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FORMAL ARTICLES

Risk Perception Among General Aviation Pilots

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Two measures of pilot risk perception are described. One measure assessed pilots' perception of the level of risk experienced by other, fictional, pilots, and the second measure assessed the pilots' perceptions of the level of risk they would experience if they were personally involved in a set of scenarios. Analyses are reported for factor scores derived from the 2 measures. Analysis of variance demonstrated significant differences in the risk ratings for the 4 pilot certificate groups, with the more advanced certificate holders (i.e., commercial and airline transport) reporting lower levels of perceived risk. Construct validity was assessed using only private pilots ($N = 369$). Correlations between the factor scores and measures related to the constructs generally supported the construct validity of the risk perception measures. Inaccurate risk perception, measured as the discrepancy between the perceived risks of flying and driving, was found to be a better indicator of involvement in hazardous aviation events than any of the factor scores. It is suggested that the risk perception measures be used by other investigators to assess the contributions of these constructs to accident involvement in comparison to the contribution of other constructs.

Risk perception and risk tolerance are constructs that have been suggested as explanations for behaviors that result in incidents and accidents for both pilots (Hunter, 2002c; O'Hare, 1990) and drivers (Trankle, Gelau, & Metker, 1990). One explanation for behavior that leads to an accident or incident is that the person did not perceive the risk inherent in the situation, and hence did not under-

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take avoidance or other risk-mitigating actions. Another explanation is that when individuals correctly perceive the risks involved in a situation, some may elect to continue because the risk is not considered sufficiently threatening. Those individuals would be described as having a greater tolerance or acceptance of risk, compared to the mainstream.

Previously, Hunter (2002c) reported on the development and initial evaluation of several measures of risk perception and risk tolerance for pilots. In that initial analysis, a set of a priori scales taken from the risk perception measures was used. In this study, analyses were conducted of empirically developed scales for the risk perception measures using data from the previous study.

METHOD

Participants

Six hundred and thirty participants who reported they held pilot certificates were recruited from visitors to a Web site sponsored by the Federal Aviation Administration. There were approximately 4,500 registered users of the Web site and approximately 2,400 visited the site during the period of the study. Participants were assured of confidentiality of results and were allowed to create a unique personal identifier (“call sign”) that was used as a means of matching results from the various scales and exercises.

Measures

Two measures of risk perception were used. For both measures, a response scale of 1 (*low risk*) to 100 (*high risk*) was used, and descriptions of the extreme and middle anchor points were given. One measure (Risk Perception–Other) consisted of 17 scenarios depicting aviation situations in which the participants were asked to rate the level of risk present in the situation. The scenarios were written in the third person, so that respondents rated the risk for the pilot described in the scenario, not for themselves. The following are two examples of items from this measure:

1. On short final a pilot drops his microphone on the floor. He looks down while bending over trying to reach it. He inadvertently moves the control yoke and the aircraft banks sharply.
2. A line of thunderstorms blocks the route of flight, but a pilot sees that there is a space of about 10 miles between two of the cells. He can see all the way to clear sky on the other side of the thunderstorm line, and there does not seem to be any pre-

cipitation along the route, although it does go under the extended anvil of one of the cells. As he tries to go between the storms, he suddenly encounters severe turbulence and the aircraft begins to be pelted with hail.

The second measure (Risk Perception–Self) consisted of 26 sentences describing an event or situation. Seven of the 26 sentences described nonaviation events (e.g., driving a car), and the remainder were concerned with aviation. Participants were asked to indicate the degree of risk present if they were involved in such a situation tomorrow. Three examples of items from this measure are given here (a complete listing of items for both measures is available from the author on request):

1. During the daytime, fly from your local airport to another airport about 150 miles away, in clear weather, in a well-maintained aircraft.
22. Take a 2-hr sightseeing flight over an area of wooded valleys and hills, at 1,000 ft above ground level.
26. At night, fly from your local airport to another airport about 150 miles away, in a well-maintained aircraft, when the weather is marginal visual flight rules (3 miles visibility and 2,000-ft overcast).

