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FORUM***PILOT'S STYLE OF LEARNING AND THINKING AND AGE-RELATED
DECLINES IN VISUAL RECALL***

Robert O. Walton and P. Michael Politano

Abstract

This study examined the styles of learning and thinking and age-related visual recall performance of pilots. The study used the Style of Learning and Thinking (SOLAT) survey instrument to determine pilot's learning preferences and compared pilot learning patterns to a control group of non-pilots. The study also examined possible decline in visual recall performance of pilots using a neuropsychological test, the Rey-Osterreich Complex Figure test (ROCF). Decline in visual recall performance of pilots can affect flight safety. There were 130 military pilots, 35 commercial aviation pilots, 26 general aviation pilots, and 57 non-pilot controls in the study.

Introduction**Pilots and Memory errors**

It is intuitively obvious that memory error of a pilot while in the cockpit can be dangerous. According to Mangold and Eldredge (1993), memory is a basic cognitive ability and capacity that is foundational to all other cognitive processes such as perception, problem solving, etc. Certain phases of flight, such as takeoff, climb-out, and landing, are high workload periods for pilots and can cause information overload and lead to pilot memory error. Pilots require both short and long-term memory function to ensure safe flight operations. Long-term memory is needed to encode information for retrieval at a later time, perhaps hours, days, or years later (Mangold & Eldredge, 1993). Information in long-term memory is also helpful as context for information being processed in current time-frames (Mangold & Eldredge, 1993). Short-term memory is necessary so that pilots can remember immediate information on which they must act immediately, such as flight parameters by air traffic

controllers. Much of the short-term memory requirement comes during the high workload phases of flight such as takeoff and landing. Learning styles and memory are linked processes where individual preferences may be for more sequential information storage or more holistic storage (Mangold & Eldredge, 1993; Torrance & Reynolds, 1980).

Purpose of This Study

The purpose of this research was to determine, if possible, the dominant learning style of pilots and compare that style to a control group of non-pilots. If a dominant learning style for pilots can be determined, then future pilot training programs can be designed to improve the education of pilots and to develop a better understanding of favorable versus unfavorable human/machine (aircraft) interactions. The survey utilized two neuropsychological instruments, the Style of Learning and Thinking (SOLAT, Torrance & Reynolds, 1980) and the Rey-Osterrieth Complex Figure test (ROCF, Stern *et al.*, 1995).

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Data were collected via an anonymous online survey. This appeared to be the best methodology when one considers the broad geographical spread of pilots, the desirability of surveying a large group of pilots, and the sensitivity of pilots to a survey that may indicate some type of weakness that may affect their flying status. The purpose of the study was to examine pilot learning styles using the SOLAT, compare pilot styles to a control group of non-pilots, and to examine potential age-related declines in visual memory and recall using the ROCF.

Instrumentation (SOLAT)

The study used the Style of Learning and Thinking (SOLAT) survey developed by Torrance and Reynolds (1980) to collect data. The SOLAT survey is used to determine left, right, or whole brain learning orientation. Learning styles reflect hemispheric functions of the brain and preferred strategies for learning and information processing. Left cerebral hemisphere brain function is primarily associated with verbal/analytic ability and the right side of the brain is associated with artistic/symbolic ability and more holistic processing (Lavach & Politano, 1989). Because of individual differences in styles of learning and thinking, people perform tasks in different ways. One person may perform tasks in an orderly, systematic way whereas another may approach a problem less systematically. Understanding the way people think and learn can provide insight into how best to develop training programs and how people may react in a stressful or emergency situation.

The SOLAT survey was scrutinized for construct validity by Lux (1983). SOLAT scores correlated with similar instruments suggesting adequate construct validity. Face and content validity were also addressed by Lux while developing the procedures used in construction of the test. Additional work on the validity of the SOLAT instrument was conducted by Vengopal and Mridula (2007).

A cover letter with instructions was provided with the instrument and deployed using SurveyMonkey, an online survey website. The SOLAT instrument uses a simple rating scale to respond to a number of paired statements such as "I like to read explanations of what I am suppose to do" or "I like to have things explained by showing them to me" (Torrance & Reynolds, 1980, p. 1). An individual can mark either of the pairs or both. The answers are then scored using a scoring sheet and the raw scores are converted to standardized scores that are used to identify the individual's learning style. In addition to the SOLAT survey questions employed with this study,

additional questions were asked to determine the type of pilot rating (military, commercial, or general aviation) of participants. Field testing of the survey was not necessary since the instrument has been previously validated (see Lux, 1983; Torrance & Reynolds, 1980; Vengopal & Mridula, 2007) and no changes to the instrument were made. Within the same survey a modified ROCF was administered.

Instrumentation (Rey-Osterrieth Complex Figure)

The Rey-Osterrieth Complex Figure (ROCF) is a neuropsychological test used to examine visual-spatial "constructional functions, visuographic memory and some aspects of planning and executive function" (Caffarra, Vezzadini, Dieci, Zonato, & Venneri, 2002, p. 443). The ROCF test normally consists of directly copying a complex figure while looking at the figure, then reproducing the figure from memory following a delay (Caffarra *et al.*, 2002). The ROCF figure consists of a number of subsets of embedded geometric designs (Chen, Cermak, Murray, & Henderson, 1999). Adequate reproduction of the figure requires spatial memory, visual-spatial integration with grapho-motor ability, and attention to detail (Chen *et al.*, 1999). In addition to visual-spatial analysis, according to Caffarra *et al.* (2002), the ROCF can also be used to study right and left-brain preferences.

