An Assessment of the ANV 20/20 Focusing Aid for Night Vision Devices

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SUMMARY: Night vision goggles (NVGs) are becoming an increasingly important tool in military aviation. They provide superior visual capability over unaided night vision, but any reduction in goggle performance can have a serious effect on flight safety and operational effectiveness. This study shows that the use of the ANV 20/20 focusing aid provides an effective method for aircrew to obtain a better visual capability than is currently obtained by focusing on distant features of the landscape or distant lights. Visual acuities using the current and proposed focusing methods were compared in 50 aircrew. The visual acuity showed an average improvement of 18% with the proposed method compared with the current method. This was found to be statistically significant ($p < 0.01$). Using the current method of focusing there was a significant ($p < 0.01$) difference in the visual acuity achieved between the right and left tubes/eyes. Using the ANV 20/20 there was no difference between tubes/eyes. ANV 20/20 was found to improve visual acuity when using NVG as well as enabling the user to achieve equal visual acuities with both eyes.

Introduction

Night operations are playing an increasing role in military operations. NVGs are widely used to enhance visual capabilities at night and as such have become an essential component of military aviation (1). They provide an amplified image of the ambient light, and although this is superior to unaided night vision, it is still inferior to daylight vision (2).

NVGs are a binocular assembly of two image intensifier tubes. Each of these has an objective lens which focuses an image onto a photo-cathode. A microchannel plate then amplifies the image onto a phosphor screen which is then viewed through the eyepiece (dioptre) lens (3). ANVIS types goggles are designed in such a way that the objective and eyepiece lenses can be adjusted (Fig 1). NVGs are a valuable aid to night flight, but they have inherent limitations. These limitations can be split into three groups: visual limitations and spatial disorientation (related to field of view, visual contrast and acuity); crew performance (affected by fatigue, endurance and crew co-ordination); and systems/hardware problems such as the inability to see wires and dimming of the image (by automatic gain control) due to bright lights (4).

Student pilots at the School of Army Aviation are given instruction on the use of NVGs as well as a briefing from a specialist in Aviation Medicine on the medical aspects of night vision and NVGs. They undergo 8 hours in flight training with goggles during the Army pilot course. As part of their training they are taught how to focus and adjust the goggles prior to flying. Observations of the pre-flight routines of Army Air Corps pilots revealed that pre-flight adjustment and focusing procedures could be

The binocular assembly contains the optical elements of the system. This component has several adjustment features. Learning to operate each feature is essential for proper alignment of the device. The following is a list of adjustment features on the binocular assembly:

- Fore and aft adjustment knob - moves the entire binocular assembly toward or away from the eyes.
- Tilt adjustment knob - allows wearer to rotate the binocular assembly.
- Interpupillary distance (eyespan) adjustment knob - allows wearer to adjust for the distance between the eyes.
- Objective focus ring - focuses the goggles for distance (adjustment range is from 10 inches to infinity).
- Diopter focus ring - compensates for individual refractive error.

Fig 1. The binocular assembly

improved. The present method can give errors which are enough to cause a significant reduction in visual acuity (5).

SPECIFICATIONS:

MECHANICAL:

Case Size (w/cover)	13H x 10.5 W x 9.6 D (inches)
Case Size (w/out cover)	13H x 10.5 W x 6.2 D (inches)
Test Set Weight (w/batteries)	26lbs (MIL-SPEC), 23lbs (Non MIL-SPEC)

ELECTRICAL:

Power Source	Four D size Alkaline Batteries
Battery Life (normal mode)	1500 cycles (minimum), 3 minute cycle
Battery Replacement Limit	<1.05 V
Ambient Light Sensor	Silicon Photodiode
Ambient Light Level Limit	<0.1 fC

OPTICAL:

Light Source	LED, Continuously Monitored
Focal Settings	100 Meters (minimum), Infinity (maximum)
Reticle Resolution	0.49 to 1.72 Line Pairs per milliradian
Reticle Luminance	Approx 1/4 Moon-Normal, Starlight-Low
Source Accuracy	+/- 5% at Normal Mode
Left/Right Collimation	<0.5 degree error
System MTF	>75%

Fig 2. ANV-20/20 NVD Infinity Focus

Common methods currently used to focus and adjust NVGs include focusing on a nearby hill or other landscape features around the airfield. In-flight adjustment of goggles is often found to be necessary, and qualified helicopter instructors (QHI) were often unsure of the visual acuity levels achieved by their students.

The use of the ANV 20/20 provides a method of accurately focusing all types of NVGs and provides the goggle user with a standard measure of his (and his/her students) goggle performance. It also allows the NVG novice to learn what should be seen through the goggles when they are properly adjusted and focused. This device can also be used when goggle adjustment 'in the field' is necessary. It is hoped that deterioration in tube performance will be noticed earlier than with current routines used, allowing defective tubes to be replaced before problems are noted in flight.

The ANV 20/20 is a compact portable system designed to provide the NVG user with an accurate means of performing infinity focus and mechanical alignment, Fig 2.

The system presents a resolution pattern at infinity focus to both NVG tubes. This allows proper adjustment to be done quickly. The resolution pattern is directly correlated to the Snellen Eye Chart providing a visual acuity range of 20/20 to 20/70.

