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# CONTROLLABILITY AND PERCEPTUAL BIASES OF RISKS AND ABILITIES: THE CASE OF AN F-16 COCKPIT

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This study investigated airmen's susceptibility to unrealistic optimism biases based on the position of control in an F-16 cockpit. Forty-seven airmen completed a questionnaire measuring their "I am above average effect" in regard to their flight ability and judgment, "below average effect" regarding their risk-taking tendencies, and unrealistic optimism about the likelihood that they would be involved in an aerial accident. The results support our main hypotheses: airmen demonstrated biased perceptions on these scales. With regard to their flight ability, pilots were more susceptible to bias than navigators. Contrary to our prediction, we did not find similar results regarding invulnerability. We discuss these results in light of controllability literature.

Risk is an unavoidable part of airmen's life and practice. Aviation psychology literature has paid much attention to various factors that help us better understand airmen's tendencies to take in-flight risks. Examples of influential factors are the situational poor assessment of deteriorating weather (Wiegmann, Goa & O'Hare, 2002), psychological biases such as sunk cost (O'Hare & Wiegmann, 2003), and framing effects (O'Hare & Smitheram, 1995). Most of the research on this topic has focused on civilian pilots. An exception to that trend was the research by Sicard and colleagues (2003) that compared the risk tendencies of commercial pilots and French Naval Aviation pilots. They found the latter to demonstrate higher risk tendencies than the commercial pilots. The current research aims to further explore the military domain using a unique sample of Israeli airmen, namely F-16 pilots and navigators. The main research question we address is the extent to which differences in susceptibility to perceptional biases regarding ability and risk-taking tendencies exist between airmen in different positions in the cockpit.

## "I am above average" effect

When people are asked to evaluate their own abilities and characteristics in comparison to their peers they tend to rank themselves above the average. This phenomenon has been documented as affecting a wide range of self estimations, among them those regarding health (Weinstein, 1980) and driving ability (Svenson, 1981). Dunning, Meyerovitz & Holzberg, (1989) demonstrated that people tend to use this self enhancing assessment and consider themselves to be above the group average when considering positive traits and below the average when considering negative ones. They further showed that the mechanism underlying this phenomenon is the extent to which the trait being assessed is ambiguous (i.e. describes a variety of behaviors). The more ambiguous the trait, the more can one attach different self-enhancing meanings to it. Thus, when asked to compare himself to his peers, one will do so on the base of that self-serving definition causing the above-average effect. For example, if one is asked to rate her height (a non-ambiguous trait) in comparison to her peers she is more likely to give a correct estimation than when she is asked to rate her managerial ability (a more ambiguous trait). In the latter comparison, one who considers herself a communicative person might define high managerial ability as being good communication skills, whereas another might consider herself as a charismatic leader and therefore define a good manager in those terms. When asked to rate their managerial ability in comparison to their peers each one will use her own self serving definition, which will put her at the top of the chart.

Similar findings were found by O'Hare (1990), who reported on the above-average effect among airmen. Civilian pilots ranked themselves above average on flight skill and judgment (both positive ambiguous traits) and below the average on in flight risk taking (a negative ambiguous trait).

Based on these findings we hypothesized that (1a) *in comparison to their colleagues, respondents will evaluate themselves as below the average on in-flight risk taking*, and (1b) *above average on flight ability and judgment.*

## Unrealistic optimism

Not only do people view themselves in unrealistic positive ways as described above. Taylor and Brown (1994) mention that they also "believe they have greater control over environmental events than is actually the case; and hold views of the future that are more rosy than base-rate data can justify" (p.22). These judgmental errors labeled "unrealistic optimism" affect people's predictions about different life events. For example, students had self-enhancing predictions about their chance of owning their own house, getting a post-graduation job, getting a high salary, not having a drinking problem, not getting fired, etc. (Weinstein, 1980). Generalizing these results to non-student population, Weinstein (1987) found similar optimistic views among the general population in New Jersey when asked about their susceptibility to health problems in the future.

Similar results were found among pilots, who estimated their own chances of being involved in an aerial accident to be lower than other pilots with similar experience (Wichman & Ball, 1983; O'Hare, 1990). The *Aeronautical Risk Judgment Questionnaire* (O'Hare, 1990) included the personal invulnerability scale as a measure for this tendency. Goh & Wiegmann (2001) demonstrated that pilots' over confidence in their own skills was a strong predictor for their risky behavior – the decision to press on and fly into deteriorating weather conditions. Accordingly, we predict that military airmen will demonstrate unrealistic optimism with regard to being involved in aerial accident. Specifically, we hypothesized that (2) *Respondents will estimate their own likelihood of being involved in an aerial accident to be lower than the likelihood of their peers*.

