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Enhancing Pilot Training Through Virtual Reality: Recognizing and Mitigating Aviation Visual and Vestibular Illusions

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Aviation illusions pose significant challenges to flight operations and have been a prevalent concern in the aviation industry for many years. These illusions are caused primarily by sensory misinterpretations, leading pilots to misperceive the motion or orientation of their aircraft (FAA, 2016; FAA, 2011; FAA, 1983). Consequently, pilots may make critical errors during flight, jeopardizing safety and leading to potentially catastrophic consequences (FAA, 2011; Sánchez-Tena et al., 2018). Most aviation illusions are experienced during adverse weather conditions, low visibility, and high-stress situations (FAA, 2016; FAA, 1983, FAA, n.d.). Illusions arise due to the complex interaction between the human sensory system and the dynamic nature of flight. Some of the most prevalent aviation illusions include the Coriolis illusion, False Horizon illusion, Autokinetic illusion, and Inversion illusion (FAA, n.d., Sánchez-Tena et al., 2018). The significance of these illusions lies in their ability to deceive pilots and compromise their situation awareness.

Pilot errors arising from aviation illusions can have severe consequences. When pilots misinterpret their aircraft's orientation or motion, they may inadvertently make incorrect control inputs, exacerbating the situation and leading to loss of control (FAA, 2016; Sánchez-Tena et al., 2018). The consequences of such error may include loss of spatial orientation, controlled flight into terrain (CFIT), loss of control, a near miss, or reduced decision-making ability. Therefore, to mitigate these aviation illusions, effective pilot training plays a pivotal role in recognizing, managing, and mitigating aviation illusions (FAA, 2016; Sánchez-Tena et al., 2018). Aviation training programs should incorporate comprehensive education on the types of illusions, their causes, and the techniques to counteract their effects. Key components of such training are rooted in awareness, simulation training, and aeronautical decision-making (Saastamoinen & Maunula, 2021).

Given current technological advances, Virtual Reality (VR) has become a tool utilized in flight training to enhance the learning experience and pilot proficiency (Thomas et al., 2022; Thomas et al., 2021). The cost-effectiveness of VR training significantly reduces the expense associated with traditional flight training, as it eliminates the need for actual aircraft and physical infrastructure. For instance, the medical field has proven that safety is improved through risk-free practice in simulation environments (Mitha et al., 2013; Scalese et al., 2008). VR allows pilots to build confidence and skills before transitioning to an aircraft. VR training is accessible and flexible, accommodating individual learning needs and busy schedules. Additionally, VR enables exposure to uncommon situations, such as aviation illusions, fostering critical decision-making and problem-solving skills. Furthermore, the reduced environmental impact, via fewer physical flights, contributes to sustainability. VR training complements real-world flight experience (Thomas et al., 2022) and continues to evolve, promising further benefits to the aviation industry. The purpose of this study is to continue to investigate the usability of Virtual Reality (VR) software and supporting devices as a visual illusion and spatial disorientation trainer while using a motion platform.

Literature Review

Experiential training in simulation has emerged as a highly efficacious andragogical approach, particularly in the context of aviation education and flight training. Foremost, the integration of flight simulators in pilot training curricula provides an unparalleled risk-free environment for learners to develop and refine their aeronautical skills (Lee, 2016; Ng & Chu, 2021). By simulating realistic flight scenarios, including adverse weather conditions, emergency situations, and system failures, pilots can acquire hands-on experience without incurring the inherent hazards of live flight operations (McDermott, 2007; Risukhin, 2015). This bolsters confidence/competence among trainees, thereby fostering a heightened sense of safety.

The remarkable authenticity of contemporary flight simulators is another pivotal asset in enhancing the experiential learning of flight students. These sophisticated training platforms meticulously replicate flight deck configurations, aircraft controls, and flight dynamics, providing learners with a heightened sense of immersion (Allerton, 2009). The faithful reproduction of real-world flight conditions facilitates the development of muscle memory and reflexes, both of which are crucial for optimal performance in urgent circumstances (Allerton, 2009; Baarspul, 1990), such as visual illusions. The repeatability inherent to flight simulators serves as a key catalyst for skill augmentation. Simulators' iterative nature of practice enables trainees to revisit specific scenarios, enhancing their decision-making acumen and refining their response to complex challenges (Risukhin, 2015). The merits of simulation-based training extend beyond the domain of routine flight procedures. Pilots can be exposed to rare or atypical scenarios, which, though infrequent, demand deftness and adeptness. Simulation training imparts valuable experiential knowledge by immersing pilots in these uncommon situations, effectively equipping aviators to tackle exigent events with poise and proficiency (Allerton, 2009; Baarspul, 1990; Lee, 2016).

