Special Report 65-4

PILOT ATTITUDES ON DARK ADAPTATION AND RELATED SUBJECTS

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June 1965

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18 June 1965

SUMMARY PAGE

THE PROBLEM

The night accident rate for carrier landings is five times the day rate. This raises the possibility that visual errors caused by lack of dark adaptation may be involved.

FINDINGS

Completed questionnaires regarding the importance of being adapted to darkness prior to and during night time aircraft carrier operations were received from 71 experienced naval aviators. Analysis of their responses showed that, generally, their opinion of the usefulness of dark adaptation is an individual matter; if the aviator had never experienced its need, he was less likely to be concerned.

The greatest value to an aviator of being adapted to the dark was said to be during pre-flight operations, i.e., on deck, when moving to and around the aircraft, taxiing, and during launch. After being airborne, however, the aviator's major visual problem lies in reflection of the instrument lights which reduces visibility and can affect dark adaptation. Poor knee-board lighting and difference in instrument light intensity were mentioned as other irritating problems.

INTRODUCTION

"In spite of our efforts to conquer the elements and maintain an all-weather aviation force, landing aboard carriers still remains a visual maneuver. The pilot must be able to see to land the aircraft" (3). The five to one ratio of night to day accident rates shown in Table I emphasizes this fact.

Table I

Accidents Reported for Fiscal Year 1964 and Rate per 10,000 Flying Hours

	Accidents in Fleet	
	Number	Rate per 10M hrs
Day	40	1.28
Night	52	6.64
Total	92	2.35

Because of this relatively high night accident rate the authors have attempted to investigate one of the possibly critical factors, dark adaptation (DA). It has been unequivocally demonstrated that a night adapted eye can see better in a dark environment (2,5). The physiological mechanisms of dark adaptation and techniques for achieving it are taught in flight training. However, if operational conditions are not conducive to maintaining dark adaptation, or if the individual pilots do not consider dark adaptation important, then the techniques may be of little practical use.

PROCEDURE

To determine the conditions under which the aviator operates and the degree of importance that he attaches to dark adaptation (DA), a questionnaire was sent out in the fall of 1962 to the commanding officers of Replacement Air Group (RAG) Squadrons, who in turn instructed some of their personnel to answer these questionnaires. The RAG squadron mission is to train designated aviators in the type of aircraft that they will fly operationally. Seventy-one experienced aviators returned their questionnaires. All had in excess of fifty night flight hours. Thirty-seven were instructors and thirty-four students. Their mean age was 29.1 and their average number of total flight hours was 2400.

In an attempt to decrease the subjective aspect of the aviators' responses, six of the seven questions in the questionnaire asked for explicit experiences rather than opinions. The seventh question asked for suggestions about cockpit lighting. To encourage truthfulness the aviators were requested to be candid and were informed they were not obliged to include their names on their forms.

After an initial review of the questionnaires, discrete categories were established for a critical incident analysis after the method of Flanagan (4). For purposes of this report the responses to each question were analyzed separately.

RESULTS AND DISCUSSION

> Question (a). At what point(s) in each type of mission does an aviator rely most upon his dark adaptation? Explain.

In answer to this question 67 per cent of those answering stated that dark adaptation was useful in taxiing and during take-offs and landings. A familiar comment was that "taxiing and take-off are critical periods during the flight and dark adapted eyes are a good back-up system in case of instrument failure." Several incidents were reported which illustrate the importance of dark adaptation during this phase of an operation:

> "Dark night--lost generator on cat shot--maintained wings level using sight horizon."

> "Taxiing out for take-off at Kirtland AFB after no night adaptation I 'sensed' something wrong--turned on the landing light and was about to taxi into a 12 in. deep, unlighted work area."

Another critical period in operations, during which dark adaptation is necessary, is in the manning of the aircraft. Forty-eight per cent of the aviators indicated that going to and from the aircraft aboard a carrier was very hazardous. Several aviators stated that the flight deck was so full of obstacles that it was impossible to move about without some degree of dark adaptation. The following comment was typical: "The flight deck is one huge booby trap."

Thirty per cent of those responding also felt that dark adaptation was an aid in night formation flying. Another 15 per cent thought that all night flight operations could benefit from some level of dark adaptation.

The general consensus seemed to be that some level of dark adaptation was useful; however, there was considerable difference of opinion concerning the point in an operation at which it was needed most.

> Question (b). In general what level of dark adaptation do you think is adequate for successful and safe night operations? Check one: Absolute maximum_____, a good deal_____, moderate_____, some_____, none_____. Why?

Listed below is the percentage distribution of responses by the aviator group for the five levels of dark adaptation.

Absolute maximum	12%
A good deal	35%
Moderate	38%
Some	7%
None	8%
	100%

It may be seen that 47 per cent of the aviators considered that "a good deal" or the "absolute maximum" DA was essential for safety, whereas 53 per cent felt that only a "moderate" amount or less was essential; and indeed 8 per cent (5 men) did not think it necessary at all.

To explore these findings in greater depth, correlational studies were performed. The stated level of necessary dark adaptation was compared with the number of flight hours of the aviator and with his age. This comparison was performed in order to examine the possibility that the older and/or more experienced pilot might take dark adaptation more seriously. It was found, however, that neither correlation coefficient was significant.