## Controllability and optimism bias

Perceived control over events or their outcome leads to higher optimistic bias. A meta-analysis revealed that across twenty-one studies control had strong effect size (r=.49) on optimistic views regarding risk perceptions (Klein & Helweg-Larsen, unpublished manuscript. Cited by Helweg-Larsen & Shepperd, 2001). In an attempt to better understand whether this optimistic view is based on people's biased underestimation of their own vulnerability or overestimation regarding the vulnerability of those they compare themselves to, Helweg-Larsen & Shepperd (2001) reviewed existing literature on the topic. They found that the sense of control over a situation influences the estimation of one's own vulnerability more than the estimation regarding the vulnerability of others.

In a dual-seat F-16 cockpit the pilot and navigator differ from each other in the level of control they possess over the aircraft during a routine flight. The pilot's responsibilities include the actual operation of the aircraft as well as taking necessary account for the safety of both the crew and the aircraft. Although navigators are knowledgeable about flying the aircraft this is not their routine duty.

As mentioned above, controllability may affect the extent to which one is biased in regard to one's superior abilities and invulnerability to risks. Derived from the different extent of control that pilots and navigators possess over the aircraft, we predicted differences in the amount of bias they would demonstrate. Specifically, we hypothesized that (3a) *pilots will consider themselves superior to their peers in flight ability and judgment more than navigators*; (3b) *Pilots will show higher levels of invulnerability than navigators*.

## Method

### Participants

Twenty-four Israeli Air Force F-16 pilots and twenty-four F-16 navigators, all of whom are active airmen in their units, volunteered to participate in the current research. Only male airmen participated in our sample and their age ranged between 22 and 51 (M=29.51, SD=6.99). Over 90 percent of them had more than 200 flight hours and over 30 percent had flown for more than 1,000 hours. The majority, more than 60 percent, had been flying for more than five years.

### Tools

We used a short Hebrew translated version of the Aeronautical Risk Judgment Questionnaire (O'Hare, 1990). *Background information* questions included age, experience as airman (both flight hours and year of practice), and years of education.

*Self Judgment* of skill and in-flight judgment as well as risk taking tendencies were measured on a seven point Likert scale. Participants ranked their flight ability and judgment in comparison to their peers with similar experience as 1 ("below average") to 7 ("above average"). We also added one comparison that was not included in the original version of the questionnaire. The airmen were asked to report on their tendency to take in-flight risks in comparison to their peers. Specifically, we asked: "In comparison to pilots [navigators] with similar experience to yours, what is the frequency in which you take in-flight risks?" The same scale was used while this time 1 indicated "lower frequency" and 7 "high frequency".

*Hazard Awareness* was measured by asking the participants to indicate the likelihood of each of the following factors to cause an aviation accident. On a seven point scale ranging from 1 (very unlikely) to 7 (very likely), they ranked the likelihood of pilot's fatigue, flying into deteriorating weather, pilot's misjudgment, and disregarding flight regulations as causing such an accident.

*Personal Invulnerability* was assessed by introducing the same set of hazard awareness questions, this time asking participants to indicate how likely is each of the factors to cause an aviation accident in which *they* would be involved. This series of questions later enabled us to estimate the personal feeling of invulnerability by comparing the personal likelihood of being involved in each type of accident with the general likelihood. Thus, a positive gap between the two indicates that airmen feel invulnerable about their own chances of being involved in such an accident in comparison to it happening to someone else.

**Procedure**

Airmen were asked to fill in a battery of questionnaires during their morning briefing. Those who agreed to do so received the questionnaires and were asked to return them as soon as they completed filling them out. All returned them within 24 hours. The experimenter asked the participants not to discuss any of the questions presented to them with their colleagues and indeed, all reported that they had not done so. One navigator returned the completed task within less than ten minutes, which was extremely fast, thus indicating that he did not pay sufficient attention to the scenarios about which they were asked. His data were therefore excluded from any further analysis. All participants were fully debriefed and thanked after completion of the questionnaire.