Experiential training in simulation exemplifies a highly advantageous approach for pilots seeking to augment their aeronautical prowess. The unification of risk-free learning, realistic replication, cost-effectiveness, scenario repeatability, and adaptability create a holistic and immersive training experience (Lee, 2016; Towne et al., 2012). Incorporating VR experiences has emerged as a compelling alternative to traditional simulation training, further enhancing pilots' learning experience as technology advances (Coyne et al., 2017; Macchiarella & Mirot, 2018; Thomas et al., 2021). VR offers a new dimension of realism and immersion, elevating the benefits of experiential training to unprecedented levels.

By leveraging VR technology pilots can delve into highly realistic and interactive virtual environments, mirroring real-world scenarios with remarkable

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fidelity. The heightened sense of presence and engagement facilitates a deeper connection with the training content, leading to accelerated skill development and improved decision-making under pressure (Jentsch et al., 2011; Lee, 2016). VR maintains the risk-free environment inherent to traditional simulation and offers enhanced adaptability and versatility. VR scenarios can be customized and adjusted to address specific training needs, allowing for a personalized learning journey tailored to individual pilot needs (Wood et al., 2021; Zahabi & Abdul Razak, 2020). This level of flexibility empowers pilots to focus on areas that require further refinement, such as aviation illusions, resulting in more efficient and practical training. Additionally, the cost-effectiveness of VR-based training augments its appeal. By reducing expenses associated with physical simulator maintenance and operational logistics, VR experiences offer a financially viable solution for pilot training without compromising quality or realism (Guthridge & Clinton-Lisell, 2023). The cost efficiency broadens access to advanced training opportunities, benefiting aspiring and experienced pilots seeking to hone their skills.

Knowledge Gain and Self-Efficacy Improvement from VR Training

VR pilot training adopts a comprehensive strategy that fosters self-confidence and knowledge acquisition using a blend of immersive learning settings, instant feedback, customized guidance, and safe practice (Lee, 2016; Ng & Chu, 2021). Through lifelike and deeply engaging simulations, pilots are fully immersed and feel actively engaged, enabling them to tackle diverse aviation challenges with the same sense of realism as they would in actual flight scenarios (Guthridge & Clinton-Lisell, 2023; Thomas et al., 2021). This heightened sense of realism fosters self-efficacy by building pilots' confidence in their abilities to handle complex maneuvers, procedures, and visual illusions (Thomas et al., 2022). Additionally, the repetitive practice afforded by VR training enhances skill acquisition and procedural memory, resulting in improved performance and competence (Guthridge & Clinton-Lisell, 2023).

The risk-free learning environment of VR training is instrumental in bolstering self-efficacy among pilots. Pilots can safely explore their limits, make mistakes, and learn from them without fearing real-world consequences. This process of trial and error, combined with immediate feedback, enables continuous learning and skill refinement, ultimately reinforcing the pilot’s belief in her/his capabilities (Guthridge & Clinton-Lisell, 2023). Furthermore, the tailored nature of VR training ensures pilots receive instruction and challenges that match their individual needs and skill levels, promoting a sense of competence and achievement. Guthridge and Clinton-Lisell (2023) argue that VR training "[…] allows the student to progress through their flight training more efficiently (with less total time to obtain their certificate or rating)" (p. 13). The adaptability of the training instills in pilots the perception that they are making progress and becoming proficient in their tasks, further enhancing their self-efficacy and motivation to excel in their aviation endeavors. Ultimately, integrating these factors in VR pilot training provides a powerful platform for promoting self-efficacy and knowledge gain among pilots, positioning them to thrive in the dynamic and challenging world of aviation.

In summary, the cognitive engagement fostered by VR training, through its interactive nature, keeps pilots mentally focused and actively participating in the learning process. This active engagement leads to better information retention and understanding of aviation concepts and procedures. When pilots perceive the successful transfer of skills from VR simulations to real-flight operations, it reinforces their knowledge gain as they witness the practical benefits of their training (Guthridge & Clinton-Lisell, 2023). It then becomes the responsibility of the higher education institutions with aviation programs to invest in these technologies to produce the best-prepared workforce.