Population and Sample

The population targeted by this study were active aircraft pilots; military, commercial, and general aviation. As of the end of 2008 there were 613,746 civilian pilots registered with the Federal Aviation Administration (FAA, 2008). A complete list of the population with contact information was not available so the study used a non-random "snowball" sampling method. This type of sampling method starts with a small number of subjects and then asks those subjects to "recommend others they know who also meet the criteria" (Trochim & Donnelly, 2008, p. 50). The advantage to the snowball method of sampling is that it helps gain access to hard to reach populations; however, the disadvantage to this sampling method is that it has low external validity (Trochim & Donnelly, 2008).

Method

Participants

Participants consisted of 191 pilots who indicated that they were currently either military pilots ($n=130$), commercial pilots ($n=35$), or general aviation pilots ($n=26$), and 57 non-pilots. Pilots were recruited by word-of-mouth through a university involved with aeronautical studies and training. Non-pilots were

recruited from among traditional college students. For the entire sample, mean age was 48.53 years (military $M=38.05$, $SD=11.91$; commercial $M=56.22$, $SD=13.57$; general aviation $M=58.31$, $SD=15.60$; non-pilot $M=41.54$, $SD=19.29$). The sample was predominantly male (87.09%). Total flying hours were collected for each pilot group with military and commercial pilots falling into the 5000 to 9999 hours-plus flying time range (22.40 and 45.70%, respectively) and general aviation pilots in the 5000 hours and under flying time range (88.05%).

Procedures

Information about participants was collected from a survey located on SurveyMonkey, a popular survey site used to collect data for a number of different studies and purposes. In addition to the demographic information as detailed above, participants responded to the Styles of Learning and Thinking (SOLAT; Torrance, McCarthy, & Kolesinski, 1988, Torrance & Reynolds, 1980), a measure that purports to indicate right, left, or whole brain preferences. Subjects were also asked to study the Rey-Osterrieth Complex Figure for 30 seconds, then move forward in the survey and pick one of 5 figures that most closely represented the original figure just studied (participants were not able to go back to the original figure after moving forward). The 5 figures for

participants to pick from deviated from the original ROCF by 3, 6, 9, 12, and 15 percent based on deletion of lines within the figure corresponding to those percentages.

Results

There was a significant difference in pilots' hemisphere preference. Pilots were significantly more likely to favor the left hemisphere (logical, sequential) than either the right, $t(190)=9.88$, $p<.001$, or whole brain orientation, $t(190)=10.16$, $p<.001$.

When compared to the non-pilot control group, no differences were found between pilots and non-pilots in terms of learning style preferences. The means for both groups on right, left, and whole brain orientation were less than a 6 points difference for all three scales.

Pilots were grouped by age into decades starting with the 20's and going through the 60's. A comparison of the accuracy of recall of the ROCF by decade, as measured by the proximity of the individual participant's choice among the 5 figures to the original, did not show any decline in visual recall across the age range, $F(4,220)=.597$, $p=.67$. See table 1 for mean scores by group on the SOLAT.

Table 1

Mean scores by group on the SOLAT

	Right Hemisphere	Left hemisphere	Whole Brain
Pilots	75.05	95.52	71.87
Non-Pilots (Control)	75.59	90.46	72.14

Discussion

It was somewhat surprising that pilots were so clearly left-hemisphere oriented since flying a plane would logically seem to be an activity that would require considerable right-hemisphere activity. Unlike driving a car, flying an aircraft involves regions of space that are not involved with driving a car, such as up and down and the ability to move through several dimensions simultaneously.

Also at first blush, it would seem that pilots would differ from the general non-flying population in hemispheric orientation as indicated by the SOLAT.

However, this assumption might be based on the perception, as suggested above, that flying is primarily a spatial, right hemisphere task. Closer examination, while not ruling out the reliance on right hemisphere spatial capabilities, would suggest that education, rational and linear thought processes, and orderly and sequential procedures are a large part of piloting an aircraft. Particularly for military pilots, and to a somewhat less extent commercial pilots, given that many come from the military aviation world, college educations are a requirement, (with the exception of rotary wing where college graduation is highly recommended but not

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required) suggesting that successful pilots have also been successful in the left-brain predominance of academic pursuits. Additionally, the data that pilots often receive in the cockpit is very linear data (e.g., direction of flight, speed) and would tap heavily into the left hemisphere.

Certainly, age would seem to be a factor in flying as well as aircraft accidents and, as such, might represent a deterioration in memory and/or the ability to make accurate decisions relative to surrounding space in very short time periods. This did not appear to be the case in terms of accuracy of ROCF matching. The ability to match one of the altered ROCF figures to the original after studying the original for 30 seconds did not decline from age 20 to age 68. It is possible that flight physicals, etc., weeded out all but the most proficient in short-term memory and visual-spatial accuracy of recall. It could also be that flying is an activity that continually challenges the

brain and memory functions and serves to keep pilots at a sharp edge as long as they are actively flying.

Conclusion

The findings of the study, while intriguing, may have left more questions unanswered than answered. Additional research is needed to examine more in-depth differences in pilot capabilities that might be related to degree of training and/or innate abilities. Such investigation may be useful in the examination of causes, number, and type of accidents among these three pilot groups. Additionally, comparing pilots by type of flying (military versus commercial versus general aviation) or by type of aircraft, determined by either size and/or speed, may shed additional light on neuropsychological functioning. →

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