Journal of Aviation/Aerospace Education & Research

Volume 13
Number 1 *JAAER Fall 2003*

Article 8

Fall 2003

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Scholarly Commons Citation
Wendell, A., Frederick-Recascino, C., DeLuca, J., & Kirton, T. (2003). The Effects of an Induced Negative Mood State on Student Pilot Learning. *Journal of Aviation/Aerospace Education & Research, 13*(1). https://doi.org/10.15394/jaaer.2003.1566

THE EFFECTS OF AN INDUCED NEGATIVE MOOD STATE ON STUDENT PILOT LEARNING

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ABSTRACT

The present study examined the effect of an experimentally induced mood state on student pilot learning for ground school- related information. The findings from this study supported the research mat has been done in the past on negative mood and memory (Leigh & Ellis, 1981). Furthermore, the researchers showed support for the hypothesis that a negative mood state will cause a decrement in memory performance for student pilots who are attempting to remember ground-based material. Although further research needs to be done in this area, evidence has shown that a negative mood state will decrease student pilot memory ability.

INTRODUCTION

The United States Department of Transportation (D.O.T.) and the Federal Aviation Administration's (FAA) *Aviation Instructors Handbook* (1999) emphasize that aviation students must maintain a healthy and positive state of mind in order to succeed at learning. Factors such as worry, complacency, lack of interest, physical discomfort, and anxiety are all listed as obstacles to a student's ability to learn successfully duringflight instruction. Interestingly, the D.O.T. has set medical guidelines in its Federal Aviation Regulations/ Airman's Information Manual (FAR/ATM [2002]) concerning a student's psychological state of mind and the ability to receive his/her pilot medical certification and student pilot certificate. Of particular interest is the occurrence of a negative mood state, which has the potential to lead to decreased student pilot learning performance. Although mood and a negative mental state are discussed in many flight instructor teaching manuals, it is generally a topic that is only briefly mentioned. Flight instructors are warned, and essentially recommended, to take note of students who appear to be psychologically compromised (Teller, & Biggs, 1988; Jensen & Adrion, 1985; U.S. D.O.T. 1997).

The study of aviation is often thought of as a solely flight-based training program, however all pilots are required to develop an extensive knowledge base of aviation related material during ground instruction. Some of this ground-based knowledge includes developing an understanding of weather, aircraft systems, flight planning, aircraft performance, and radio communications (D.O.T. 2002). For the average beginning student pilot, this material is relatively new, complex, and quite overwhelming (Tessonneau, 1973). Furthermore, the learning of new information generally requires a higher level of concentration for most student pilots (Squire, Byrne, Nadel, Roediger, Schacter & Thompson, 1992), particularly those seeking a flight certificate. If the student pilot is burdened by distractions, especially those involving emotional content, during the ground learning process, then the student may not be able to achieve the high level of concentration needed in order to retain the important aviation concepts (D.O.T. 1999; Jones, Stacey & Martin, 2002; Lang, Craske, Brown & Ghaneian, 2001). The present study investigates the relationship between negative mood state and ground school learning hi student pilots using an empirical methodology. *Effect of Mood State on Learning*

In a study performed by Leigh and Ellis (1981), the effects of experimentally induced mood states on recall and the chunking of letter sequences was examined. The results of the study showed that subjects in the neutral mood condition had higher performance on the recall task than those in the sad mood condition. The results indicate that a sad emotional state may interfere with encoding. Several years later, Ellis, Thomas and Rodriguez (1984) performed a more thorough version of the earlier study. The new study involved the examination of mood effects on elaborative encoding. The elaboration hypothesis proposed

that deeper levels of processing would result in increased retention due to the more complex encoding of the information (Searleman & Herrmann, 1994).

In the Ellis et al. study, (1984) participants were also put into various mood states using a mood induction technique. Participants were men presented with either base sentences, or elaborated sentences. The base sentences consisted of simple, coherent sentences, such as, The hungry child opened the door" or "In the event of a compressor stall, one should reduce fuel flow". After reading this sentence, the participant would later see the same sentence with the target word, "hungry" or "stall" missing. The elaborated sentences included the base sentence, plus a phrase, which contained information that elaborated upon a target word in the sentence. The elaborated sentence might be, "The hungry child opened the door of the refrigerator" or "In the event of a compressor stall, one should reduce fuel flow, reduce angle of attack, and increase airspeed." In the elaborated sentence, the participant was still required to later remember the word "hungry" or "stall." In the elaborated condition, however, the words or phrases following the target word were used in order to help bring out distinctive properties of the target word. The elaboration was hypothesized to help aid in memory retention.