Methodology

Embry-Riddle Aeronautical University (ERAU) subject matter experts and the Extended Reality Lab developed the Virtual Reality Aviation Illusion Trainer (VRAIT) software program to provide users with a complete VR experience and training on visual and vestibular illusions (Thomas et al., 2022; Thomas et al., 2023). This study was conducted using the VRAIT software, and participants from ERAU’s Daytona Beach Campus and the local area were at least 18 years old. Participants were recruited using emails and posters. All participants met one-on-one with one of the researchers for the entire duration of the study. Participants were seated at a desk and used a desktop computer to complete the pre- and post-training questionnaires and surveys.

At the beginning of the study, upon entering the lab, participants were presented with the informed consent form, along with a medical release form, which was approved by the ERAU’s Institutional Review Board and Legal Department [IRB# 23-032]. The researcher presented these forms on paper to the participants. After the participants agreed to participate and signed the consent form, they were provided with a Demographic Questionnaire, a Pre-Training Knowledge Test, and a Pre-Training Self-efficacy questionnaire, which were administered electronically via Microsoft Forms. The Demographic Questionnaire included information such as flight experience, ratings, and certificates held. The knowledge test (Appendix B) assessed participants' understanding of illusions, while the self-efficacy questionnaire (Appendix A) prompted participants to rate their confidence in defining, recognizing, and describing each illusion.

The VR system utilized was the Valve Index Headset. Participants were then briefed on how the VR equipment functioned and what would be expected from the training session. Participants were then given a safety briefing on the motion simulator, which is located in ERAU’s College of Aviation’s Spatial Disorientation Lab. The motion device was the Force Dynamics 401cr Motion

Simulator, a full-motion flight simulator with four degrees of freedom: pitch, roll, heave, and 360° of continuous yaw (figure 1). The 401cr uses a variety of existing popular flight simulator software titles, with or without a virtual reality component, in addition to custom-made applications by ERAU's Extended Reality Lab. The 401cr motion system provides a large range that simulates forces, delivers high-impact acceleration, and has a best-in-class frequency response that helps eliminate motion sickness.

Figure 1

Force Dynamics 401cr Motion Simulator at Embry-Riddle Aeronautical University's Daytona Beach Campus with the Occupant Wearing VR headsets

On average, each participant spent 90 minutes completing the experiment, which included an optional intermission at the halfway point. Participants were exposed to 12 aviation illusions during the experiment, as detailed in Table 1. Six of these illusions required participants to experience a spinning motion to elicit a vestibular illusion. The sequence of illusions was alternated to prevent sensory overload, creating a short break from spinning between each vestibular illusion. The vestibular illusions varied in duration, spanning from four to six minutes each. The rotation time allocated to each vestibular scenario was approximately two minutes. Across the entire 60-minute virtual reality session, participants experienced approximately 12 minutes of spinning in total.

Table 1
VRAIT Sequence and Timing

Illusion Number	Illusion	Time (minutes)
1	Runway Width[a]	5
2	Coriolis[b]	4
3	Sloped Runway[a]	5
4	Leans[b]	6
5	Black Hole[a]	4
6	Graveyard Spiral[b]	5
	Intermission	10
7	False Horizons Day[a]	6
8	Nystagmus[b]	4
9	False Horizons Night[a]	5
10	Oculogyral[b]	4
11	Autokinesis[a]	4
12	Somatogravic[b]	4

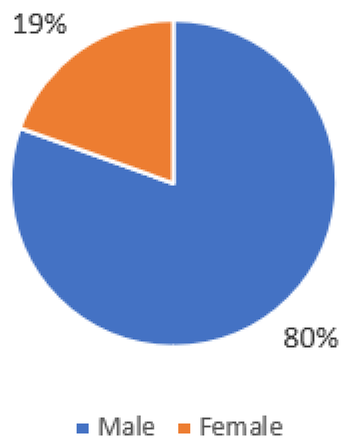
Note. [a] denotes illusions are visual illusions. [b] denotes illusions are vestibular illusions.

After the VR session, participants first completed the Simulator Sickness Questionnaire (SSQ) (Kennedy et al., 1993) to assess the possibility and severity of discomfort or any physical illnesses that arose from the virtual reality simulator sessions. Next, participants completed the post-training knowledge test, post training self-efficacy questionnaire, and the Training Satisfaction Survey (TSS). The TSS will measure the enjoyment of the participants as well as their technological satisfaction (Domingo et al., 2023).