The reticle pattern seen by the NVG user can be seen at

Fig 3. Reticle Pattern

Table 1
Visual acuity using each tube independently after the subject had focused the goggles by his/her usual method

CREW POSITION	FLYING HOURS ON NVG	RIGHT V/A WITH CURRENT METHOD	LEFT V/A WITH CURRENT METHOD	RIGHT V/A WITH ANV 20/20	LEFT V/A WITH ANV 20/20
Instructor	100	50	45	40	40
Student	0	50	70	40	40
Student	5	60	70	30	35
Student	0	45	70	40	50
Student	4	50	45	50	45
Instructor	70	60	50	45	35
Student	4	40	45	35	45
Student	4	40	45	40	40
Instructor	150	60	60	45	35
Instructor	60	50	50	45	35
Student	20	70	70	70	70
Student	4	70	40	45	40
Student	5	70	45	40	45
Instructor	230	40	45	40	45
Student	5	20	40	40	40
Student	0	40	50	35	45
Student	0	45	45	40	40
Student	0	50	70	40	40
Student	0	60	60	50	45
Instructor	80	40	45	35	35
Student	3	45	50	45	45
Student	4	70	70	40	40
Instructor	220	40	35	40	35
Instructor	230	35	70	35	45
Instructor	9	50	60	45	45
Pilot	40	50	70	45	45
Pilot	120	50	40	40	40
Pilot	90	70	60	45	45
Pilot	100	40	35	35	35
Pilot	90	35	40	35	40
Pilot	50	40	45	35	40
Pilot	200	40	40	35	30
Pilot	18	60	60	45	40
Pilot	40	50	70	45	45
Pilot	10	35	60	35	45
Pilot	30	45	45	40	40
Pilot	350	40	45	40	45
Pilot	50	40	45	40	45
Pilot	30	40	60	35	45
Pilot	160	50	60	30	35
Pilot	30	50	40	35	35
Pilot	17	40	40	35	35
Pilot	30	50	70	35	40
Pilot	95	40	45	40	45
Pilot	8	35	45	35	40
Pilot	40	60	60	40	40
Pilot	95	40	45	40	45
Pilot	70	30	45	30	35
Pilot	15	45	35	40	35
Instructor	800	40	40	35	35

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Fig 3. It should be noted that the numbers seen in the centre grids correlate with the American 20/20 Snellen scale for visual acuity.

Subjects

Data were collected at the School of Army Aviation (a training environment) and in Northern Ireland (an operational environment). Fifty helicopter aircrew were studied, 10 qualified helicopter instructors, 24 helicopter pilots and 16 student pilots. All of the subjects had undergone ground-based NVG training and the NVG experience ranged from 0 to 800 NVG flying hours.

Method

The ANV 20/20 is a focusing aid, not a direct measurer of visual acuity. It was felt however, that a comparison could be made between acuities achieved using the current focusing technique, and those achieved using the ANV 20/20.

Visual acuity was 'measured' using each tube independently after the subject had focused the goggles by his/her usual method. The subject was asked to look at the reticle image and note the lowest number around which they could differentiate between the horizontal and vertical lines. They were then asked to refocus the tube being measured, using the reticle pattern as a focusing aid. Again the lowest number around which the horizontal and vertical lines could be differentiated between was noted.

The tube not in use was covered with a lens cap, to avoid the subject having to close one eye. The 'starting' visual acuity (i.e. without NVG) of each subject was 20/20 or better, corrected where necessary with flying spectacles.

Results

The results can be seen in Table 1. The numbers represent the bottom figure of the 20/20 Snellen Fraction. There was a mean improvement in visual acuity from 20/49.4 to 20/40.5. By using the Bonferron test this was found to be statistically significant, $p < 0.01$.

The test also showed that using the current method, visual acuities achieved with the right eye (and tube) were better than those achieved with the left eye (and tube), $p < 0.01$. However, using the ANV 20/20 there is no significant difference between the two eyes (and tubes).

Discussion

The use of the ANV 20/20 for focusing results in better visual acuity than using the current techniques of focusing. This indicates better visual performance and should lead to a greater operational effectiveness and safety during night missions. This may also help alleviate

visual fatigue problems, caused by poor focusing and misalignment of goggles.

It was found that the visual acuity of the right eye was superior to that of the left eye when using the current method of NVG adjustment. Even slight differences in focus between the eyes are thought to result in visual fatigue and this observation may explain some of the current problems of headaches and visual discomfort currently being experienced by aircrew after NVG sorties (5, 6). This is the subject of ongoing research at the School of Army Aviation. Using the ANV 20/20, no significant differences in the visual acuity were found between the eyes. Unlike previous standardised focusing techniques studies (5), the ANV 20/20 is a truly portable device. It is light (26lbs), and travels in a robust box, and is battery operated. Presenting the user with an image at infinity means that no further adjustment of the goggles is necessary before flying. The NVG does not have to be mounted or attached to the unit. The user simply looks into the unit and focuses. This means that the ANV 20/20 can be used with all types of NVG currently used by the Army Air Corps.

Although the goggles need to be focused in darkness using the ANV 20/20, it is not essential to have a completely light tight room. This makes it a more practical tool for operational use.

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