly optimistic views regarding the likelihood of this type of event may lead to pilots committing judgemental errors such as continuation of VFR flight into adverse weather condition. The likelihood of a pilot exhibiting such behaviour tends to be higher when the pilots are familiar with the area such as in the vicinity of home base. Consequently, despite accurate assessment of a given weather by pilots, they may not perceive the risks involved due to pilots' optimistic view toward controlled flight into terrain accident. Thus, continuation of VFR flight into deteriorating weather, particularly if pilots descend below the minimum safe altitude may increase the likeliness of controlled flight into terrain accident. The Civil Aviation Authority of United Kingdom (1997) found that approximately 35% of controlled flight into terrain accidents occurred in the vicinity of pilots' home base local area at the time of the accident.

A further reason for such behaviours may be that the pilot might have been successful with the same or similar situation in the past therefore the pilot may expect the same successful outcome from the current situation. This is partly why several studies (e.g., Gilbey, Fifield & Gibson, 2006; O'Hare, 1990) argued that the level of perceived invulnerability appears to be a function of experience. This type of attitude and consequent behaviour could more than distort the judgement. Indeed, they would likely place pilots at an increased risk of negative outcomes (Shepperd, Carroll, Grace & Terry, 2002).

Secondly, responses to the question regarding unknowingly breaching the controlled airspace indicated that the majority of the participants perceived themselves invulnerable to such event. Such optimistic views toward the likelihood of this type of event may be due to overconfidence in one's navigational skills and additionally an overly optimistic view toward the likelihood of committing airspace incursion. Consequently, feeling overconfident and invulnerable toward such events could potentially result in less preparation for the flight, such as carrying out of date aeronautical maps or being unfamiliar with recent or temporary changes on airspaces. Thus, the likeliness of unknowingly breaching controlled airspace may increase.

According to the Civil Aviation Authority of New Zealand (1996), pilot induced airspace incidents increased approximately 20% between 1993 and 1995 (although as this is an absolute increase, rather than an increase in rate, such finding may have been related to increased flying activity over the same period). Nevertheless, this finding raises a serious concern as controlled airspace is shared between air transport aircraft and general aviation aircraft. At worst, the risk encountered by air transport aircraft may be heightened by airspace incursions by general aviation aircraft (O'Hare, 1999). In addition, the Civil Aviation Authority of New Zealand (1996) noted that the majority of airspace incidents were reported by the air traffic service provider, rather than by the pilot or aircraft operator. This suggests that pilots may not be aware of such overly optimistic attitudes would lead to behaviours inconsistent with safe operation. Regardless of either intentional or accidental airspace incursion, the true airspace incident rate would be greater than it was reported. Thus, the risk due to airspace incident by general aviation aircraft would be greater than it seemed.

To safeguard against mid-air collision, most air transport aircraft are equipped with Airborne Collision Avoidance System (ACAS) or Traffic Alert and Collision Avoidance System (TCAS) which essentially monitors the relative position of other aircraft nearby and warns a pilot if the aircraft in the vicinity becomes a threat (Underdown, 1993). Consequently, the danger of encountering mid-air collision between aircraft has in principle been reduced. However, both ACAS and TCAS rely on the transponder signal from other aircraft and without transponder signal neither ACAS nor TCAS will be able to warn a pilot although the aircraft nearby becomes a threat (Underdown, 1993). According to Civil Aviation Authority of New Zealand (2007), it is not mandatory to equip with operative transponder if the aircraft remain outside the controlled airspace. Thus, if general aviation aircraft without an operable transponder unknowingly infringed the controlled airspace, the potential risk of mid-air collision due to airspace infringement would be greater, although air transport aircraft are equipped with ACAS or TCAS.

Lastly, responses to the question regarding poor fuel management that could result in either fuel exhaustion (the depletion of all available fuel on board, [AOPA, 2002]) or fuel starvation (interruption of the fuel supply although fuel is still available in the fuel tank, [AOPA, 2002]), indicated that the majority of participants perceived themselves invulnerable to such aviation event. Although accidents due to poor fuel management accounts for a relatively small portion, and seem reasonably easy to avoid, these accidents are yet to be eliminated.

According to AOPA (2002) there were 127 accidents due to poor fuel management in 2000. In principle this type of accident should be relatively easy to avoid, providing each pilot takes a careful steps such as thorough flight planning and fuel analysis, accurate measure of fuel carried and taking a conservative manner when calculating fuel consumption in flight. It is noteworthy that according to AOPA (2002), poor fuel management is not the sole domain of the inexperienced pilots.

In addition to the three items which had the large effect size, there were 15 additional events toward which the majority of pilots exhibited perceived invulnerability. The three items discussed were selected because those events seem relatively easy to avoid, yet accidents due to the events discussed continue to occur and the consequences of those accidents are relatively severe.

The finding from the present study suggests that the majority of the participants do not exhibit perceived invulnerability toward events such as having a bird strike and making a mistake on a flight plan. The possible explication for the finding may include participants' perception that having a bird strike is out of individual's control, as a bird could appear at any phase of flight. In addition, many pilots may have made a mistake on a flight plan at some stage of the training. Thus participants may have taken into consideration the likelihood of previous mistakes reoccurring when they answered such question.

The findings of both studies I and II were consistent with the conclusions of numerous other studies (e.g., Gilbey, Fifield, & Gibson, 2006; Lester & Collony, 1987) that optimistic views toward aviation related negative events are wide spread and persistent in aviation. Although efforts have been made to reduce attitudes such as perceived invulnerability, feeling invulnerable particularly toward negative events is general and robust in aviation and consequently, this might affect safety related decision. It is of interest to note, however, that the effect of perceived invulnerability was negligible among air traffic controllers, particularly toward aviation specific negative events (Gilbey, Fifield, & Rogers, 2006). Although the authors suggested that it may be possible to learn why air traffic controllers tend not to exhibit perceived invulnerability, it is not known whether this strand of research is actively being pursued.

4.3 Effects of group polarisation on perceived invulnerability

Hypotheses three and six predicted that the level of perceived invulnerability measured in the presence of additional passenger or pilot on board condition will be significantly higher than the level of perceived invulnerability measured in the pilot alone condition due to the presence of group polarisation. The findings suggested that although participants exhibited perceived invulnerability toward a range of aviation related behaviours and events, perceived invulnerability did not appear to increase due to the effect of group polarisation in either of the two experimental manipulations (low group interaction and high group interaction).

