BEHAVIORAL VALIDATION OF A HAZARDOUS THOUGHT PATTERN INSTRUMENT

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One approach to examining errors or potential errors in aviation has focused on measuring the hazardous thought patterns of pilots. Previous research identified five thought patterns and assumed that all pilots fall into one of these categories. The current research was designed to develop and behaviorally validate a new instrument to measure hazardous thought patterns. The research confirmed previous work in finding five hazardous thought patterns. However, the research also suggested the presence of a sixth factor related to confidence/competence. The validation suggested that the individual hazardous thought patterns differentially predicted accidents and incidents. The behavioral validation also identified relationships between particular hazardous thought patterns and specific driving behaviors that supported the validity and utility of the newly designed instrument.

INTRODUCTION

One approach to examining errors or potential errors in aviation has focused on measuring the hazardous thought patterns of pilots (e.g. Lester and Connolly, 1987). Previous research (e.g., Buch & Diehl, 84) has identified five hazardous thought patterns: "anti-authority", "impulsivity", "invulnerability", "macho", and "resignation" and has assumed that all pilots fall into one of these categories. In the current research, we developed a new instrument for measuring hazardous thought patterns. This instrument measured hazardous thought patterns by using content or domain sampling for the item pool and factor analysis for scale construction and internal validation.

We also wanted to conduct an external validation of our scale with behavioral criteria. However, validation against pilot accidents is difficult due to the relatively lower rate of accidents and the limited number of hours most pilots fly per year. We therefore decided to develop parallel item pools for pilots and car drivers, and to carry out the factor analysis and initial external validation with a car driver sample. The relative rates for car accidents is higher than for aircraft and people typically drive cars many hours per year, which give a much better base rate for the external validation of the hazardous thought pattern measures.

METHOD

Measures

Hazardous thought pattern measure. Based on definitions, scenarios, and examples of hazardous thought patterns used in previous research, parallel item pools were developed for the aviation domain and the driving domain. Each item was a simple declarative statement such as "I like to do spins" (aviation domain) or "I like to do spin-outs" (driving domain). The response scale for each item was a Likert-type response scale of strongly agree, agree, neutral, disagree, and strongly disagree. A systematic attempt was made to develop both positive and negative items for each hazardous thought pattern. The initial pool of items was rated for relevance to the defined thought patterns by seven raters. These ratings were used as the basis for the final selection of 20 items per thought pattern used in the questionnaire. The items in the final sample again balanced positive and negative items for each thought pattern.

Behavioral measure. The external validation measure was a questionnaire designed to measure accidents and incidents as completely as possible. These included reported and non-reported accidents, moving violations, parking tickets, insurance problems, and critical behaviors such as seat belt use, drinking and driving, and falling asleep at the wheel. People were also asked to report others' reactions to their driving.

Sample

Completed questionnaires were received from 237 students at George Mason University. The mean age of the subjects completing usable questionnaires was 23.2, (s.d. = 7.8) and 63% of sample were < 23 years.

RESULTS

Factor Analysis of Thought Patterns

The scree plot of eigenvalues suggested six factors representing distinct thought patterns. Since we felt these factors could be related, we performed an oblique (Oblimin) rotation. The rotated six factors directly represented four of the hypothesized factors: macho, impulsivity or impatience, anti- vs. pro-authority, and resignation or external locus of control. The invulnerability factor seemed to be more coherently represented by questions on the opposite pole tapping anxiety or worry about driving. The unanticipated extra factor seems to represent confidence or general competence in driving. These six factors are not highly related--the maximum correlation is .22 between macho and impatience and all other correlations are below .20. This six factor oblique rotation was used to derive factor scores for the regression analyses.

Prediction of Thought Patterns from Demographic Variables

The demographic variables used as predictors were age, gender, grade point average, education level, driver's ed, age started driving, age license received, number of years they had their license, and total experience driving wheeled vehicles. All thought patterns except anti- vs. pro-authority were significantly predicted by one or more demographic variables (Table 1). As can be seen in the table, the major predictor of macho thinking was male gender. Higher GPAs predicted less macho thinking. Increased level of education predicted more invulnerable and less anxious thinking. Increased level of education predicted less impatient thinking. Lack of experience, lack of driver's ed training, starting to drive at an older age, and female gender predicted higher levels of resigned, fatalistic thinking. Higher confidence in driving was exhibited by older drivers, those receiving their license at an older age, and those having their license a shorter time. The latter finding suggests that the longer this sample of predominantly young drivers held their license, the less confident they were about their driving.