The results of the Ellis et al. (1984) study showed a clear interaction between mood states and the processing of various sentence conditions. In comparing the sad and neutral mood states, participants in the depressed state showed a significant reduction in the recall of target words in comparison to subjects in the neutral condition. In addition, more target words in the elaborated condition were remembered by both groups. The study confirms the hypothesis that individuals in a depressed mood state will have a difficult time processing and remembering information (Ellis et al., 1984). *Flight Training and Learning Issues*

Once an individual has received a student pilot medical certificate, he/she will likely begin looking for places in which to begin a flight-training program. Flight training programs may vary widely from flight school to flight school, both in the type of aircraft flown, and in the manner in which aeronautical concepts are explained (U.S. D.O.T., 1997). Large colleges, such as Embry Riddle Aeronautical University (ERAU), are normally under part 141 of the *Federal Aviation Regulations* (U.S. D.O.T., 2002). Under a part 141 flight-training program, aviation schools are required to meet numerous, specific requirements regarding the amount of hours and type of training required in order to receive a flight rating. For the private pilot airplane course, a minimum of 35 hours of ground training must be completed in order to cover the required aeronautical knowledge curriculum. Ground training must include such topics as pre-flight actions, aeronautical decision-making, aerodynamics, aircraft systems, aircraft performance, radio communication procedures, aeronautical charts, the accident reporting system, and all applicable *Federal Aviation Regulations* (U.S. D.O.T., 2002). This list demonstrates the importance of classroom learning during student pilot training. The student is not simply stepping into the airplane and learning how to fly. If student pilots are not able to learn effectively and efficiently in the classroom environment, the success of the overall flight training program will be hindered.

Most studies that examine the performance of student pilots seem to focus on specific aspects of flight training, such as special orientation and flight adaptation (Henley, 1985; Tessonneau, 1973). However, emotions and effective learning are also linked with safety in the sky (e.g. students should be concentrating on the flight maneuver rather than daydreaming about something else.) Studies on ground learning and emotion, however, are much less prevalent. If ground- based instruction is such a large requirement for the private pilot license, it would be appropriate to expect knowledge to be significantly and directly linked with safety. For example, a student who is mentally distracted during a lesson on the stall/ spin recovery procedure may not be able to retain the knowledge of how to maneuver the aircraft in case this event were to actually occur. In addition, the stall/spin recovery procedure is not taught or demonstrated during actual in-flight training, due to the fact that a spin entry can be dangerous and cause damage to the aircraft. A student may never have been shown how to perform or recover from a spin in the aircraft until he or she is working on the Certified Flight Instructor (CFI) course. Student pilots, however, are given a logbook endorsement to practice solo flights with the understanding that stall/spin recovery procedures have been discussed in an oral ground lesson (U.S. D.O.T., 2002). This is an example of a situation in which student retention of ground-based instruction is extremely important If the student departs on a solo flight and accidentally ends up in a stall/spin situation, there is no

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DOI: https://doi.org/10.15394/jaaer.2003.1566

CFI on board to recover the aircraft from the very dangerous flight attitude. This could lead to catastrophic consequences for the student, and is largely due to retention problems during the ground instruction. (U.S. D.O.T., 1997).

Pilot Learnine and Emotion. Student pilots are all unique individuals, and each learns in a different way. There are several common beliefs, however, which describe some general theories relating to pilot learning. The *Aviation Instructor'sHandbook(U.S.* D.O.T., 1999) refers to the first principal of learning as the "Law of Readiness." The "Law of Readiness" pertains to the idea that student pilots will not learn effectively unless they are ready and eager to acquire new information (U.S. D.O.T., 1999). From the previous discussion on mood and learning, it seems likely that students will not be ready and eager to acquire new information if their minds are preoccupied with negative feelings. *The Aviation Instructor's Handbook* emphasizes that there may be very little a flight instructor can do in order to inspire the student to learn if the student is not ready, willing, and interested in obtaining new knowledge. Another mood-related concept mentioned in *ibe Aviation Instructors Handbook* is the "Law of Effect", which states that the emotional reaction of the learner is very important in strengthening student knowledge (U.S. D.O.T., 1999). Learning will be strengthened when accompanied by pleasant and satisfying feelings, and weakened when accompanied by unpleasant feelings. *The Present Study*