Although previous research (e.g., Isenberg, 1986; McCauley & Segal, 1987; Myers & Lamm, 1976) has suggested that the group polarisation effect is remarkably general and robust, having been obtained in a wide variety of domains, the effect was not found in the current study. There are a number of potential explanations as to why hypotheses three and six were not supported.

First, the reason that group polarisation was not observed in the present study may be because real decision making group was used. The real decision making group refers to a group consists of real people and it is opposite to artificially created group. According to Semin and Glendon (1973), the generality of group polarisation phenomenon tends to be in question when real decision making groups are involved. Almost all the studies that have examined the existence of group polarisation were conducted in laboratory settings with artificially created group thus group polarisation phenomenon has been readily observed (Brown, 2000). However, findings of the present study where real decision making groups were used is consistent with Semin and Glendon's (1973) claim that group polarisation in real decision making groups may not be as pervasive as previous studies claimed.

In addition, an effect due to group polarisation may not have been observed because of small numbered group (two–person group). According to Teger and Pruitt (1967), the presence of group polarisation phenomenon is a function of the number of people in a group. A minimal shift in decision was observed in a group of three (three–person group). In the present study, two–person group was used thus, although group polarization might have been present, the effect of group polarization could not be as evident due to small numbered group.

Lastly, an effect of group polarisation may not have been observed in the present study due to the possible presence of *type II error* during data analyses. Details on possible presence of *type II error* are discussed in section 4.6.5 (p. 89).

Hypothesis seven predicted that the increase in perceived invulnerability will be significantly greater when there is no limit on discussion (high interaction) of flying related matters than when discussion is limited (low interaction). The findings suggested that group polarisation phenomenon in the present study was neither present nor affected by experimental manipulations; that is, low interaction and high interaction.

Previous research (e.g., Brown, 2000; Isenberg, 1986; Myer & Lamm, 1976) suggested that more enhanced group polarisation was observed after active discussion than after limited discussion. On the other hand, other research (e.g., Cason & Mui, 1997; Goethals & Zanna, 1979) suggested that although the influence of active discussion on group polarisation phenomenon could not be completely excluded, effect of limited discussion on group polarisation phenomenon was as strong. However, the findings from the previous researches were not replicated in the present study. The findings from the present study suggested that frequency of group interaction (low and high interactions) does not seem to relate to the strength of group polarisation phenomenon.

4.4 Perceived invulnerability, level of licence held and flight experience

Although the effect of the level of licence held and flight experience on the level of perceived invulnerability was not the central focus of the present study, two additional analyses were conducted to test whether there was any difference in the level of perceived invulnerability associated with the level of licence held and flight experience.

The findings suggested that there were no significant differences in the level of perceived invulnerability associated with the level of licence held and flight experience.

Previous research (e.g., Gilbey, Fifield, & Gibson, 2006; O'Hare, 1990; Wichman & Ball, 1983) found that perceived invulnerability was a function of flight experience and higher licence held (generally a pilot with higher licence is more experienced). In addition, Telfer (1989) identified that student pilots initially perceive that their judgement could be defective and as a result, they tended to be more cautious. However, after accumulating flying hours over approximately six months, they tended to be less prepared and unwilling to admit that their judgement could be defective. However, this perceptual shift was not found in the present study. This is considered to be positive as such perceptual shift would more likely result in exhibiting perceived invulnerability that would likely lead to incidents or accidents.

4.5 Exhibition of higher level of perceived invulnerability by flight instructors

Although this was not a central focus for the present study, changes in the level of perceived invulnerability were compared in a pilot-pilot group and a pilot-flight instructor group. The comparison showed that there was no significant change in the level of perceived invulnerability within a pilot–pilot group. In contrast, the comparison within a pilot–flight instructor group showed that there was a significant change in the level of perceived invulnerability. This finding suggests that when an aviation event was discussed with a flight instructor, the level of perceived invulnerability is more likely to be increased.

In principle this could be a safety concern, as flight instructors have a formative influence on the attitudes and behaviours of the trainee pilots (Ramsey & Ramsey, 1996). Jensen (1995) argued that attitudes toward risk taking in aviation may have developed within the trainee pilots as a result of their flight training, in particular, watching how flight instructors deal with decisional issues. Thus, attitudes learnt from this may be either positive (taking a cautious approach to risk) or negative (taking a greater or unnecessary risk). In addition, Hunter (1999) argued that such attitude (e.g., perceived invulnerability) learnt in early stage of training is likely endured onto the future aviation career. Thus if a trainee pilot learnt negative attitude such as perceived invulnerability at the early stage of training, he/she is then likely to exhibit such attitudinal behaviour throughout his/her aviation career. This raises a safety concern as perceived invulnerability is likely to affect one's quality of decisions.

The present study also suggested that a change in the level of perceived invulnerability was greater among a pilot–flight instructor pair than a pilot-pilot pair. Such finding may be because as flight instructors exhibited higher level of perceived invulnerability than non-flight instructors, pilots who were paired with flight instructor might have been overly influenced by risk-prone flight instructors. This may serve as a possible explanation of O'Hare's (1999) finding that pilots who were 'under instruction' at the time of the crash were more likely to receive a fatal injury. Overall risk of injury was also found to be greater in a pilot-flight instructor pair than in flights completed without a flight instructor.

4.6 Potential limitations of the present study

4.6.1. Nature of activities

Participants in the present study were mostly recruited from training organisations. It is thus inadvisable to generalise the current findings to other areas of general aviation as general aviation encompasses a wide variety of activities that include business flying, agricultural aviation, personal flying for pleasure or sports and flight training (Kumar *et al.*, 2005). The level of perceived invulnerability within other sectors of general aviation may be measured different from the current study. For instance, typical pilots under part 135 operations (air operation using small aircraft) are deemed to be engaged in more challenging flying activities than typical pilots in flight training organisations thus, there is a possibility that perceived invulnerability or personal confidence level may be higher than those pertain to flight training organisations.