Prediction of Behavior from Thought Patterns

The driving-related behavioral criteria were measured in clusters related to different aspects of driving such as insurance, seat belt use, drinking and driving, moving violations, parking tickets, reported and unreported accidents, incidents, and the reactions of passengers and other drivers to one's driving. For each cluster of items on the questionnaire, a regression was calculated to examine how well the behaviors could be predicted from the thought patterns (see Table 2). These regressions were calculated using either a summary item (e.g., total number of reported accidents) or a composite index formed from individual questions in the cluster (e.g., increases or decreases in insurance). If the overall regression was significant (at the .05 level), regressions were then calculated to see whether the thought patterns could predict behaviors indexed by individual questions (again at the .05 level).

Insurance. We constructed a composite index by subtracting decreases in premiums due to a good record from increases in insurance premiums due to a bad record. Anti-authority and impatient drivers tended to have more rate increases and fewer rate decreases. Subsequent analyses of increases and decreases as separate dependent measures indicated that rate increases were more predictable from these thought patterns than rate decreases.

A related finding is that both impatient and macho drivers reported trouble obtaining insurance. For both groups of drivers, this difficulty may be due to their accident record. In addition, the macho drivers' rates may be influenced by their gender (male).

Seat belt usage. The seven items that measured a person's tendency to use seat belts themselves or to make their passengers use them were summed to create the overall seat belt use measure. Macho, anti-authority, resigned, impatient, or invulnerable (non-anxious) drivers scored significantly lower on this measure.

As drivers and as front-seat passengers, macho and impatient persons used their belts less. As rear-seat passengers, impatient and resigned persons used their belts less. Macho, anti-authority, and invulnerable persons do not make their adult front-seat passengers use belts, while resigned, anti-authority, and invulnerable persons do not make adult rear-seat passengers use belts. Although the results are weaker, macho persons do not require children in front or rear seats to use belts as often, while anti-authority persons do not require children to use belts in the rear seats.

Thus, different thought patterns predispose persons to different patterns of belt use. Macho persons do not want to use or require others to use seat belts across

the board. Impatient persons just don't want to use seat belts themselves as drivers or passengers. Anti-authority persons do not want to make others use seat belts. Resigned persons seem not to see the necessity of using belts in the rear seat.

Drinking and Driving. Four items measured a person's tendency to drink and drive; the overall measure used for the preliminary analysis was an average of these items. Macho, impatient, anti-authority, and confident/competent drivers scored higher on this general tendency. In examining this pattern for each of the four questions separately, the pattern was consistent across the board: macho, impatient, anti-authority and confident/competent drivers are more likely to drive within one hour of drinking anywhere from 1 to 5 drinks or with a hangover.

Moving Violations. The seven items measuring different kinds of moving violations were summed to produce an overall moving violations index. Macho, impatient, and anti-authority drivers had significantly more moving violations than other drivers. Given this overall result, we analyzed each type of moving violation separately.

The overall regressions for driving under the influence, following too close and failure to yield moving violations were not significant although a particular thought pattern did significantly predict each of these violations. Specifically, macho drivers had more driving under the influence violations, and impatient drivers had more following too close and failure to yield convictions. The lack of overall significance for these violations is partly due to a low base rate of occurrence of these types of moving violations and partly due to the fact that only one thought pattern seemed to relate to each of these violations.

Other violations could be significantly predicted from several thought patterns. Running a traffic control (e.g. stop sign, stop light) was more frequent for anti-authority and confident/competent drivers. Speeding violations were particularly frequent for macho drivers, but also significantly more frequent for impatient and anti-authority drivers. Macho, impatient, and confident/competent drivers also reported a significantly higher number of "other" violations (our catch-all category).