The purpose of the present study was to examine the relationship between an induced negative mood state and the ability of a student pilot to remember material that requires knowledge and understanding of specific aviation concepts. Although numerous studies have demonstrated a relationship between mood and memory, (Asuncion & Lam, 1995; Clark, Milberg & Ross, 1983; Ellis, Thomas & Rodriguez, 1984; Hertel & Hardin, 1990; Leigh & Ellis, 1981; Parrott & Sabini, 1990) the literature is void of relevant studies of this type relevant to student pilot learning. It would seem, however, that the results obtained from the Ellis et al. (1984) study would be similar to those expected in the present study, based on the theories of pilot learning (U.S. D.O.T. 1999).

The two questions being examined in this study are as follows:

1- How will an induced negative mood state affect a student pilot's ability to retain aviation material?

2- Will there be a difference in the student pilot's ability to remember base, aviation related sentences in comparison to elaborated, aviation related sentences?

Based on previous research, it is believed that the Velten Mood Induction technique will be able to produce a temporary negative mood state in healthy college students (Jennings, 2000; Finegan & Seligman, 1995; Frost & Green, 1982). Likewise, a methodology testing memory for specific sentence, similar to that of Ellis and his colleagues (1984), is expected to produce comparable results. Specifically, the study will include the use of both base sentences and elaborated sentences that pertain to aviation concepts. The base sentences will be shorter sentences that include a key word (the participants will not know what the key word is while reading the sentence.) The elaborated sentences will include the base sentence, the same key word, and an additional phrase intended to assist the student in memory retention. It is anticipated that those participants in the negative mood state will remember fewer of the key words in both the simple and elaborative sentences. Furthermore, is it anticipated that both groups will remember more of the key words in the elaborative sentences, but that the participants in the neutral mood state will remember a significantly greater number. The aviation concepts in the sentences will include topics related to aircraft performance, aircraft operations, and aircraft systems. The sentences will include more advanced concepts that are not taught in the private pilot course. As a result, beginning student pilots will not likely have been exposed to the material used in the study. This will ensure that there is not a learning bias between those students who are already familiar with the aviation concepts, and those who are not.

METHOD

Participants

Forty student volunteers from private pilot ground courses at Embry Riddle Aeronautical University in Daytona Beach, Florida served as experimental participants. Students were told that they were volunteering to assist in a mood- related learning experiment. Volunteers were offered small amounts of class credit as an incentive to participate in the study. All volunteers were student pilots who held either a first, second, or third class airman's medical certificate. Twenty-eight male student

pilots and 12 female student pilots participated in the test. The student pilot volunteers ranged in age from 18 to 27 years old. All were unmarried, full time college students.

Student pilots were informed of the chance to participate in this study approximately one week prior to the initiation of the testing. Students were presented with the opportunity to enroll in the study during their private pilot ground school course at Emory Riddle Aeronautical University. On the enrollment form, students were given the opportunity to provide an Electronic mail (E-mail) address. One day prior to the initiation of testing, all students received an E-mail reminding them of the study, and encouraging them to obtain a regular night's sleep.

Materials and Apparatus

The entirety of the test was performed in an average college classroom, containing 85 seats that were spaced approximately 20 inches apart from one another. The work areas were spread out across the room with the hope of discouraging student interaction. The room was air conditioned and well lit, in order to provide a comfortable environment for learning. A PowerPoint presentation was used to issue most of the instructions for each task. The PowerPoint presentation was projected on a large screen in order to increase the visibility and readability of the instructions. Written instructions were used in order to prevent potential experimenter error or bias that could occur while issuing the instructions. Each of the written tests and surveys was printed on standard white paper, and passed out individually to the participants.

The mood induction statements were typed on 3 x 5, white index cards. The cards contained a set of 40 neutral, or 40 negative statements, which intended to produce a neutral or negative mood state in the students. The cards with the negative statements were ordered so that the content of the statements became progressively more emotional, as recommended by Ellis et al. (1984). The cards were also handed out individually to each subject, in order to prevent participants from viewing the statement cards of fellow classmates.