4.6.2. Participants

All participants in the present study fly fixed wing piston engine aircraft. It is thus unclear whether finding of current study could generalise to other types of aircraft as there are various types of aircraft used in general aviation operations, including single engine and multi engine piston aircraft, turboprops, turbojets, helicopters, gliders and experimental aircraft (GAO, 2004). The level of perceived invulnerability exhibited by pilots operating other categories of aircraft may be different from the level of perceived invulnerability measured in the present study. For instance, the average flight time for a helicopter flight is generally shorter than the average flight time for fixed wing aircraft. Consequently, helicopter pilots may conduct more take offs and landings for a given flight time when compared to a number of take offs and landings by fixed wing pilots for the same flight time. Thus, it may be possible for helicopter pilots to exhibit higher level of perceived invulnerability or personal confidence because more exposure to take offs and landings may lead helicopter pilots to perceive themselves less likely to be involved in accidents during take off and landing due to higher currency.

4.6.3 Number of organisations participated

As the current study was not funded, flight training organisations in the South Island of New Zealand could not be included in the sampling frame. In addition, only eight organisations in North Island were involved in the present study. As there are more than eight flight training organisations in North Island it may therefore be inadvisable to generalise the current findings to all other flight training organisations in New Zealand.

4.6.4 Limitation of an artificially created setting

The generality of a result observed in a study in laboratory settings with artificially created groups and hypothetical (i.e., pen and paper) tasks is often in question when compared to a real life involving real group members. Because the present study was a hypothetical laboratory based study with hypothetical aviation events, an effect which may well have been present in real life may not been observed in this study.

4.6.5 Increased chance of *type II error* due to low sample size

A *Type II error* occurs when the research fails to reject a null hypothesis that is in fact false (Reber & Reber, 2001). The chances of presence of *type II error* is inversely related to the sample size (Hopkins, 2003). Due to restrictions on the availability of participants and the resources available for this study, it is possible that with a larger sample size a statistically significant effect could have been found. However, it should be noted that although a statistically significant effect will always be found if the sample is large enough, it may no longer have real-world relevance.

4.6.6 Strength of experiment manipulation

A general principle when designing research is to ensure the manipulation is as strong as possible in order to increase the chances that the independent variable will have a statistically significant effect on the dependent variable (Cozby, 2004). It is possible that the experimental manipulation(s) used in the present study were not strong enough to create the hypothesised change in the dependent variable. However, although the strongest possible experiment manipulation is desirable, it is almost always moderated due to involving real world situation because design and use of the strongest manipulation need to be within the bounds of ethics in order to prevent any potential physical and psychological harm to participants (Cozby, 2004).

4.6.7 Controlling for participant expectations

The experimental hypotheses were not disclosed to participants at the time of participation in order to minimise any biases such as demand characteristics (e.g., Orne, 1962 cited in Cozby, 2003). However, because the overall purpose of this research was described to participants in order to obtain their consent to participate, it is possible that the participants may have predicted the experimental hypotheses. In addition, although participants were asked to refrain from discussing the experiment with any other person for at least one week after the time of their participation so that other potential participants were not prejudiced, the experiment may well have been discussed as the data were gathered over a few days.

4.7 Further research

The present study was a hypothetical laboratory based study with hypothetical aviation events. Consequently, the generality of a result observed in this study may not be a true reflection of real life with real scenarios. Thus, a study could be designed using a simulator or observing a real flight to increase the validity of the findings. In addition, using a simulator may allow more time for group polarisation to influence participant's perception of risk.

Although the current study demonstrated that perceived invulnerability is persistent amongst pilots in flight training organisations, the findings should be treated with some caution if they are to be generalised across to flight training organisations in New Zealand due to small number of organisations participated which has not included flight training organisations in the South Island of New Zealand. Thus, if the data could be collected from the flight training organisations in South Island and also more flight training organisations in North Island were visited then more accurate reflection of overall level of perceived invulnerability on general aviation pilots in New Zealand would be achieved. In addition, it is worth examining the level of perceived invulnerability among charter pilots (e.g., pilots from Sunair, Air2there, Great Barrier, Mount Air and so forth) or freight pilots as their operations are generally considered more challenging than the pilots in flight training organisations, moreover, their normal flight times per annum tend to be greater than most of the trainee pilots who were main participants in the present study.

It could also be worth comparing the level of perceived invulnerability among the pilots with similar age and experience trained in a university setting, trained in training organisations under Part 141 (aviation training organisations) and trained in training organisations under Part 149 (aviation recreation organisations). Hunter (1999) argued that there is some evidence suggesting that pilots who were trained at well-established pilot training schools (those certificated under Federal Aviation Regulation Part 141) or in a university setting generally perform better than pilots who received their initial training at other locations, even ten years or more after completion of the training. This may imply that those pilots trained at well-established pilot training schools or in a university setting could have been taught more and better on human factors, including perceived invulnerability. Thus, if Hunter's (1999) argument is corroborated by other studies, then human factors training could prove an important variable in understanding differential performance by pilots and possibly their differential risk potential.

4.8 Recommendation

Numerous studies, including the present study, identified that perceived invulnerability amongst pilots are persistent and widespread in general aviation. However, in reviewing aviation literature and current rules, more emphasis is placed on physiological considerations (stick and rudder skills), rather than psychological considerations (human factors) particularly in general aviation. Thus, it is important to focus on human factors side of training and the theory taught needs to be applied and reinforced in the general aviation area. In addition, general aviation pilots need to ensure that regular revision of the human factor related subjects needs to be made.

Further recommendation is to revise and develop better structured initial and subsequent human factors training in general aviation, particularly risk taking behaviour. It is perhaps beneficial to compare current human factors training syllabus with human factors training syllabi used by other area of aviation such as air traffic control and airline and incorporate training syllabi that for instance, would reduce feeling of perceived invulnerability, and subsequently, reducing unnecessary risk taking behaviour.

CHAPTER FIVE

CONCLUSION

5.1 Conclusion

The aim of the present study was to test whether there were any changes in individuals' level of perceived invulnerability via a process of group polarisation and to investigate the level of perceived invulnerability amongst pilots in general aviation.

Although group polarisation phenomenon does not seem to affect individuals' level of perceived invulnerability, the majority of the participants in the present study exhibited perceived invulnerability in both the control and the experimental conditions; that is, hypothetically flying alone and hypothetically flying with an additional pilot or passenger on board. Additional findings from the present study suggested that flight instructors exhibited higher level of perceived invulnerability than non-flight instructors and perhaps as a consequence, pilot-flight instructor pairs exhibited higher level of perceived invulnerability.