Procedure

All items were presented one at a time, and responses were automatically saved to a database on the server computer. The scales were presented in a fixed order, with Risk Perception–Other being given first, followed by Risk Perception–Self. Participants completed three risk tolerance scales, which are not discussed in this article. Many, but not all, participants also completed several other scales that were offered on the Web site. Participants were free to complete those scales in any order.

RESULTS

A principal components factor analysis of the item responses was conducted for each of the two measures separately using SPSS (Version 9.0). Varimax rotation was then applied. For the Risk Perception–Other measure, an interpretable three-factor solution was obtained that accounted for 50% of the variance. The first rotated factor consisted of eight items and was labeled delayed risk, as the items comprising this factor were characterized as involving hazardous situations that did not require an immediate response. The second factor consisted of five items and was labeled nominal risk as the items comprising the factor described normal flight operations and contained no unusual hazards. The third factor consisted of four items and was labeled as immediate high risk as the items comprising the factor involved high-risk situations with high urgency and time pressure. A measure of internal consistency reliability (coefficient α) was computed for each of the scales. These reliability values were .81, .75, and .32, for delayed risk, nominal risk, and immediate high risk, respectively. The low internal consistency value (.32) for the immediate high risk factor indicates that those four items are measuring rather different constructs. Because this is largely an exploratory study and the items seemed to be qualitatively different from those contained in the other scales, the scale was retained in the analyses; however, continued use would certainly require modification of the scale to improve its reliability.

For the Risk Perception–Self measure, five interpretable factors accounting for 65% of the variance were identified. These factors were: (a) general flight risk, which included 10 items covering both normal and high-risk flight operations; (b) high flight risk, consisting of 10 items that described high-risk flight conditions; (c) altitude risk, which consisted of 7 items in which the altitude of flight was a risk element; (d) driving risk, consisting of 3 items that described different driving situations; and (e) everyday risk, which was defined by 4 items that dealt with everyday life situations. Measures of internal consistency (coefficient α) for the five scales were .93, .87, .87, .79, and .63, for the first through fifth factors, respectively.

Unit-weighted scores were computed for each of the three scales from the Risk Perception–Other measure and the five scales from the Risk Perception–Self measure. Analysis of variance (ANOVA) was used to compare the mean scale scores for the four levels of certification (i.e., student, private, commercial, and airline transport). The results, summarized in Table 1, demonstrated significant differences among the certificate levels on many of the scales from both the risk perception measures. Most notably, there was a strong tendency for the more experienced and qualified pilots who held advanced certificates (commercial and airline transport) to view the situations depicted in both risk perception measures as involving less risk than the less advanced certificate holders (student and private). To eliminate this confound, subsequent analyses were restricted to private pilot certificate holders (approximately 370 participants).

The construct validity of the scales was assessed by correlation of the factor scores with several variables. The construct validation measures included (a) three scales from the Aviation Safety Attitude Scale (ASAS; Hunter, 2002a; Hunter, 2004); (b) Situational Judgment Test (SJT; Hunter, 2003); (c) Aviation Safety Locus of Control–Internality (LOC–I; Hunter, 2002b); (d) Hazardous Event Scale (HES; Hunter, 1995); and (e) Thrill and Adventure-Seeking scale (TAS; Zuckerman, 1994). The means and standard deviations for the construct validation variables are given in Table 2. Table 3 provides the intercorrelations among the risk perception factors, and correlations with the demographic and construct validation variables.

TABLE 1
Summary of ANOVA Results for Certificate Levels

	df	*MS*	*F*	*Significance*
Delayed risk[a]	3/622	151.32	1.256	.239
Nominal risk[a]	3/622	279.62	1.153	.327
Immediate high risk[a]	3/626	607.16	3.644	.013
General flight risk[b]	3/534	2510.16	11.007	.0005
High flight risk[b]	3/535	922.41	6.150	.0005
Altitude risk[b]	3/539	253.59	1.388	.246
Driving risk[b]	3/558	316.36	2.040	.107
Everyday risk[b]	3/554	237.71	1.120	.340

[a]Risk Perception—Other factors. [b]Risk Perception—Self factors.