Twenty aviation-based sentences were produced for the teaching lesson. All sentences contained statements about advanced aviation concepts. Ten of the sentences were simple, base sentences. These sentences were formatted to be similar to those used in the Ellis et al. study, (1984) but were related to advanced aviation concepts. An example of a base sentence might be, "Wing mounted vortex generators reduce the drag caused by supersonic airflow." After reading all sentences, the student was later presented with the same sentence, and the word "Wing" missing. The student was then required to guess the word "Wing" in place of the blank line. The remaining 10 sentences were elaborated sentences. The elaborated items included each base sentence, plus a phrase that served to make the target word more distinctive. An example of the elaborated sentence would be, "Wing mounted vortex generators reduce the drag caused by supersonic airflow over the portion of the wing." In this sentence, the word "Wing" was thought to be easier for the student to remember, because the elaborated sentence included the word "wing" at the end of the sentence.

Screening Procedure

Before initiating the mood induction procedure, participants were asked to complete a Beck Depression Inventory (1967) in order to test for signs of pre-test depression. The Beck Depression Inventory is composed of 21 questions, each related to emotional state. After each question, a group of four statements follow. These four statements describe a range of feelings that are combined with numerical values. Higher numerical values (2, 2, 3) represent more depressed feelings, such as, "I am so sad or unhappy that I can't stand it," while lower numbers (0,1) represent non-depressed feelings such as, "I do not feel sad." Instructions for completing the inventory were displayed on the screen in front of the classroom via the PowerPoint presentation. Following the completion of the Beck Inventory, the forms were examined and the scores of the inventory were totaled. If any participants had received a score higher than 20, they would have been excused from the study. The screening was done to ensure that students were not depressed at the onset of the study.

Mood Induction and Assessment

Student pilots were induced into a negative mood state or left in a neutral mood state with the use of the Velten Mood Induction procedure (Velten, 1968). For this procedure, students read a series of 40 cards at regular 15-second intervals (as prompted by an audible beeping noise). One group of students read cards with negative self-statements, while the other group read cards with neutral statements. After reading through all 40 cards, a Depression Adjective Checklist (DACL; Zuckerman & Lubin, 2001) was handed out to each student. The checklist was used in order to ensure that each student was induced into the expected mood state before the learning procedure began. Before reading the statements, all students were

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DOI: https://doi.org/10.15394/jaaer.2003.1566

informed that the sentences might influence their mood. They were also told that they were free to terminate their participation in the experiment at any time if they wished.

Design and Analysis

The current experiment was set up as a 2 x 2, nitty factorial, mixed design. The first set of conditions involved either a student pilot experiencing an induced negative mood state, or a student pilot who was in a neutral mood state. The second set of conditions involved a series of two types of sentences. The first 10 sentences served as base sentences from which the student pilot was required to remember a missing word. The second set of sentences included the elaborated sentence, in order to give a better indication of the missing word. All participants read the same sentences and completed the same memory tests. This allowed the two hypotheses to be tested. The mood-induction cards were handed out to each student face down after being shuffled. This attempted to ensure that the design was randomized in selecting individuals for the neutral or negative mood condition. The independent variables in the experiment included type of sentence (base vs. elaborated) and mood state (negative or neutral). The dependent variable in the study was memory ability.

A power analysis was performed prior to initiating the study by using the results obtained from the Ellis, et al., (1984) data in order to estimate optimal sample size needed to maximize the probability of obtaining statistically significant results for the present study (Cohen, 1988). The power analysis indicated that a power value of 0.93 was achieved with the use of 40 participants when sentences were shown for 10-second intervals. The 0.93 value was achieved when alpha was set at .05. In addition, all possible pair wise comparisons were made. Although a power value of .80 is normally suggested for statistical data collection, it was decided that a higher power value and a slightly larger sample size would strengthen the experiment. Although the Ellis, et al. (1984) study was conceptually the same as the current experiment, the two tests were methodologically different. This was due to the fact that the current study used aviation- based sentences, rather than typical, "every day" sentences as used by Ellis and colleagues (1984).

Procedure

Upon arriving at the testing site, participants were given a consent form to sign. The form reminded students that they were free to leave the test at any time if they felt uncomfortable. Moreover, the consent form contained a reminder that the individual would not have his/her name related to any of the findings in the study. After signing the consent form, students were individually given a form to complete which contained questions concerning personal information such as age, gender, flight level, medical certification and knowledge of complex aircraft performance and operations. The personal survey was combined with a designated number that the student pilots were told to write on the top of each paper (for tracking purposes). This survey was then completed and handed back to the experimenter. Next, students were given a copy of the Beck Depression Inventory (1967) to complete. No students received a score of 20 or higher, thus none were excused from participation in the experiment.