Gilbey, Fifield and Rogers' (2006) findings indicate that, unlike pilots, air traffic controllers appear to be less susceptible to perceived invulnerability in air traffic control related matters. Thus, there may be a lesson to be learnt from initial and/or recurrent training syllabi for air traffic controllers that may be applied to training syllabus for general aviation pilots (Gilbey, Fifield & Rogers, 2006).

Although safety seminars are held regularly, it is possible that they are not reaching the total general aviation pilot population. Thus developing alternatives to disseminate training information on those not attending safety seminars would improve the safety of general aviation (Hunter, 1999). In addition, it needs to be noted that pilots who demonstrate a safe course of action on a written scenario may not do so at the critical phase in real-time situation as the accident reports suggest. Thus, an instrument capable of reliably detecting individual differences in decision-making skills could have a substantial impact on aviation safety by for instance, identifying those individuals most at risk for a decision-related accident or incident (Driskill, Weissmuller, Quebe, Hand & Hunter, 1998).

It is concluded that feelings of perceived invulnerability are persistent and widespread in many different communities including aviation that may be impossible to stop them from developing. Thus, it is important to be aware of symptoms that lead to perceived invulnerability in order to take appropriate action to prevent perceived invulnerability from affecting decision making. In addition, regular revision of human factors and regular attendance on safety seminar would further reduce the chance of being involved in an incident or accident. Equally, regulatory authorities need to revise current syllabus to ensure that all human factor related topics are sufficiently taught at the various level of flight training and perhaps to compare current human factors training syllabus with human factors training syllabi used by other areas of aviation such as air traffic control and corporate aviation organisations and incorporate methods that were proven to be valuable in reducing the feeling of perceived invulnerability.

Lastly, the findings from the present study suggested that the level of perceived invulnerability did not appear to be accentuated by group polarisation effect due to the presence of additional person (passenger or pilot) on board with high group interaction. This is considered to be a positive finding as a central focus of the present study relates to aviation safety in general aviation.

REFERENCES

AOPA. (2002). *2001 Nall report: General aviation accident trends and factors for 2000*. Fredrick, MD: AOPA Air Safety Foundation.

Apanovitch, A. M., Salovey, P., & Merson, M. (1998). *The Yale-MTV study of attitudes of American youth*. Unpublished manuscript.

Baron, R. A., & Byrne, D. (2000). *Social psychology (9^{th} ed.)*. Boston: Allyn and Bacon.

Bureau of Air Safety Investigation. (1996). *Human factors in fatal aircraft accidents*. Canberra, Australia: Author.

Beesley, L. G. A. (2003). *Relationships among knowledge creation, diffusion and utilisation in the CRC process*. Unpublished doctoral dissertation, Griffith University, Brisbane, Australia.

Berlin, J.I., Gruber, E. V., Holmes, C. W., Jensen, P. K., Lau, J. R., Mills, J. W., & O'Kane, J. M. (1982). *Pilot judgment training and evaluation* (DOT/FAA/CT-82/56). Daytona Beach, FL: Embry-Riddle Aeronautical University.

Besco, R. O. (1992). Analyzing knowledge deficiencies in pilot performance. *International Journal of Aviation Psychology, 2*(1), 53–74.

Binnema, G. J. (2005). The effect of accident report formats on invulnerability and hindsight bias. *Human Factors and Aerospace Safety*, *5*(4), 295–308.

Booze, C. F. (1977). *An epidemiologic investigation of occupation, age and exposure in general aviation accidents* (FAA-AM-77-10). Oklahoma city, OK: FAA civil aeromedical institute.

Borges, M. A., & Dutton, L. J. (1976). Attitudes toward aging: Increasing optimism found with age. *The Gerontologist, 16*(3), 220–224.

Breheny, M., & Stephens, C. (2004). Barriers to effective contraception and strategies for overcoming them among adolescent mothers. *Public Health Nursing, 21*(3), 220–227.

Brown, R. (2000). *Group process – dynamic within and between groups (2nd ed.)*. Malden, MA: Blackwell.

Buehler, R., Messervey, D., & Griffin, D. (2005). Collaborative planning and prediction: Does group discussion affect optimistic biases in time estimation? *Organizational Behavior and Human Decision Processes, 97*(1), 47–63.

Bureau of Transportation Statistics (2007). National transportation statistics. Retrieved January 29, 2008, from http://www.bts.gov/publications/national_transportation_statistics/html/front_matter.html.

Burger, J. M., & Burns, L. (1988). The illusion of unique invulnerability and the use of effective contraception. *Personality and Social Psychology Bulletin, 14*, 264–270.

Burnstein, E., & Vinokur, A. (1975). What a person thinks upon learning he has chosen differently from others: New evidence for the persuasive-arguments explanation of choice shifts. *Journal of Experimental Social Psychology, 11*(5), 412–426

Burnstein, E., & Vinokur, A. (1977). Persuasive argumentation and social comparison as determinants of attitude polarization. *Journal of Experimental Social Psychology, 13*(4), 315–332.

Campbell, R. D., & Bagshaw, M. (2001). *Human performance and limitations in aviation (3rd ed.)*. Malden, MA: Blackwell Science.

Cason, T. N., & Mui, V. L. (1997). A laboratory study of group polarisation in the team dictator game. *The Economic Journal, 107*(444), 1465–1483.

Chambers, A. B., & Nagel, D. C. (1985). Pilots of the future: Human or computer? *Computer*, *11*, 74–87.

Chambers, J. R., & Windschitl, P. D. (2004). Biases in social comparative judgments: The role of nonmotivated factors in above-average and comparative-optimism effects. *Psychological Bulletin*, *130*(5), 813–838.

Choo, C. W. (2005). *An information perspective of organizational disasters*. (Primaveral working paper No. 2005-07). University of Amsterdam, Netherland.

Civil Aviation Authority of New Zealand. (1996). *CAA review*. Wellington, New Zealand: Author.

Civil Aviation Authority of New Zealand. (2001). Toward 2005: The aviation safety plan. Wellington, New Zealand: Author.

Civil Aviation Authority of New Zealand. (2007). *Civil Aviation Advisory Circular 61-5*. Retrieved October 31, 2007, from http://www.caa.govt.nz

Civil Aviation Authority of New Zealand. (2007). *Civil Aviation Rule 61*. Retrieved February 26, 2008, from http://www.caa.govt.nz

Civil Aviation Authority of New Zealand. (2007). *Civil Aviation Rule 91*. Retrieved February 26, 2008, from http://www.caa.govt.nz

Civil Aviation Authority of United Kingdom. (1997). *Review of general aviation fatal accidents 1985-1994*. West Sussex, UK: Author

Clemen, R. T., & Winkler, R. L. (1999). Combining probability distributions for experts in risk analysis. *Risk Analysis, 19*(2), 187–203.