Results

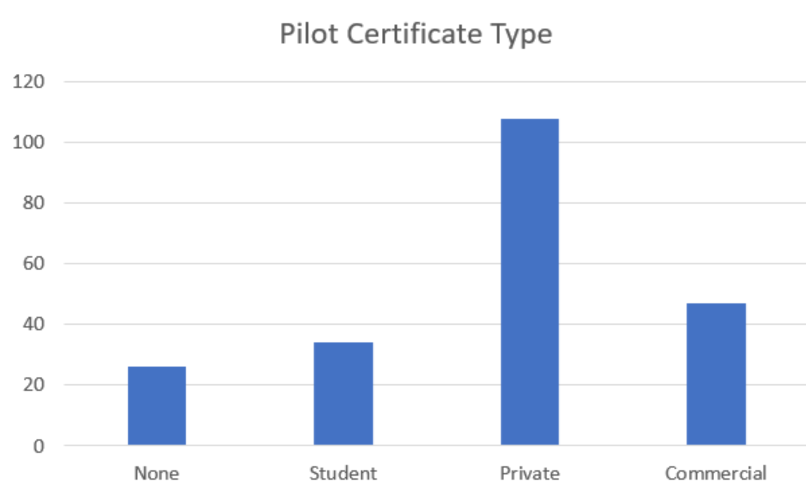
The sample of $N = 215$ participants completed the study. The participants were Embry-Riddle Aeronautical University-Daytona Beach Aeronautical Science students. Among the 215 participants, 173 (80.5%) identified as male, while 42 (19.5%) identified as female (figure 2).

Figure 2
Gender of Participants



Out of the 215 participants, 26 (12.1%) held no pilot certification, 34 (15.8%) were student pilots, 108 (50.2%) had private pilot certifications, and 47 (21.9%) held commercial pilot certifications (figure 3).

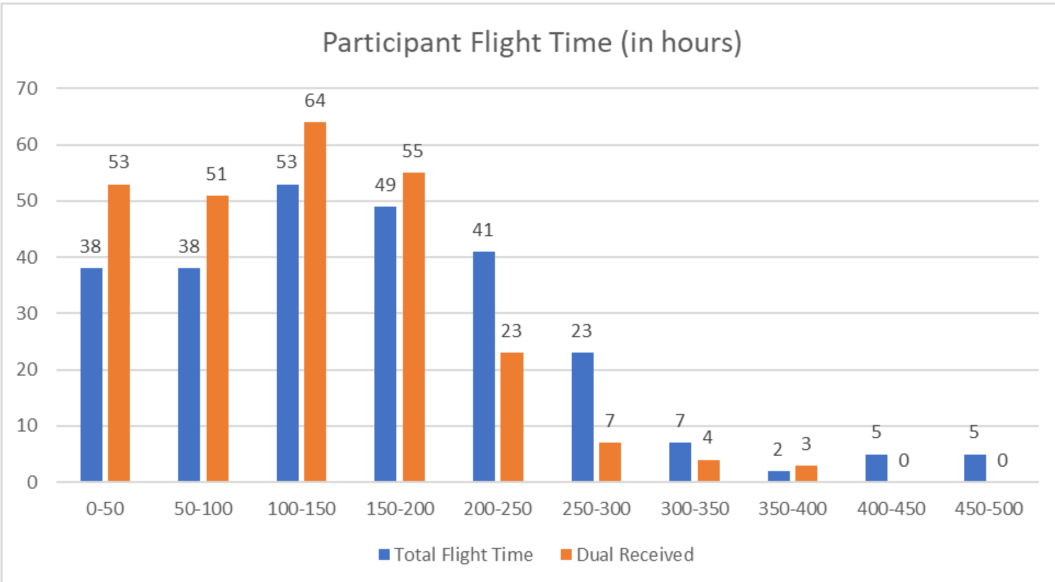
Figure 3
Frequency of Pilot Certificate Type of Participants



The participants' ages ranged from 18 to 32 with a mean of $M = 21.06$, $SD = 2.324$. Of the participants, 122 (56.7%) held an Instrument Rating, and 12 (5.6%) held a flight instructor certificate. The reported flight time of the participants ranged from zero to 500 with a mean flight time of $M = 149.52$, $SD = 103.15$. The dual received time (training hours flown with a flight instructor) of the participants ranged from zero to 380 with a mean time of M = 116.18, SD = 79.65 (figure 4).