Parking Tickets. The three items measuring different kinds of parking tickets were summed to produce a total of all parking tickets. Macho and invulnerable drivers received more total tickets. Looking at the specific violations, we found that macho

and invulnerable drivers received more expired parking meter tickets and more illegal zone parking tickets.

Accidents and Incidents. The respondents were asked to report the total number of reported accidents in the last three years and to classify those accidents into fault categories. Overall, macho and impatient drivers had more total reported accidents while confident/competent drivers had fewer reported accidents.

We then examined separately the total reported accidents where the respondent was ticketed (at fault) and the total where the respondent was not at fault. Although the overall regressions were not significant, both analyses showed significant regression weights that indicated the impatient drivers had more accidents (both at fault and not at fault) while competent drivers had fewer accidents of both types.

We also examined the relationship between total number of unreported accidents and hazardous thought patterns; this analysis was not significant. However, in examining the number of unreported accidents and incidents where the person was at fault, we found significant regression weights indicating that macho, anti-authority, and impatient drivers had more at fault unreported accidents.

In looking at the total number of incidents, we found that anti-authority and impatient drivers were significantly more likely to have incidents than other drivers. This pattern was more strongly evident in the subanalysis of incidents where the person was at fault rather than incidents where they were not at fault. Thus, there seems to be some consistency for drivers with macho, anti-authority, and impatient thought patterns to have more accidents (reported and non-reported) and incidents, while confident/competent drivers have fewer reported accidents.

Passenger Reactions. The reactions of passengers to the person's driving were measured by four questions, two of which involved positive or negative comments by the passengers. An overall index of passenger comments was constructed by taking the frequency of positive comments and subtracting the frequency of negative comments. Anti-authority, impatient, and resigned drivers had a lower index of passenger reactions while confident/competent drivers had a higher index score.

Although an overall regression for the positive comments question was not significant, the significant regression weight for confident/competent drivers indi-

cated that they get more positive comments. Negative comments were more predictable from the driver's thought patterns. Macho, impatient, resigned, and anti-authority drivers received more negative comments while confident/competent drivers received fewer.

Other forms of passenger negative reactions were also predictable from thought patterns. Macho, impatient, resigned, and anti-authority drivers reported that their passengers more frequently tried to put on the brakes or brace themselves in the seat, or looked nervous or ill at ease. Confident/competent drivers reported that their passengers significantly less frequently tried to put on the brakes or braced themselves in the seat. These results raise the intriguing possibility that one way of assessing the adequacy of a driver would be to assess the reactions of passengers to their driving.

Negative Reactions of Other Drivers. The negative reactions of other drivers to the person's driving were measured by six questions. We constructed an overall index of other drivers' negative reactions by summing these items. Thought patterns significantly predicted this overall sum. Macho, impatient, anti-authority, and anxious/worried drivers received more negative reactions from other drivers. Given this overall result, we analyzed each item in this index and found that different thought patterns contribute to different types of negative reactions from other drivers.

Macho, impatient, anti-authority, and resigned drivers get more rude gestures from other drivers, while confident/competent drivers get fewer. Macho, impatient, anti-authority, resigned, and anxious drivers elicit yelling and screaming from other drivers. Macho, impatient, and anxious drivers elicit honking from other drivers. Macho and impatient drivers find that other drivers attempt to keep them out of a lane to which they want to shift. Impatient drivers are blocked by other drivers when they try to pass. Finally, macho, impatient, and anxious drivers report other drivers passing them just after they have passed. The consistent trend in these results is for impatient and macho drivers to elicit a variety of negative reactions from other drivers, while resigned and anxious drivers elicit only certain kinds of negative reactions. Confident/competent drivers have no tendency to elicit increased negative reactions; in fact, they actually elicit fewer rude gestures.

Self Rating of Driving. Are drivers with these tendencies aware of their own driving problems? At the very beginning of the questionnaire we asked the

respondents to give an overall rating of their driving. Overall, thought patterns significantly predicted this rating ($R = .33$, $F(6,231) = 4.62$, $p < .01$). Anti-authority and resigned drivers rated their driving more negatively while confident/competent drivers rated their driving more positively. However, macho, impatient, and anxious drivers do not rate their driving as significantly better or worse than average. This result suggests that while anti-authority and resigned drivers may be aware of deficiencies in their driving, drivers with macho and impatient thought patterns are not aware of or do not admit the deficiencies in their driving.