Cozby, P. C. (2003). *Methods in behavioral research (8th ed.)*. Boston: McGraw-Hill.

Davis, J. H. (1973). Group decision and social interaction: A theory of social decision schemes. *Psychological Review, 80*(2), 97–125.

Davis, J. H., & Stasson, M. F. (1988). Small group performance: Past and present research trends. *Advances in Group Processes*, *5*, 245–277.

Deakin, J. (2004). *Pelican's perch #80: Gear-up landing in a 747?* Retrieved December 17, 2007, from http://www.avweb.com/news/pelican/188536-1.html.

Degani, A., & Wiener, E. L. (1997). Procedures in complex systems: The airline cockpit. *Systems and Humans, 27*(3), 302–312.

Dismukes, K., & Tullo, F. (2000). Aerospace forum: Rethinking crew error. *Aviation Week and Space Technology, 153*(3), 63–65.

Driskill, W. E., Weissmuller, J. J., Quebe, J., Hand, D. K., & Hunter, D. R. (1998). *Evaluating the decision-making skills of general aviation pilots* (DOT/FAA/AM-98/7). Washington, DC: Office of Aviation Medicine.

Ellis, D. G., & Fisher, B. A. (1994). *Small group decision making: Communication and the group process (4th ed.).* New York: McGraw-Hill.

Federal Aviation Authority. (2002). *The aeronautical newsletter of Seattle.* Renton, WA: Author.

Feggetter, A. J. (1985). Human factors: The key to survival. In R. Hurst & L. R. Hurst (Eds.), *Safety in General Aviation* (pp1–66). London: Collins.

Feldman, R. S., & Rosen, F. P. (1978). Diffusion of responsibility in crime, punishment, and other adversity. *Law and Human Behavior, 2*(4), 313–322.

Festinger, L. (1954). A theory of social comparison processes. *Human Relations, 7*, 117–140.

Forsyth, D. R. (1999). *Group dynamics (3rd ed.)*. Belmont, CA: Wadsworth.

Gagne, R. M. (1984). Learning outcomes and their effects: Useful categories of human performance. *American Psychologist, 39*(4), 377–385.

Gilbey, A., Fifield, S., & Gibson, A. (2006). *The development of comparative optimism in ab-initio pilots*. Poster presented at the 27th EAAP Jubilee Conference " 50 Years of EAAP - Accomplishments and future Challenges in Aviation Psychology", Potsdam (Germany), 24–28 September

Gilbey, A., Fifield, S., & Rogers, S. (2006). Comparative optimism and stress: are air traffic controllers immune? *Human Factors and Aerospace Safety*, *6*(2), 89–102.

Gilbey, A., & Hill, S. (2008). Confirmation bias in general aviation lost procedure. Proceedings of the Eighth Australian Aviation Psychology Association (AAvPA). Sydney, Australia.

Goethals, G. R., & Zanna, M. P. (1979). The role of social comparison in choice shifts. *Journal of Personality and Social Psychology, 37*(9), 1469–1476.

Goh, J., & Wiegmann, D. A. (2001). Visual flight rules flight into instrument meteorological conditions: An empirical investigation of the possible causes. *The International Journal of Aviation Psychology, 11*(4), 359–379.

Goh, J., & Wiegmann, D. (2002). Human factors analysis of accidents involving visual flight rules flight into adverse weather. *Aviation, Space, and Environmental Medicine, 73*(8), 817–822.

Government Accountability Office (2004). *General aviation security: Increased federal oversight is needed, but continued partnership with the private section is critical to long-term success* (GAO-05-144). Washington, DC: Author.

Heath, C., & Gonzalez, R. (1995). Interaction with others increases decision confidence but not decision quality: Evidence against information collection views of interactive decision making. *Organizational Behavior and Human Decision Processes, 61*(3), 305–326.

Helmreich, R. L., & Foushee, H. C. (1993). Why crew resource management: Empirical and theoretical bases of human factors training in aviation. In: E. L. Wiener, B. G. Kanki, & R. L. Helmreich (Eds.), *Cockpit resource Management* (pp. 3–45). San Diego, CA: Academic.

Hinsz, V. B., Tandale, R. S., & Vollrath, D. A. (1997). The emerging conceptualization of groups as information processors. *Psychological Bulletin, 121*(1), 43–64.

Hobbs, A. (2004). Human factors: The last frontier of aviation safety? *The International Journal of Aviation Psychology, 14*(4), 335–341.

Holt, J. (2007, January 21). You are what you expect. *The New York Times*.

Hoorens, V. (1996). Self-favoring biases for positive and negative characteristics: Independent phenomena? *Journal of Social and Clinical Psychology*, *15*, 53–67.

Hunter, D. R. (1999). The general aviation pilot: Variety is the spice of flight. In D. O'Hare (Ed.), *Human Performance in General Aviation* (pp. 25–46). Aldershot, UK: Ashgate.

International Civil Aviation Organization. (2005). *ICAO Accident Prevention Programme*, Montreal, Quebec, Canada: Author.

Isenberg, D. J. (1986). Group polarization: A critical review and meta-analysis. *Journal of Personality and Social Psychology, 50*(6), 1141–1151.

Jensen, R. S. (1995). *Pilot Judgement and Crew Resource Management*. Aldershot, UK: Ashgate.

Jones, P. E., & Roelofsma, P. H. M. P. (2000). The potential for social contextual and group biases in team decision-making: Biases, conditions and psychological mechanisms. *Ergonomics, 43*(8), 1129–1152.

Kern, T. (1998). *Flight Discipline.* New York: McGraw-Hill.

Klar, Y., Medding, A., & Sarel, D. (1996). Nonunique invulnerability: Singular versus distributional probabilities and unrealistic optimism in comparative risk judgements. *Organisational Behaviour and Human Decision Process, 67*(2). 229–245.

Koonce, J. M. (1999). A historical overview of human factors in aviation. In D. J. Garland, J. A. Wise, & V. D. Hopkin (eds.), *Handbook of aviation human factors* (pp. 3–13). Mahwah, NJ: Lawrence Erlbaum.