TABLE 2
Means and Standard Deviations of Factor Scores and Construct Validation Variables for Private Pilot Certificate Holders

	M	*SD*	*N*
Delayed risk[a]	73.63	10.92	366
Nominal risk[a]	39.94	15.83	369
Immediate high risk[a]	86.84	9.50	368
General flight risk[b]	48.02	14.79	326
High flight risk[b]	70.38	11.58	328
Altitude risk[b]	62.11	13.08	329
Driving risk[b]	55.25	11.51	340
Everyday risk[b]	35.19	14.44	338
Total flight time	406	536	365
Recent flight time	61	52	365
Age	46.1	11.45	368
ASAS–SC	45.39	5.76	228
ASAS–RO	17.39	2.98	228
ASAS–SO	16.15	1.64	228
SJT	25.31	4.62	75
TAS	28.37	6.00	102
LOC–I	38.50	4.28	107
HES	3.00	3.35	235

Note. ASAS = Aviation Safety Attitude Scale; SC = Self-Confidence; RO = Risk Orientation; SO = Safety Orientation; SJT = Situational Judgment Test; TAS = Zuckerman's Thrill and Adventure-Seeking Scale; LOC–I = Locus of Control–Internality; HES = Hazardous Event Scale.
[a]Risk Perception–Other factors. [b]Risk Perception—Self factors.

TABLE 3
Intercorrelations of Factor Scores and Correlations With Construct Validation Variables

	Delayed Risk[a]	*Nominal Risk*[a]	*Immediate High Risk*[a]	*General Flight Risk*[b]	*High Flight Risk*[b]	*Altitude Risk*[b]	*Driving Risk*[b]	*Everyday Risk*[b]	*Risk Perception Accuracy*[c]
Delayed risk[a]	—								
Nominal risk[a]	.426*	—							
Immediate high risk[a]	.609*	.235*	—						
General flight risk[b]	.371*	.575*	.244*	—					
High flight risk[b]	.654*	.426*	.481*	.642*	—				
Altitude risk[b]	.515*	.502	.353*	.805*	.810*	—			
Driving risk[b]	.400*	.355*	.331*	.392*	.517*	.409*	—		
Everyday risk[b]	.386*	.391*	.297*	.565*	.552*	.507*	.504*	—	
Total flight time	–.122*	–.131*	–.126*	–.167*	–.185*	–.080	–.094	–.053	–.053
Recent Flight Time	–.023	.059	–.018	–.015	–.030	.054	.038	.027	.022
Age	–.028	–.140*	.096*	–.099*	–.053	–.045	.066	–.067	–.149*
ASAS–SC	–.077	–.170*	–.049	–.307*	–.134*	–.205*	–.068	–.008	–.245*
ASAS–RO	–.148*	–.093	–.170*	–.167*	–.256*	–.216*	–.148*	–.027	–.041
ASAS–SO	.086	–.046	.194*	–.105	.104	–.056	–.041	.010	–.114
SJT	.346*	.240*	.178	.055	.177	.124	.219*	.009	–.060
TAS	–.063	–.031	–.035	–.144	–.110	–.176	–.131	–.134	.027
LOC–I	.112	.062	.137	–.016	.201*	.012	.013	–.025	–.091
HES	–.019	–.032	–.019	–.059	–.123*	.033	.095	.042	–.168*

Note. ASAS = Aviation Safety Attitude Scale; SC = Self-Confidence; RO = Risk Orientation; SO = Safety Orientation; SJT = Situational Judgment Test; TAS = Zuckerman's Thrill and Adventure-Seeking scale; LOC–I = Locus of Control–Internality; HES = Hazardous Event Scale.

[a]Risk Perception—Other factors. [b]Risk Perception—Self factors. [c]Defined as nominal flight risk (Question 1) minus nominal driving risk (Question 20).

*$p < .05$.