DISCUSSION

Summary of Results

The factor analysis confirmed the presence of the five thought patterns previously found (macho, impatient/impulsive, anti-authority, resignation, and invulnerable) plus a confident/competent thought pattern.

Regression analyses found that all except the anti-authority thought pattern are predictable from demographic data. Female gender predicted less macho thinking but more resigned thinking. Higher GPA students were also less macho. Increased education reduced impatience but increased invulnerable thinking. Older drivers and drivers who had their licenses a shorter time were more confident. These results support future research on the development of these thought patterns, and differences in thought patterns for target groups such as drivers with a bad record.

These thought patterns were significantly related to reported driving behavior. In general, impatient and anti-authority drivers had a wide variety of problems with increased insurance rates, drinking and driving, moving violations, accidents or incidents, decreased seat belt usage, and negative reactions from their passengers and other drivers. Macho drivers also had extensive problems with drinking and driving, moving violations, accidents, and decreased seat belt usage and negative reactions from other drivers. Invulnerable drivers had a less serious set of problems with parking tickets, decreased seat belt usage, and negative reactions from other drivers. Resigned drivers only had problems with not using seat belts and negative reactions from passengers. Confident/competent drivers had a mixed bag of positive and negative aspects to their driving. Although confident/competent drivers did drink and drive, they had fewer reported accidents and elicited positive rather than negative reactions from their passengers. While certainly no

angels, these drivers appeared to have the best records. Further research should develop more items to measure this tendency and its consequences.

Generalization to pilots

A critical issue in the generalization of these results to pilots is whether the thought patterns are stable patterns or context dependent. If so, measuring thought patterns in the driving context should predict corresponding thought patterns in the flying context and should predict flying problems similar to the driving problems analyzed in this research. If certain types of driving incidents were shown to reliably index certain thought patterns, then the use of driving records to suspend or revoke pilot licenses may be justified.

However, if these thought patterns are context dependent, measuring thought patterns with aviation-content items might reveal a very different profile of thought patterns from driving content items. If this is the case, the use of driving records to suspend or revoke pilot licenses is not justified. Therefore, future research with a pilot sample must use parallel instruments with driving and flying context items to examine this issue.

REFERENCES

Buch, G., & Diehl, A. (1984) An investigation of the effectiveness of pilot judgment training. Human Factors, 26, 557-564.

Lester, L. F., & Connolly, T. J. (1987) The measurement of hazardous thought patterns and their relationship to pilot personality. Fourth International Symposium on Aviation Psychology, Columbus, OH.

Table 1

Multiple Correlation and Regression Weights
Using Demographic Variables to Predict Thought Patterns

Demographic Variables:

Thought Patterns:	R	Age	Gender	GPA	Yrs. Educ.	Drive Educ.	Start Drive	Age lic. Received	#Years w/lic.	Drive Exper.
Macho	.525		.45	-.13						
Invulnerable-Anxious	.270				.22					
Impatient/Impulsive	.323			-.28						
Resigned	.426		-.15			-.13	.23		-.16	
Confident/Competent	.330	.31						.17	-.35	

Table 2

Multiple Correlation and Regression Weights
Using Thought Patterns to Predict Driving Criteria

Thought Patterns:

Driving Criteria:	R	Macho	Invulnerable vs. Anxious	Impatient/ Impulsive	Resigned	Anti vs. Pro Authority	Confident/ Competent
Insurance Index	.313			.196		.272	
Seat Belt Average	.349	-.243	-.178	-.183	-.133	-.256	
Drink & Drive Av.	.467	.437		.197		.187	.129
Moving Violations	.352	.306		.208		.151	
Parking Tickets	.271	.184	.157				
Reported Accidents	.274	.135		.205			-.158
Driving Incidents	.230			.190		.153	
Passenger Comments	.320			-.152	-.157	-.209	.204
Negative Reactions	.419	.264	.157	.319		.156	