Stated level of DA necessary & age	r = .009
Stated level of DA necessary & number of flight hours	r = .002

N = 71

The questionnaire responses seem to indicate that dark adaptation is an individual matter both in the degree deemed necessary and in the degree of adherence to standard dark adaptation procedures.

> Question (c). Please relate an incident when maximum dark adaptation was essential for successful and safe completion of a night mission.

Fifty-eight per cent of the aviators could not relate an incident during which they relied upon maximum dark adaptation. This large proportion with no actual recallable experience is an important factor to consider when evaluating these results. When the stated level (cf. Question b) of necessary dark adaptation for this 58 per cent is compared with those who recalled an incident (42 per cent), a significant difference is noted. These data appear in Table II.

Table II

Levels of Adaptation Deemed Necessary by Two Groups with Varying Experience

Level Necessary	Per Cent of Experienced Group (N = 30)	Per Cent of Nonexperienced Group (N = 41)
Absolute maximum	24	3
A good deal	38	25
Moderate	32	47
Some	3	12.5
None	3	12.5

$\chi^2 = 11.79$ df = 4 Probability of .02

Individuals who experienced no incident in which maximum dark adaptation was essential in flight tended to rate its necessity lower. Aviators who had been in situations where dark adaptation aided them in their performance rated its necessity higher.

> Question (d). Express your opinion on how important you think dark adaptation is prior to launch, when taxiing, or at any other time on the deck, and give an example(s) of an occasion when you had to rely on dark adaptation on the deck.

As previously stated, dark adaptation was considered most important during taxiing, landing, and take-off operations. Sixty-seven per cent of the aviators made comments to this effect. Forty-eight per cent also felt that movement about the deck was facilitated by dark adaptation. The aviators sampled considered this to be true not only for themselves, but even more so for the deck crews.

The following is one of the more dramatic examples of how proper dark adaptation was used on a dark night.

> "While walking across flight deck I noticed an oil cap to an A4D lying near catapult. The A4D's launched off that cat were recalled and one was found to have almost all the oil missing. If I hadn't seen the thing on the deck that engine would have seized."

> Question (e). How do you prefer cockpit lights during the performance of various types of missions? Bright? Dim? Do you change them often? Why or why not?

Forty-four per cent of the aviators answering the questionnaire stated that they varied the brightness of their cockpit lights according to the outside intensity: the

brighter the outside intensity, the brighter they had their cockpit lights. Most of the aviators kept the cockpit lights fairly dim to avoid canopy glare. Many of the respondents felt that the reflection from the canopy was a major problem in that glare reduces visibility and retards dark adaptation. Questionnaire responses indicated that glare shields were ineffective and had often been removed from the aircraft. There seems to be an interaction problem whereby: 1) When cockpit lights are turned up for better instrument readability, external vision is reduced because of glare; 2) when the reflection is reduced by turning down the light intensity, the panel is difficult to read.

> Question (f). In the squadrons in which you have flown, how seriously did aviators take pre-flight dark adaptation procedures? What did they do? What were the effects of their actions in terms of how well they could see at night?

Sixty-one per cent of the aviators completing the questionnaire thought that pre-flight dark adaptation procedures in the fleet were adequate. They also felt that these procedures were adequately enforced.

Fifty-two per cent of the aviators stated that dark adaptation procedures at airfields were ineffective. The pilots stated that lights on and around the fields were so bright as to make dark adaptation of minor importance. Because of these factors little stress was placed upon following dark adaptation procedures ashore. This suggests that some problems may be encountered in the transition from shore duty to sea duty.

The general impression gained from the responses to this question tend to indicate that the extent to which the dark adaptation procedures are followed is again an individual matter (cf. Question b) and subject to great variation.

> Question (g). The lighting of the cockpit obviously plays a part in determining your level of dark adaptation. With this in mind do you have any suggestions about how cockpit lighting could be improved in order to aid the pilot flying at night?

Listed below are the general suggestions that the aviators included in their questionnaires. Only those suggestions which were mentioned by 19 per cent or more of the aviators are included.

Change type of lighting	32%
Reduce reflectance from canopy	22%
Establish an equal brightness for all instruments	22%
New type of lighting for knee-board	19%

The comments regarding "change type of lighting" dealt primarily with the inadequacy of the existing "reflective type lights" which are typical of the major

proportion of flight instruments. Some of the aviators indicated preferences for the "internal glow" type of lighting and they felt that this made the instruments easier to read.

The canopy reflection problem has already been mentioned in Question c.

Twenty-two per cent of the aviators made statements concerning variable instrument illumination. Several situations were related where light intensity was turned up to read one or two dim instruments and the other instruments became so bright as to cause excessive reflection. The pilots were faced with choosing between two levels, neither of which was desirable: dimly lit, hard to read instruments, or bright, glare producing instruments.

The knee-board light problem seems to be an unusually perplexing one. While the other problem areas mentioned were categories consisting of several related problems, the knee-board problem was a single specific item. Thirteen individuals included comments concerning the knee-board, making it the single most often mentioned problem. No one who mentioned knee-boards considered them acceptable. To correct this problem, three aviators suggested that the power for the knee-board lighting should come from the aircraft's supply rather than from batteries. This suggestion seems to merit some further investigation.

Other suggestions which were made included changes in: lighting position (14.5%); position of instrument console (5.8%); position of switches (4.3%); and better rheostat control (10.1%). These comments, when coupled with those suggesting that cockpit lighting in general should be changed, appear to indicate an over-all dissatisfaction with the present lighting systems.

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