Inspection of the mean risk ratings for individual items comprising the Risk Perception–Self scale revealed that the mean rating for Question 20 (Drive your car on freeway near your home during the day, at 65 MPH in moderate traffic) was 47.5 ($SD = 13.5$), whereas the rating for Question 1 (During the daytime, fly from your local airport to another airport about 150 miles away, in clear weather, in a well-maintained aircraft) was 35.8 ($SD = 21.8$). A t test for correlated means showed that difference is statistically significant, $N = 340$, $t = 10.21$, $p < .0005$.

These results indicated that, on average, the participants clearly thought that flying was less risky than driving at a global level. However, for general aviation flying (i.e., outside of the scheduled airlines), that belief is inaccurate. Comparison of the responses to these two questions, therefore, provides a measure of the degree to which participants have an inaccurate overall perception of flight safety. Specifically, this was accomplished by computing the difference in risk ratings between Question 1 and Question 20. This score is simply the risk rating for flying minus the risk rating for driving, and may be interpreted as an index of the participant's risk perception accuracy (RP–A). If the RP–A is greater than zero, it indicates an accurate assessment of flying risk. If the RP–A is less than zero, it reflects an inaccurate assessment. For the private pilot participants, the mean of the RP–A is –11.48 ($SD = 20.73$), reflecting an overall belief that flying is safer than driving.

Correlations of RP–A and the construct validation variables are given as the last column in Table 3. The RP–A was significantly correlated with age, but not with total or recent flight time. Specifically, there was a significant negative correlation ($r = –.149$) between age and RP–A. The negative sign indicates that as age increased, the RP–A decreased (i.e., became more negative, reflecting more inaccurate assessments of risk). The RP–A was also significantly correlated ($r = –.168$) with HES. After holding age constant, the correlation between RP–A and the HES was –.132, a larger correlation with HES than that obtained for any of the factor scores. When total flight time is held constant, the partial correlation between RP–A and age is –.151 ($p < .05$), which is virtually identical to the original correlation ($r = .149$).

DISCUSSION

Overall, the construct validation results, as shown in Table 3, suggest that the two scales are valid measures of risk perception by pilots. For both the Risk Perception–Other and Risk Perception–Self scales, all correlations with the Self-Confidence and Risk-Orientation subscales from the ASAS are negative, and the majority (i.e., 9 of 12) are statistically significant. The ASAS subscales are scaled such that higher scores indicated higher levels of that attitude. Hence, participants who exhibited greater self-confidence and risk orientation tended to rate the situations as less risky. Conversely, a significant positive correlation was obtained between the ASAS subscale for safety orientation and the immediate high risk factor from Risk Perception–Other. This indicates that participants who exhibited greater safety orientation tended to rate the situations as higher in risk.

Significant, although moderate, correlations were also obtained between the SJT and the delayed risk and nominal risk factors from the Risk Perception–Other scale. Additionally, all the other correlations, although not statistically significant, are positive, indicating relationships in the expected direction. Higher SJT scores indicate better agreement with the recommended solutions of instructors. Hence, positive correlations indicate that those pilots who scored well on the SJT tended to rate the scenarios as higher in risk.

Using more traditional measures of personality, weak support for construct validity was obtained. For the Zuckerman TAS, no significant correlations were obtained. However, all the correlations were negative indicating a tendency for participants who rated the scenarios as lower in risk to have greater TAS scores (i.e., be more thrill-seeking). On the LOC–I scale, the significant correlation with the high flight risk factor from the Risk Perception–Self scale indicates that those participants who were more internal in orientation (i.e., believed themselves to be in control of outcomes) tended to rate the scenarios as higher in risk. However, all the other correlations were quite small and nonsignificant.

Similarly, weak support was provided by correlations with the HES. Only the high flight risk from the Risk Perception–Self and the RP–A scores were significantly correlated with previous involvement in hazardous aviation events. Both of these correlations were negative, indicating that those participants who had been in more hazardous aviation events (a) tended to rate the scenarios as lower in risk, and (b) had a more inaccurate estimate of the safety of general aviation.