## Results

The results support our first hypothesis. A one-sample t-test (N=47) with test value of 4 (indication average on the scale) revealed that across the different positions in the cockpit, airmen evaluated themselves as taking less in-flight risk than their peers in terms of their perceived frequency of making risky choices (M=3.32, SD=1.39). As predicted, they also evaluated their flight ability (M=5.0, SD=1.21) and flight judgment (M=5.49, SD=.95) as superior to their colleagues, p<.01 in all cases. As can be seen in table 1, this tendency was observed for both pilots and navigators. Pilots evaluated themselves as less in-flight risk-taking than their peers (M=3.33, SD=1.46). They also evaluated their flight ability (M=5.21, SD=1.41) and flight judgment (M=5.71, SD=.86) as superior to their colleagues. Similarly, navigators evaluated their frequency of in-flight risk-taking to be lower (M=3.3, SD=1.33) then their peers. They also evaluated their flight ability (M=4.77, SD=1.27) and flight judgment (M=5.26, SD=1.05) as superior to their colleagues, p<.05 in all cases.

***Table 1.*** rmen's mean† perception of flight ability, judgment, and in-flight risk taking

| | Total (n=47) | Pilots (n=24) | Navigators (n=23) |
|---|---|---|---|
| *Risk taking* | -.68** | -.67* | -.70* |
| *Flight ability* | 1.0** | 1.21** | .77** |
| *Flight judgment* | 1.49** | 1.71** | 1.26** |

Significance level, *p<.05, ** p<0.01.

† Means in the table indicate a distance from the average (4). Thus, a positive figure indicates an above average estimation, whereas a negative one indicates a below average estimation.

Our second hypothesis was also supported. A paired-samples t-test (N=46, p<.01 in all comparisons) revealed that airmen estimate the chances that they will be involved in aerial accident to be lower then the likelihood that such an accident will take place in general across all four given reasons (a high score indicates high chances of being involved in accident). Specifically, they estimated their own chances of being involved in an accident caused by *pilots' fatigue* to be lower (M=3.8, SD=1.67) than the chances that such an accident would happen in general (M=5.0, SD=1.28). When asked about an accident caused by *flight into deteriorating weather* a similar pattern was revealed; they estimated their own chances of being involved as lower (M=3.59, SD=1.57) than the general chance of occurrence (M=4.63, SD=1.48). Evaluating *pilots' misjudgment* as a cause for accident did not change this invulnerability pattern: own chances of being involved in such accident were estimated to be lower (M=4.65, SD=1.63) than the general estimation of the chance of such an accident occurring (M=5.63, SD=1.39). Finally, participants evaluated their own likelihood of being involved in an aerial accident caused by pilots' *disregarding flight regulations* to be lower (M=3.43, SD=1.67) than the likelihood of such an accident occurring in general (M=4.98, SD=1.29). As can be seen in table 2, both pilots and navigators estimated their likelihood of being involved in an aerial accident to be lower than the general likelihood of such an accident occurring.

*Table 2.* Airmen's mean† invulnerability perception

| Cause of accident | Total | Pilots | Navigators |
|---|---|---|---|
| *Pilots' fatigue* | 1.2** | 1.35** | 1.04** |
| *Flight into deteriorating weather* | 1.04** | 1.43** | .65* |
| *Pilots' misjudgment* | .98** | 1.09* | .87* |
| *Disregarding flight regulations* | 1.54** | 1.57** | 1.52** |

Significance level, *p<.05, ** p<0.01.

† Means in the table represent the participants' estimation of their likelihood of being involved in an aerial accident subtracted from their estimation of the likelihood that such an accident will occur in general. Thus, a positive figure indicates a feeling of invulnerability whereas a negative one indicates a feeling of vulnerability.

Our third hypothesis predicted (3a) that airmen in a high controllability position (pilots) will show higher levels of bias regarding their superior flight skills (in comparison to their peers) than airmen in a low controllability position (navigators). In order to test this hypothesis we computed a *flight expertise index* to be the mean of the airmen's responses to the two questions measuring their flight ability and judgment in comparison to their peers. This index ranged between 1 (below average ability and judgment) to 7 (above average ability and judgment, the Cronbach's alpha of this index was 0.6. As predicted, pilots demonstrated higher bias on the *flight expertise index* (M=5.46, SD=.82) than navigators (M=5.02, SD=.97), t (45) = 1.67, p=.05 (one-tailed).