In the next phase of the study, Velten Mood induction cards were individually handed out to each participant, faced down. Students were instructed to read the top card several times until hearing a bell ring. At 15-second intervals, the bell would ring, prompting the students to switch to the next card. After 10 minutes, all mood statement cards had been read by the students. At this point, the Depression Adjective Checklist was handed out. Students completed the checklist, and each paper was collected. This took approximately three minutes. In the next stage of the experiment, the learning session began. A mixture often base sentences and ten elaborated sentences were presented individually and randomly on the overhead screen for a period of 10 seconds each. Students were instructed to read each sentence, and were advised to refrain from taking notes.

After the teaching session, students were instructed to complete a series of simple math problems (addition and multiplication) for one minute. This was to ensure that the students were not rehearsing the previously viewed sentences. After completing the math problems, students were given the final test in which the target word was missing. Participants were told that they would see each of the previously viewed sentences again, but that each sentence would contain a blank line in which a target word had been left out. They were also told that they may use the same word more than once, and that guessing was encouraged. Each sentence was then displayed for 10 seconds, but the order in which the sentences were presented was randomized. The participants were asked to recall and record the missing word.

Mood Induction

Post Testing

After all tests were completed, each participant was given 10 note cards that contained positive Velten Mood Induction statements. These cards were again read at 15-second intervals via the prompting of an audible beep. Before leaving the test site, an abbreviated version of the Beck Depression Inventory was completed by each student pilot. The experimenter checked to ensure that each participant did not depart the testing environment in a depressed mood state. Participants were then thanked and dismissed.

RESULTS

Data

The data from the dependent variable (Memory Score) was collected for the forty participants. This data was divided between the levels of the independent variable (Mood or Sentence Type,) and the data were summarized (see Table 1). Results were tested for significance and effect size using a repeated measures analysis of variance (see Table 2).

Table 1. **Descriptive Statistics**

Mood	Sentence Type	N	Mean	Std. Deviation
Neutral	Base	20	6.05	1.57
	Elaborative	20	6.40	1.85
	Total	40	6.22	1.70
Negative	Base	20	3.90	1.29
	Elaborative	20	4.10	1.48
	Total	40	4.00	1.38

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DOI: https://doi.org/10.15394/jaaer.2003.1566

Table 2. **Analysis of Variance of Mood vs. Sentence Type on Recall**

	Sum of Squares	Degrees of Freedom	Mean Square	F	Sig-
Mood	99.01	(1,38)	99.01	23.45	.00
Sentence Type	1.51	(1,38)	1.51	2.31	.14
Mood*Type	.11	(1,38)	.11	.17	.68

Target Word Recall

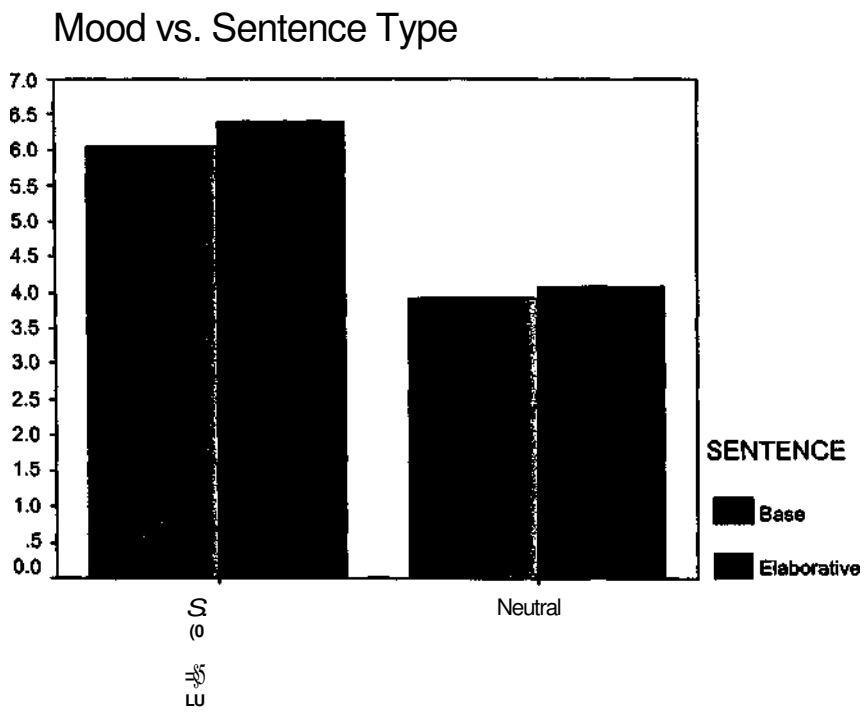
The results indicated that the subjects in the negative mood state recalled fewer target words than the subjects in the neutral mood state, *F(*\, 38) = 23.45, /K.001, eta squared = .38. There was not, however, a significant interaction between the recollection of words in the base vs. elaborative sentences, *F(l,* 38) = 2.31, *p* = .137, eta squared = .057. Likewise, there was no significant interaction between mood and sentence type, *F(l,* 38) = .046, *p*= .681, eta squared = .005.