The correlations with the other scales tend to support the construct validity of the Risk Perception–Other and Risk Perception–Self scales. However, the latter scale seems, based particularly on the correlations with the SJT and the HES, to be a more valid measure of pilots' risk perception. Furthermore, the lower reliabilities for Risk Perception–Other compared to Risk Perception–Self could be interpreted as indicating that pilots are better (or at least more consistent) judges of their own risks than those of others.

If that interpretation is correct, it would suggest that measures of perception of risk in general may be of limited value in understanding behavior in particular. Measures of risk perception may be conceptualized as representing a continuum, ranging from generalized assessment of risk of mode of travel, to third-party and personal risk as assessed in these scales. In the middle might lay measures such as RP–A, which provides a quantitative assessment of the inaccuracy of pilots' assessments of risk.

It is interesting to note that the correlation between HES and RP–A was larger than the correlation between HES and the Risk Perception–Self factors. A tentative explanation for this finding would be that the relative level of risk perception for a situation may not be as important as the disparity between the perceived and actual risk. As this disparity becomes more extreme (i.e., more inaccurate), the risk for being in a hazardous event becomes greater. Because this explanation is based on a comparison of only two correlations, the tentative nature cannot be overemphasized. However, such an interpretation would account for the effect of the interaction of personal capabilities and situation demands on situational risk. That is, some situations present greater risk for some individuals (e.g., with less experience) than they do for other individuals (e.g., with more training). Simple measures of risk perception, as are used in these scales, do not take this effect into account, but assume that everyone is equally capable. Clearly, that assumption is not correct, although it may not be badly false for a select group of individuals, such as low-time private pilots. Much better assessment would be made if both the situational demands and the individual capabilities could be measured, and the difference between demands and capabilities determined. That approach is outside the scope of this article, but would be a worthy goal of future research.

Within the category of private pilot certificate holders, the risk perception accuracy score changes with age, with younger pilots having a more accurate view of flight risk than older pilots. This is consistent with the work of O'Hare (1990), who found that younger pilots rated the likelihood of being in an accident higher than did older pilots. However, as noted earlier, it is impossible in this study to account for differences in personal capabilities that might influence the accuracy of those ratings. Because it is possible (perhaps even likely) that older, presumably more experienced pilots are more capable than younger pilots, the RP–A scores for older pilots may not reflect the true difference in risk levels for those individuals. However, that view is not supported by the data reported here.

It has been suggested both for pilots (O'Hare, 1990) and for drivers (Trankle et al., 1990) that failure to accurately perceive the risks involved in flying and driving contributes to accident involvement. Although additional refinements are certainly needed, the measures described in this study are offered as one means of assessing individual differences among pilots in their perception of risks in aviation situations. Starting from a psychometrically sound measure, investigators may then assess how the contribution of that construct to accident involvement compares to the contributions of other constructs.

REFERENCES

Hunter, D. R. (1995). *Airman research questionnaire: Methodology and overall results* (Rep. No. DOT/FAA/AM–95/27). Washington, DC: Federal Aviation Administration.

Hunter, D. R. (2002a, September). *Aviation Safety Attitude Scale: Preliminary analysis.* Paper presented at the 25th Conference of the European Association for Aviation Psychology, Warsaw, Poland.

Hunter, D. R. (2002b). Development of an aviation safety locus of control scale. *Aviation, Space, and Environmental Medicine, 73,* 1184–1188.

Hunter, D. R. (2002c). *Risk perception and risk tolerance in aircraft pilots* (Rep. No. DOT/FAA/AM–02/17). Washington, DC: Federal Aviation Administration.

Hunter, D. R. (2003). Measuring general aviation judgment using a situational judgment technique. *International Journal of Aviation Psychology, 13,* 373–386.

Hunter, D. R. (2004). Measurement of hazardous attitudes among pilots. *International Journal of Aviation Psychology, 15, 23-43.*

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

Trankle, U., Gelau, C., & Metker, T. (1990). Risk perception and age-specific accidents of young drivers. *Accident Analysis and Prevention, 22,* 119–125.

Zuckerman, M. (1994). *Behavioural expressions and biosocial bases of sensation seeking.* Cambridge, England: Cambridge University Press.

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