Acknowledgment

Marlene Hoffmann, James R. Kelln, Julian T. Saldivar, and John Vaughan had major responsibilities for collection of the data. Jess M. McKenzie was responsible for analysis of metabolite excretion. Fred Porter and Reynolds Smith of the Flight Standards Branch (AAC–950) served as check pilots. The contributions of these individuals are gratefully acknowledged.

EFFECTS OF GROUND TRAINER USE ON THE PSYCHOLOGICAL AND PHYSIOLOGICAL STATES OF STUDENTS IN PRIVATE PILOT TRAINING

I. Introduction.

Physiological measurements suggest that student pilots working toward certification as private pilots are subjected to a high degree of stress during flight training.[3 5] Such stresses may result in anxiety of sufficient intensity to negatively affect the learning of the complex tasks required of pilots; it has been shown in a variety of settings that high levels of anxiety interfere with learning of complicated material.[e.g., 6] If flight training could be restructured to reduce the stress in such programs, it might prove beneficial to student pilots.

Apprehension over physical safety, the demanding nature of training procedures, and physical discomfort are among the potential stressors in flight training. However, as in other types of instruction, the primary source of stress may well be the presence of an instructor. The instructor, in addition to being a teacher, embodies the role of evaluator. Therefore, the student is under the constant threat that his performance will be judged inadequate.

While it is clear that the instructor, and therefore the threat of evaluation, cannot be readily removed from the flight instruction setting, there may be other approaches to modifying training that could lessen the stress inherent in such activity. The use of ground trainers could prove beneficial in this respect. In ground trainers, the student pilot may feel somewhat less concerned about the highly probable occurrence of procedural and performance errors, since there are no serious negative consequences to be suffered from such errors. Moreover, the ground trainer provides the instructor with greater time to explain and demonstrate matters not well understood by the student, since the simulator can be stopped, axes of rotation can be eliminated, and other problems can be simulated at any point that will aid the teaching process. This obviously is not possible in a moving aircraft. The ground trainer also allows the instructor to give full attention and support to the student, since there is no need for the instructor to monitor the safety of the aircraft. Thus, although the studet pilot is still faced with evaluation by the instructor, the ground trainer may provide a better overall teaching climate for flight instruction.

Since there may be teaching benefits, and there are certainly benefits in terms of costs, weather, maintenance, and safety, in using the ground trainer, the major issue is to determine the extent to which substitution of the trainer for an aircraft during portions of training affects the proficiency of student pilots. This study considers the proficiency question and also assesses the degree to which use of the ground trainer reduces the stress of such training, as measured through the psychological (anxiety) and physiological states of the student pilot.

II. Method.

A. *Subjects.* Sixteen male volunteers, all FAA employees with no more than casual experience in flying general aviation aircraft, participated in this study. The volunteers ranged in age from 30 to 42, and all were well established in nonflying professions. None expressed an avowed intent to make flying a career, and most were principally motivated by the opportunity to acquire much of the training required for certification as a private pilot.

trainer (for a more detailed discussion of these findings, see Melton *et al.*[4]).

The heart rate data clearly indicated that students in the aircraft for all lessons (AG) had higher heart rates than did the TG students (Table 2). However, these differences were typically present under all conditions, not just on comparisons between flights in the trainer and comparable flights in the aircraft. For example, the difference between the resting heart rates for both groups prior to aircraft flights is of the same magnitude as other differences between the two groups, although in this particular comparison the difference in means is not quite sufficient to achieve statistical significance. This suggests that the group themselves differed somewhat in basal heart rates, just as they differed in A-Trait; however, it should be noted that the group with the higher basal heart rate, the AG students, had the lower A-Trait level. If the differences between the groups on the various comparisons of heart rates while undergoing training are then adjusted by the apparent differences in basal heart rate, it can be seen that changes in heart rates from resting to flight were generally comparable for both groups. Heart rates for TG students increased 14.0 beats per minute (bpm) on aircraft flights and only 3.5 bpm on trainer lessons. Interestingly, this same pattern was found for AG students. Their heart rates (all measured in the aircraft) increased 14.2 bpm from rest on those flights corresponding to flights in which the TG students were also in the aircraft but increased only 7.0 bpm on those flights corresponding to ground trainer lessons for the TG students.

Blood pressure measurements yielded no significant effects.

Energy expenditure, as measured by 0_2 consumption, showed TG students apparently used somewhat less energy on trainer lessons than on aircraft lessons; however, all comparisons concerning 0_2 use were nonsignificant (Table 2). There was no relationship between 0_2 use and heart rate.

There were no consistent differences between groups on the biochemical indices (Table 2). Students in both groups did show substantial increases from basal levels in metabolite excretion during nearly all flights.