Mood-Induction Procedure

The success of the Velten Mood Induction procedure was confirmed with the scores of the DACL. The participants in the neutral mood state had an average score of 5.85 on the DACL, while the participants in the negative mood state had an average score of 11.2. This difference was shown to be significant, /^l.SS) = 27.401, /K.001.

Beck Screening

The average Beck Inventory (1967) scores for both groups of participants was 5.0 upon initial testing. This indicates that there were no real differences between the mood-states of each group upon beginning the study. All participants received a score lower than 20 on the initial Beck Inventory (1967); therefore, none of the participants were excluded from the study because of high scores.



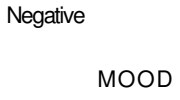


Figure L **Graph showing recall of target words from elaborated and base sentence types.**

https://commons.erau.edu/jaaer/vol13/iss1/8
DOI: https://doi.org/10.15394/jaaer.2003.1566

Mood Induction

DISCUSSION

The results of the data indicate that a negative mood state had a significant impact on student pilots' ability to remember complex aviation sentences. This was shown by the significant difference in correct answers produced by the students in the neutral and negative mood states. The average score of the student pilots in the negative mood was significantly lower that that of the student pilots in the neutral mood These results indicate that a negative mood state does have an effect on a student pilot's ability to recall aviation-related material.

While the Ellis et al. (1984) study showed that a negative mood state effected college students and their ability to retain words from simple sentences, this study showed that the same effect occurred when using student pilots and discipline-specific, advanced-level, aviation concepts. This supports the theory that the mind of an individual will likely not retain as much information when under the burden of negative thoughts. This study indicates that the theory may hold true for a variety of learning situations. Student pilots seem to be affected by a negative mood state in much the same way that a typical college student is affected by a negative mood state. Both groups have been shown to have trouble retaining information

In comparing base and elaborated aviation sentences, however, there does not seem to be a significant effect on recall. Students remembered the missing target word in the aviation sentences similarly for both the base and elaborated sentence structures. This may be due to the fact that the study was performed using advanced, technical sentences, rather than sentences based on simple concepts. While the Ellis et al. (1984) study showed that there was a difference in a student's ability to remember a target word in a base versus elaborated sentence, the sentences he was using were based on general knowledge (opening doors, etc.) Likewise, the elaborated sentences may have helped to produce a visual image in the mind of the student in order to help with memory retention. In this study, aviation concepts were used. Due to the highly technical content of the material, the elaborated sentences did not likely help to produce a visual picture in the mind of the student pilot It may be that aviation material must be remembered for its conceptual ideas, rather than remembered by a simple elaboration of the sentence. This point would need to be examined with further research and testing.

Although the FAA warns flight instructors about teaching a student pilot who is not in a positive mood state for learning, the idea has never been tested in the past. The present research supports the belief that a negative mood state will hinder a student pilot's ability to learn the ground-based material required to become a private pilot. This research may be helpful to aviation ground instructors and certified flight instructors who wish to explain the importance of a positive mental state to their students. If these results are supported by future research, it may be advisable to include information about mood state and learning in training for flight instructors, such that they can assess, and perhaps alter, mood states in their students prior to ground school training sessions. If both students and instructors understand the possible consequences of attempting to learn while in a negative mood state, steps may be taken to avoid this situation. In turn, this may increase the productivity of the learning process and the overall safety of flight training. •>•

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https://commons.erau.edu/jaaer/vol13/iss1/8
DOI: https://doi.org/10.15394/jaaer.2003.1566

Mood Induction

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