Koonce, J. M. (2002). *Human factors in the training of pilots*. London: Taylor & Francis.

Kumar, B., DeRemer, D., & Marshall, D. M. (2005). *An illustrated dictionary of aviation*. New York: McGraw-Hill.

Kunda, Z. (1987). Motivational inference: Self-serving generation and evaluation of causal theory. *Journal of Personality and Social Psychology, 53*(4), 636–647.

Lester, L. F., & Bombaci, D. H. (1984). The relationship between personality and irrational judgement in civil pilots. *Human Factors*, *26*, 565–572.

Lester, L. F., & Connolly, T. J. (1987). The measurement of hazardous thought patterns and their relationship to pilot personality. In R. S. Jensen (Ed.), *Proceedings of the Fourth International Symposium on Aviation Psychology* (pp. 286–292). Columbus, OH: Ohio State University.

Li, G. (1994). Pilot-related factors in aircraft crashes: A review of epidemiologic studies. *Aviation, Space, and Environmental Medicine, 65*(10), 944–952.

Li, G., & Baker, S. P. (1999). Correlates of pilot fatality in general aviation crashes. *Aviation, Space, and Environmental Medicine, 70*(4), 305–309.

Li, G., Baker, S. P., Grabowski, J. G., & Rebok, G. W. (2001). Factors associated with pilot error in aviation crashes. *Aviation, Space, and Environmental Medicine, 72*(1), 52–58.

Love, M. C. (1999). *Flight Maneuvers*. New York: McGraw Hill.

McCauley, C. R., & Segal, M. E. (1987). Social psychology of terrorist groups. In C. Hendrick (Ed.), *Group process and intergroup relations*. Newbury Park, CA: Sage.

McCoy, S. B., Gibbons, F. X., Reis, T. J., Gerrard, M., Luus, C. A., & Sufka, A. V. (1992). Perceptions of smoking risk as a function of smoking status. *Journal of Behavioral Medicine,* 15(5), 469–488.

Murray, S. R. (1997). Deliberate decision making by aircraft pilots: A simple reminder to avoid decision making under panic. *The International Journal of Aviation Psychology*, *7*(1), 83–100.

Myers, D. G. & Lamm, H. (1976). The group polarization phenomenon. *Psychological Bulletin, 83*(4), 602–627.

Myers, D. G. (1978). Polarizing effects of social comparison. *Journal of Experimental Social Psychology, 14*(6), 554–563.

National Transportation Safety Board. (2007). *Annual review of aircraft accident data: U.S. general aviation, calendar year 2003*. Washington, DC: Author.

O'Hare, D. (1990). Pilot's perception of risks and hazards in general aviation. *Aviation, Space, and Environmental Medicine, 61*(7), 599–603.

O'Hare, D., & Smitheram, T. (1995). "Pressing On" into deteriorating conditions: An application of behavioural decision theory to pilot decision making. *The International Journal of Aviation Psychology*, *5*(4), 351–370.

O'Hare, D. (1999). Introduction to human performance in general aviation. In D. O'Hare (Ed.), *Human performance in general aviation* (pp. 3–10). England: Ashgate.

O'Hare, D., & Chalmers, D. (1999). The incidence of incidents: A nationwide study of flight experience and exposure to accidents and incidents. *The International Journal of Aviation Psychology, 9*(1), 1–18.

Orasanu, J. M. (1993). Decision-making in the cockpit. In E. L. Wiener, B. G. Kanki, & R. L. Helmreich (Eds.), *Cockpit resource management* (pp. 137–172). San Diego, CA: Academic Press.

Orasaun, J. M., & Salas, E. (1993). Team decision making in complex environment. In G. Klein, J. Orasanu, R. Calderwood, & C. Zsambok (Eds.), *Decision making in action: Models and methods* (pp. 327–345). Norwood, NJ: Ablex.

Pearson, R. G. (1963). *Human factors aspects of lightplane safety* (FAA/AM/63-35). Oklahoma city, OK: FAA Civil Aeromedical Research Institute.

Perloff, L. S. (1987). Social comparison and illusions of invulnerability to negative life events. In C. R. Snyder, & C. Ford (Eds.), *Coping with negative life events: Clinical and social psychological perspectives on negative life events* (pp. 217–242). New York: Plenum Press.

Pulford, B. D., & Colman, A. M. (1996). Overconfidence, base rates and outcome positivity/negativity of predicted events. *British Journal of Psychology, 87*(3), 431–445.

Ramsey, D. C., & Ramsey, P. L. (1996). Feminine and masculine values in flight instructing. *Women in Management Review, 11*(8), 4–12.

Reason, J. T. (1997). *Managing the risks of organisational accidents.* Aldershot, UK: Ashgate.

Reber, A. S., & Reber, E. S. (2001). *The penguin dictionary of psychology (3rd ed.)*. London; Penguin Group.

Regan, J. W., Gosselink, H., Hubsch, J., & Ulsh, E. (1975). Do people have inflated views of their own ability? *Journal of Personality and Social Psychology, 51*(2), 295–301.

Salvatore, S., Stearns, M. D., Huntley, M. S., & Mengert, P. (1986). Air transport pilot involvement in general aviation accidents. *Ergonomics, 29*(11), 1455–1467.

Sanders, G. S., & Baron, R. S. (1977). Is social comparison irrelevant for producing choice shifts? *Journal of Experimental Social Psychology, 13*(4), 303–314.

Sarter, N. B., & Alexander, H. M. (2000). Error types and related error detection mechanisms in the aviation domain: An analysis of aviation safety reporting system incident reports. *The International Journal of Aviation Psychology, 10*(2). 189–206.

Scheier, M. F., & Carver, C. S. (1987). Dispositional optimism and physical well-being: The influence of generalized outcome expectancies on health. *Journal of Personality, 55*(2). 169–210.

Semin, G. R., & Glendon, A. I. (1973). Polarization and the established group. *British Journal of Social and Clinical Psychology, 12*, 113–121.

Shappell, S. A., & Wiegmann, D. A. (2004). *HFACS analysis of military and civilian aviation accidents: A north american comparison.* Paper presented at the annual meeting of the International Society of Air Safety Investigators, Queensland, Australia.

Shepperd, J. A., Carroll, P., Grace, J., & Terry, M. (2002). Exploring the causes of comparative optimism. *Psychologica Belgica, 42*, 65–98.