TABLE 2. Heart Rates, O_2 Consumption, and Metabolite Excretion for AG and TG Students Under Various Training Conditions

	AG		TG	
	Resting	Training	Resting	Training
Heart Rates (beats per minute)				
Trainer Flights[a]	90.0	97.0	80.7	84.2
Aircraft Flights	89.6	103.8	81.2	95.2
Mean	89.7	101.6	81.0	91.2
O_2 Consumption (milliliter $O_2/min/m^2$)				
Trainer Flights[a]	----	248.1	----	197.7
Aircraft Flights[b]	----	264.1	----	270.2
Metabolite Excretion (per 100 mg creatinine)				
Epinephrine	1.03	4.01	0.97	4.51
Norepinephrine	5.00	10.24	5.72	10.15
17-KGS	795.09	1528.23	859.82	1692.90

[a] Trainer equivalent flights for AG were in aircraft.
[b] Only through flight 11.

No correlations between anxiety levels and either physiological or biochemical measures were noted.

C. *Performance Findings.* There were no significant differences between the two groups on any of the object flight measurements. Furthermore, the flight test examiner could not distinguish the performance of those students who had partial experience in a ground trainer from those who received all training in the aircraft.

IV. Discussion.

The results of the analyses for type of flight lesson suggest that use of the ground trainer in training has very little effect on the student pilot's self-reported anxiety level. While some slight support for the hypothesis that use of the trainer reduces student pilot anxiety might be inferred from the direction of differences between trainer and other types of flights, the reactions of individuals were sufficiently varied to indicate that no generally appreciable benefit with respect to self-reported anxiety reduction was derived from trainer use.

The results of the comparisons between solo, dual, and evaluation flights are generally in keeping with findings of previous research.[5] It is of interest that the relatively high degree of anxiety reportedly experienced by student pilots prior to solo flight was significantly reduced at the completion of the flight, while there was no such reduction for dual flight; if anything, there was a tendency for anxiety to increase from before to after such flights. These results suggest that the presence of an instructor in the aircraft has a beneficial effect on anxiety prior to the flight but either increases anxiety or inhibits its reduction during the course of the flight. The student about to undertake a dual flight knows that the primary responsibility for the flight rests with the instructor and an expert is available to deal with any difficulties that might arise. However, once the flight has started, the student on a dual flight must perform new or difficult tasks at the direction, and under the scrutiny, of the instructor. On the other hand, the student flying solo is able to do much as he pleases without being subject to evaluation by the instructor. Thus, on dual flights the student may not experience significant relaxation of anxiety, because the threat of a negative evaluation is present throughout the flight; however, on solo flights the student may feel a relative high degree of preflight anxiety arousal, due perhaps to some physical and/or competence concerns, which is subsequently reduced by the successful progress of the solo flight.

The results indicating that evaluation flights are the most anxiety arousing of all types of flights are in keeping with the results of several studies on student populations.[e.g.,2 7] These studies indicate that the threat of failure, which is implied in an evaluation setting, is a major determinant of A-State levels.

A question still remains as to why TG students showed no general tendency to report experiencing increased anxiety in association with flight lessons. It seems unlikely that this result can be ascribed to a reassuring effect of the ground trainer on the TG students, since evidence from physiological measures and informal observations by the flight instructor indicated that all participants in the TG, as well as those in the AG, reacted with increased arousal and tension to flight training. Perhaps for some individuals, particularly those with relatively high A-Trait, the process of flight training diverts attention from other conditions that are anxiety arousing. It also may be that the student pilots who are relatively high in A-Trait tend to deny that there is a high level of anxiety associated with flight training. In other words, an individual who is relatively susceptible to anxiety may not be able to admit to himself that such stressful activities are intensely anxiety arousing, especially when the successful completion of these activities may have significance for the individual's self-esteem and prestige. A related finding by Bucky, Spielberger, and Bale[1] in another aviation context was that candidates for naval flight training tended to deny anxiety associated with imagined carrier landings. This was interpreted as defensiveness on the part of these student aviators in admitting to anxiety when it pertains directly to aviation skills.

The physiological and biochemical findings, like the results on anxiety levels, suggest that use of the ground trainer has relatively little effect on these variables in the student pilot. What differences there were tended to suggest that stress may be slightly lower during instruction with the trainer than during instruction within the aircraft; however, the differences appear to have negligible significance.

In conclusion, it should be noted that in considering the feasibility of using the ground trainer as a substitute for the aircraft during some portions of training, no apparent proficiency penalty is paid for such use. Evidence from the performance assessments indicated that students who had some experience in the trainer were able to perform as well as those students trained only in the aircraft. Therefore, it can be seen that use of the trainer in the private pilot course can result in pilot proficiency comparable to that of aircraft training, at least with respect to the parameters measured in this study. This suggests that the ground trainer with its several advantages (i.e., its efficiency for instructional purposes, lack of dependence on weather conditions, relatively low operating costs, and other positive factors) could receive wider utilization in private pilot training with beneficial results. There are no contraindications to this conclusion in either the psychological or physiological data.

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23113