We further predicted (3b) that pilots will show a higher level of invulnerability than navigators. In order to test this hypothesis we computed an *Invulnerability Index* to be the mean difference between the estimation of one's likelihood of being involved in an accident subtracted from the general likelihood of such an accident. The new index therefore ranges between -6 (estimating own likelihood of being involved in each type of accident as much higher than the likelihood of such accident to occur in general) to 6 (estimating own likelihood of being involved in each type of accident as much lower than the likelihood of such accident to occur in general). Thus, a high score on that index indicates a sense of invulnerability of the airman.

The results did not support our prediction: on the *invulnerability index*, pilots (M=1.39, SD=1.44) did not differ from the navigators (M=1.02, SD=1.1), t (44) = .889, p>.05.

In order to further explore post-hoc comparisons between pilots' and navigators' perceptions we calculated the Pearson correlations between all measured variables. Table 3 illustrates these correlations.

*Table 3.* Pearson correlations between measured variables for pilots and navigators†

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. *Age* | - | .98** | .38‡ | .20 | -.22 |
| 2. *Experience (years)* | .97** | - | .37 | .20 | -.17 |
| 3. *Invulnerability Index* | .15 | .10 | - | -.12 | .04 |
| 4. *Flight-expertise index* | -.24 | -.19 | -.11 | - | .54 |
| 5. *Risk taking* | -.15 | -.13 | -.49* | .06 | - |

Significance level ‡p<.1 (marginal), * p<.05, **p<.01.

† The correlations presented in the lower left part of the table are for pilots while those in the upper right side are for navigators.

As can be seen in table 3, a different trend appears for pilots and navigators in regard to the correlation between perceived risk taking tendency and the invulnerability index. Among pilots, as the level of invulnerability to accident increases, the perception of risk taking in comparison to others decreases (r =-.49, p<.05). For navigators, this correlation is not significant (p>.05). To put this differently, as a pilot feels that his chances of been involved in aerial accident are lower than the chances of a similar accident occurring to other (i.e., higher invulnerability bias) he also reports that he tends to take less in-flight risks in comparison to his peers (i.e., higher "below average" bias).

## Discussion

The present research contributes to the aviation decision making literature in two distinct ways: first, by demonstrating the above average effect and unrealistic optimism biases in military aviation, and second, by discussing the airmen's position in the cockpit in terms of controllability and showing differences in their susceptibility to such biases.

The results fully supported our first hypothesis predicting airmen's tendency to rank themselves above average on positive traits (flight ability and flight judgment) and below average in negatives ones (risk taking tendency). When asked to compare themselves to their peers both pilots and navigators demonstrated this biased perception. The second hypothesis was also supported, showing that airmen feel invulnerable with regard to their chances of being involved in an aerial accident. Across four different possible causes of such accidents respondents, both pilots and navigators, ranked their likelihood of being involved in an accident as lower than the general likelihood of such an accident occurring. In part, these findings replicate previous findings in the civil aviation domain (O'Hare, 1990), which are extended here to military aviation and to different crew-members in the cockpit.

The results also supported our third hypothesis. Previously, controllability has been found to affect the extent to which people demonstrate above average effect and unrealistic optimism. We introduced the airman's position in the cockpit as a distinguishing factor of the controllability level they possess. During flight a pilot has higher levels of controllability over the aircraft than a navigator. Therefore, we predicted that pilots will show higher levels of bias with regard to their superior abilities (in comparison to their peers) than navigators will. As predicted, pilots ranked themselves higher above the average concerning their flight expertise, more than navigators did. It is important to note that both pilots' and navigators' comparison groups were their peers who have similar experience; hence, the reported difference is in the level of bias they showed and not merely their ability estimation. We did not find similar differences in the level of bias pilots and navigators have on their optimistic perception of accident invulnerability. A possible explanation for this difference is that among the two biases flight expertise was more directly related to the control position in the cockpit than invulnerability was.