Simpson, P., & Wiggins, M. (1999). Attitudes toward unsafe acts in a sample of Australian general aviation pilots. *The International Journal of Aviation Psychology, 9*(4), 337–350.

Spector, P. E., Cohen, S. L., & Penner, L. A. (1976). The effect of real vs. hypothetical risk on group choice-shifts. *Personality and Social Psychology Bulletin, 2*(3), 290–293.

Stephenson, G. M., Clark, N. K., & Wade, G. S. (1986). Meeting make evidence? An experimental study of collaborative and individual recall of a simulated police interrogation. *Journal of Personality and Social Psychology, 50*(6), 1113–1122.

Stoner, J. A. F. (1961). *A comparison of individual and group decisions involving risk.* Unpublished master's thesis, Massachusetts Institute of Technology, Cambridge, MA.

Svenson, O. (1981). Are we all less risky and more skilful than our fellow drivers? *Acta Psychologica*, *47*(2), 143–148.

Taylor, S. E., & Brown, J. D. (1988). Illusion and well-being: A social psychological perspective on mental health. *Psychological Bulletin*, *103*(2), 193–210.

Teger, A. I., & Pruitt, D. G. (1967). Components of group risk taking. *Journal of Experimental Social Psychology, 3*(2), 189–205.

Telfer, R. A. (1989). *Pilot Decision Making and Judgement*. Aldershot, UK: Grower Technical.

Trollip, S. R. (1997). Assessing human factors in primary aviation. In G. J. F. Hunt (Ed.), *Designing instruction for human factors training in aviation* (pp. 279–303). Aldershot, UK: Ashgate.

Trollip, S. R., & Jensen, R. S. (1991). *Human factors for general aviation*. Englewood, CO: Jeppesen Sanderson.

Underdown, R. B. (1993). *Ground studies for pilots (5^{th} ed.)*. London: Blackwell Science.

Vaughan, G. M., & Hogg, M. A. (2005). *Introduction to social psychology (4^{th} ed.)*. Frenchs Forest, N.S.W: Pearson Prentice Hall.

Wallach, M. A., Kogan, N., & Bem, D. J. (1962). Group influence on individual risk taking. *Journal of Abnormal and Social Psychology, 65*(2), 75–86.

Weinstein, N. D. (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology*, *39*(5), 806–820.

Wetmore, M., & Lu, C-t. (2005b). Reducing hazardous attitudes: The effects of pilot certification and flight experience. *White paper*. Central Missouri State University.

Wetmore, M., & Lu, C-t. (2006). The effect of hazardous attitudes on crew resource management skills. *International Journal of Applied Aviation Studies, 6*(1), 165–182.

Whyte, G. (1989). Groupthink reconsidered. *The Academy of Management Review, 14*(1), 40–56.

Wichman, H., & Ball, J. (1983). Locus of control, self-serving biases, attitudes towards safety in general aviation pilots. *Aviation, Space and Environmental Medicine, 54*, 507–510.

Wiegmann, D., Faaborg, T., Boquet, A., Detwiler, C., Holcomb, K., & Shappell, S. (2005). *Human error and general aviation accidents: A Comprehensive, Fine-Grained Analysis Using HFACS* (DOT/FAA/AM-05/24). Washington, DC: Office of Aerospace Medicine.

Wiegmann, D. A., & Shappell, S. A. (2001). Human error perspective in aviation. *The International Journal of Aviation Psychology*, *11*(4), 341–357

Wiegmann, D., & Shappell, S. (2003). *A human error approach to aviation accident analysis: The human factors analysis and classification system.* Aldershot, UK: Ashgate.

Wiggins, M. (1999). The development of Computer-Assisted Learning (CAL) systems for general aviation. In D. O'Hare (Ed.), *Human performance in general aviation* (pp. 153–172). Aldershot, UK: Ashgate.

Wilson, D. R., & Fallshore, M. (2001). Optimistic and ability biases in pilots' decisions and perceptions of risk regarding VFR flight into IMC. *Proceedings of the 11th International Biennial Symposium on Aviation Psychology*, March 5-8, 2001, Columbus, OH: Ohio State University.

Wyczalek, F. A. (1997). Transport safety – New math lessons learned. *Energy Conversion Engineering Conference, Proceedings of the 32nd Intersociety,* 3, July 27-Aug 1, 1997, Honolulu, HI.

Zuber, J. A., Crott, H. W., & Werner, J. (1992). Choice shift and group polarization: An analysis of the status of arguments and social decision schemes. *Journal of Personality and Social Psychology, 62*(1), 50–61.

APPENDIX A

Questionnaire form

Dear fellow pilots

First of all, I would like to thank you for your participation in this research project. This research focuses on identifying a factor that may affect your in-flight decision making.

There are two parts in this questionnaire.
First part is to be answered individually. Second part, however, needs to be answered after a short discussion with your fellow pilot on each question.

Completion and return of this questionnaire implies your consent to participate.

Once again, I would like to thank you for your valuable responses and time.

Yours sincerely,

Seung Yong (Paul) LEE
Post-graduate student at Massey University.

"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.
If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Ethics & Equity), telephone 06 350 5249, e-mail humanethics@massey.ac.nz".

About Yourself.

What is your age? ……………………….. years

Please state your gender. Male / Female (please delete one)

How many hours have you flown? ……………………….. hrs

Have you had any experience flying with another licensed pilot? Yes / No (Please delete one)

Which flying organisation do you currently belong to?

………………………………………………………………………………

Which is the highest licence and what ratings do you currently hold? (Please tick the options below that best describe you)

☐ PPL

☐ CPL

☐ ATPL

☐ Instrument Rating

☐ Instructor Rating

Note: all information you give will be treated as strictly confidential – you are not asked to provide your name and no attempt will be made to match your data to a name.

PART I.

There are 10 statements in this part. For each statement, place a tick in the box that best describes your assessment of your risk.