Furthermore, a post-hoc comparison revealed an interesting difference between pilots and navigators. The correlation between the "below average" risk taking bias and the invulnerability unrealistic optimism bias was significant only for pilots but not for navigators. Earlier we suggested considering airmen in controllability terms, where pilots are considered to be higher in their in-flight controllability level than navigators. As shown in figure 1, for airmen high in controllability (pilots) but not for those low in controllability (navigators) there is a negative correlation between risk-taking frequency and invulnerability. Note that low ranking on the risk taking scale indicates a high level of bias (i.e. one considers himself to have lower risk-taking tendencies than his peers), whereas on the invulnerability scale high bias is indicated by high scores (i.e. one consider himself to be less vulnerable than others to accidents). Hence, the negative correlation indicates that the more one is biased in regard to his risk-taking tendencies the more he is biased about his level of invulnerability. Again, this correlation between the biases exists only for airmen in high controllability position.

Klein & Kunda (1994) showed that people prefer controlled risks over less dangerous uncontrolled ones. Moreover, this tendency was evident when the ability required for controlling the outcome was conducive to the "I am above average" bias. They conclude "this suggests that the belief that one's ability to control outcome is better than average plays an important role in creating the preference for controllable risks" (p.423). Intriguingly, our results indicate that (only) for those in a position of control, the lower they rank themselves below average on risk taking (demonstrate high bias), the more they feel invulnerable to being involved in accidents. Thus, this sense of invulnerability might act as a mediator in the tendency to prefer risky choices for those in a position of control. As our analysis is correlational, any causal interpretations should be considered with appropriate caution. Having said that, the current research demonstrates that position of control (in an F-16 cockpit setting) had a different effect in regard to the airmen's susceptibility to unrealistic optimism biases. Further experimental research should investigate the role of unrealistic optimism as a possible mediator between control position and the tendency to prefer risky alternatives.

## Conclusions

*"Fatal aviation accidents are more often associated with decision errors than minor accidents, which tend to be associated with procedural execution errors"*

(Goh & Wiegmann, 2001, p. 360)

Airmen make judgmental mistakes; in that sense they are just like anyone else. The above quotation reminds us how costly these decision errors may be. Operating a powerful air-vehicle in an ever changing, unpredictable environment requires a high level of attention and expertise. These highly trained experts face life risking decisions as a daily routine. Although airmen are aware of the risky aspects of their work they do demonstrate perceptional biases regarding their superior ability and low susceptibility to be involved in accidents. The importance of the current research is encompassed in presenting the higher manifestation of such biases among those in position of control (F-16 pilots) when compared to those who have less control over the situation (F-16 navigators).


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### References


Dunning, D., Meyerovitz, J.A. & Holzberg, A.D. (1989). Ambiguity and self-evaluation: the role of idiosyncratic trait definitions in self serving assessment of ability. *Journal of Personality and Social Psychology*, 57(6), 1082-1090.

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

Helweg-Larsen, M. & Shepperd, J.A. (2001). Do moderators of the optimism bias affect personal or target risk estimates? A review of literature. *Personality and Social Psychology Review*, 5(1), 74-95.

Klein, W.M & Kunda, Z. (1994). Exaggerated self assessments and the preference for controllable risks. *Organizational Behavior and Human Decision Processes*, 59, 410-427.

O'Hare, D. (1990). Pilots' perception of risk and hazard in general aviation. *Aviation, Space & Environmental Medicine*, 61(7), 599-603.

O'Hare, D. & Smitheram, T. (1995). Pressing on into deteriorating conditions: an application of behavioral decision theory to pilot decision making. *The International Journal of Aviation Psychology*, 5(4), 351-370.

O'Hare, D. & Wiegmann, D.A. (2003). Continued VFR flight into IMC: situational awareness or risky decision making? *Final report, FAA grant 2000-G010*.

Sicard, B., Taillemite, J. P., Jouve, E., & Blin, O. (2003). Risk propensity in commercial and military pilots. *Aviation, Space & Environmental Medicine*, 74(8), 879-881.

Svenson, O. (1981). Are we less risky and more skillful than our fellow driver? *Acta Psychologica*, 47, 143-148.

Taylor, S.E. & Brown, J.D. (1994). Positive illusions and well being revisited: Separating fact from fiction. *Psychological Bulletin*, 116(1), 21-27.

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

Weinstein, N.D. (1987). Unrealistic optimism about susceptibility to health problems: conclusions from a community-wide sample. *Journal of Behavioral Medicine*, 10(5), 481-500.

Wiegmann, D.A., Goa, J. & O'Hare, D. (2002). The role of situation assessment and flight experience in pilots' decisions to continue visual flight rules into adverse weather. *Human Factors*, 44(2),189-197.