1. Compared to other pilots of similar age and experience, my chances of an 'embarrassing' (e.g., wing-touch) incident whilst taxiing in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

2. Compared to other pilots of similar age and experience, my chances of unknowingly breaching controlled airspace in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

3. Compared to other pilots of similar age and experience, my chances of accidental <u>controlled flight into terrain</u> in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

4. Compared to other pilots of similar age and experience, my chances of an unplanned <u>heavy landing</u> in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

5. Compared to other pilots of similar age and experience, my chances of misinterpreting an aerodrome chart or approach plate in the future are:

- Almost certain ☐
- Much above average ☐
- Above average ☐
- A little above average ☐
- Average for pilots with similar age and experience ☐
- A little below average ☐
- Below average ☐
- Much below average ☐
- Never happen ☐

6. Compared to other pilots of similar age and experience, my chances of descending too quickly, resulting in passenger discomfort in the future are:

- Almost certain ☐
- Much above average ☐
- Above average ☐
- A little above average ☐
- Average for pilots with similar age and experience ☐
- A little below average ☐
- Below average ☐
- Much below average ☐
- Never happen ☐

7. Compared to other pilots of similar age and experience, my chances of <u>getting lost whilst flying</u> in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

8. Compared to other pilots of similar age and experience, my chances of <u>deviating from an assigned altitude</u> when I am flying in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

9. Compared to other pilots of similar age and experience, my chances of an unplanned stall in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

10. Compared to other pilots of similar age and experience, my chances of omitting a checklist item(s) in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

Thank you very much for completing Part I.

You will shortly be paired with other participant to answer Part II together after short discussion on each statement.

PART II.

There are 10 statements in this part. For each statement, place a tick in the box that best describes your assessment of your risk after discussing with your pair on each statement.

1. Compared to other pilots of similar age and experience, my chances of misinterpreting or failing to notice instrument readings in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

2. Compared to other pilots of similar age and experience, my chances of completing a manoeuvre with inappropriate or wrong flap settings in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

3. Compared to other pilots of similar age and experience, my chances of either fuel starvation or fuel exhaustion whilst flying due to poor fuel management in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

4. Compared to other pilots of similar age and experience, my chances of causing injury or death whilst flying in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

5. Compared to other pilots of similar age and experience, my chances of <u>being the cause of a near-miss</u> in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

6. Compared to other pilots of similar age and experience, my chances of <u>in flight engine failure</u> in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

7. Compared to other pilots of similar age and experience, my chances of <u>making a mistake(s) on a flight plan</u> in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

8. Compared to other pilots of similar age and experience, my chances of <u>in flight bird strike</u> in the future are:

Almost certain	☐
Much above average	☐
Above average	☐
A little above average	☐
Average for pilots with similar age and experience	☐
A little below average	☐
Below average	☐
Much below average	☐
Never happen	☐

9. Compared to other pilots of similar age and experience, my chances of taxiing to the wrong place in the future are:

- Almost certain ☐
- Much above average ☐
- Above average ☐
- A little above average ☐
- Average for pilots with similar age and experience ☐
- A little below average ☐
- Below average ☐
- Much below average ☐
- Never happen ☐

10. Compared to other pilots of similar age and experience, my chances of misunderstanding an ATC instruction in the future are:

- Almost certain ☐
- Much above average ☐
- Above average ☐
- A little above average ☐
- Average for pilots with similar age and experience ☐
- A little below average ☐
- Below average ☐
- Much below average ☐
- Never happen ☐

Thank you very much for taking the time to complete this questionnaire. Your responses and time are greatly appreciated.

APPENDIX B – Low risk notification

Massey University

OFFICE OF THE ASSISTANT
TO THE VICE-CHANCELLOR
(Ethics & Equity)
Private Bag 11 222
Palmerston North
New Zealand
T 64 6 350 5573/350 5575
F 64 6 350 5622
humanethics@massey.ac.nz
animalethics@massey.ac.nz
gtc@massey.ac.nz
www.massey.ac.nz

11 April 2007

Seung Yŏng (Paul) Lee
[redacted]
PALMERSTON NORTH

Dear Paul

Re: The Implication of Group Polarisation Affecting the Degree of Invulnerability amongst Pilots during Mutual Flight in General Aviation

Thank you for your Low Risk Notification which was received on 5 April 2007.

Your project has been recorded on the Low Risk Database which is reported in the Annual Report of the Massey University Human Ethics Committees.

Please notify me if situations subsequently occur which cause you to reconsider your initial ethical analysis that it is safe to proceed without approval by one of the University's Human Ethics Committees.

A reminder to include the following statement on all public documents:

> *"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.*
>
> *If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Ethics & Equity), telephone 06 350 5249, e-mail humanethics@massey.ac.nz".*

Please note that if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to provide a full application to one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

Sylvia Rumball

Sylvia V Rumball (Professor)
Chair, Human Ethics Chairs' Committee and
Assistant to the Vice-Chancellor (Ethics & Equity)

cc Dr Andrew Gilbey
School of Aviation
PN833

Capt Ashok Poduval, GM
School of Aviation
PN833

Massey University Human Ethics Committee
Accredited by the Health Research Council

Te Kunenga ki Pūrehuroa

APPENDIX C

Sample letter to organisations seeking for participation

[Name of organisation]
[Address]

[Date]

Dear Chief Flying Instructor

My name is Paul Lee. I work as a tutor and I am also a postgraduate student at Massey University. I am writing to you seeking for your co-operation on a research project that I am currently conducting as part of my postgraduate research at Massey University.

The research focuses on identifying factors that may affect the quality of pilot's in-flight decision making, and requires participants to complete a short questionnaire in pairs.

In order to complete the research, I would like to invite pilots with private pilots licence (or higher licences) in your organisation to participate in completing a short set of questions. Participation should not take more than 10 minutes for each pilot. All participants and the organisations they belong to will remain anonymous.

For this project, I need to give questionnaires out in person, as two participants need to complete each questionnaire together because some discussions are required on some questions. Therefore, I would be grateful if you could advise me the best times that I can visit your organisation and I will organise my trip from Palmerston North accordingly. When I visit, I will ensure that I do not get in the way or interrupt normal operations. I envisage waiting in a convenient area and approaching pairs of pilots at a time when they appear to have the required time free.

As I will be visiting several organisations in different parts of the country to carry out this research, it would be greatly appreciated if you give me a few options on the dates that I can visit.

You can contact me in the following ways.

Work: [redacted]
Residential: [redacted]
Mobile: [redacted]
e-mail: S.Y.Lee@massey.ac.nz
Post: Milson Flight System Centre, School of Aviation,
Airport Drive, Palmerston North.

I would like to thank you in advance for your co-operation on this research project.

Yours sincerely,

Seung Yong (Paul) LEE

Post graduate student at Massey University