Figure 4

Frequency of Participants Flight Time



Paired sample t-tests were conducted to assess the impact of the VR motion simulator illusion training on participants' pre-training and post-training knowledge scores as well as their self-efficacy scores. Knowledge test scores improved after VR motion simulator illusion training. Out of a maximum score of 100, pre-training knowledge scores (M = 64.36, SD = 12.71) compared to post-training knowledge scores demonstrated increased scores after the training (M =79.41, SD = 15.02). The paired sample t-test showed a significant increase in knowledge scores, $t(214) = -12.433$, $p < .001$, with a large effect size indicated by Cohen's d = 0.848 (Table 2). Self-efficacy scores also improved after training. Out of a maximum score of 10, self-efficacy scores increased from pre-training (M = 5.50, SD = 2.01) compared to scores after the training (M =8.31, SD = 1.55). The paired sample t-test showed a significant increase in knowledge scores, $t(214) = -17.712$, $p < .001$, with a large effect size indicated by Cohen's d = 1.208 (Table 2).

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Table 2
Paired Sample t-Test results

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval Lower	Upper			
Self-Efficacy Pre vs Post	-2.81	2.33	0.16	-3.12	-2.50	-17.712	214	<0.001
Knowledge Score Pre vs Post	-15.05	17.75	1.21	-17.44	-12.67	-12.433	214	<0.001

The simulator sickness questionnaire (SSQ) was used to evaluate participant’s simulator sickness after the training. After training, participants reported an average nausea level of 34.91 (*SD* = 33.92), with the minimum and maximum values being 0.00 and 152.64, respectively. Similarly, participants' average oculomotor discomfort level was 40.35 (*SD* = 30.80), ranging from a minimum of 0.00 to a maximum of 128.86. In terms of disorientation, the average level reported was 55.74 (*SD* = 55.88), with a minimum of 0.00 and a maximum of 250.56. The overall simulator sickness experience had an average value of 48.57 (*SD* = 40.29), with values spanning from 0.00 to 172.04. Of the 16 factors measured by the SSQ, only three symptoms had values of note:

1. Thirty-five percent (35%) of the participants reported feeling moderate to severe eyestrain.
2. Twenty-five percent (25%) reported feeling moderate to severe levels of general discomfort.
3. Twenty-five percent (25%) reported feeling moderate to severe levels of fatigue.

The Training Satisfaction Survey used a 5-point Likert scale to assess how participants enjoyed the training and their technological satisfaction. The participants’ mean enjoyment score was *M* = 4.14, *SD* = 0.73, and the mean technological satisfaction score was *M* = 4.35, *SD* = 0.61.

Discussion

The primary objective of this study was to assess the effectiveness of a motion-based visual and vestibular illusion training session. The study results indicate a significant improvement in both knowledge and self-efficacy scores following the training. This noteworthy increase in scores indicates that the application of virtual reality (VR) training, incorporating visual and vestibular illusions, holds promise as a practical training approach to develop a deeper understanding of complex concepts and boost learners' confidence. The statistically significant increases in both knowledge and self-efficacy scores provide compelling evidence in support of the efficacy of this specific training approach. These results align with the underlying principles of using immersive environments to simulate real-world scenarios and create impactful learning experiences.

Furthermore, the study's findings regarding simulator sickness are notable. The low incidence of simulator sickness reported by participants suggests that the training's duration and the order of presented illusions were well-tolerated. Although some effect was observed (eyestrain, general discomfort, fatigue) due to the time frame and sequence of illusions, it is significant that none of the participants experienced discomfort to the extent that would lead them to terminate the training prematurely. This aspect is crucial for successfully implementing training sessions, ensuring that participants remain engaged and complete the intended program without adverse effects. Additionally, participants' Training Satisfaction Scores (TSS) scores indicated that they enjoyed the training and were satisfied with the technology used to present the experience.

Practical Applications

Introducing visual and vestibular illusions to pilots is integral to pilot training. The diverse training locations and weather conditions necessary to illicit these illusions in the real-world may pose challenges, making it difficult or even impossible to replicate consistently. The VRAIT can be used to provide pilots with a more standardized training session in virtual locations where the illusions are guaranteed to occur. This immersive training experience, coupled with narrated instruction, has been shown to be effective in enhancing both knowledge and self-efficacy.

Limitations

The sample of data was collected using volunteers from the student population at Embry-Riddle Aeronautical University-Daytona Beach Campus. Therefore, generalizability to the entire general aviation population may be limited. Additionally, only one type of VR headset and motion platform was used in this study. Other VR headsets or motion platforms may have different results. Consequently, the extent to which these findings can be applied to the broader general aviation community may be restricted.

Future Research

Future research is recommended on VRAIT by obtaining a larger sample of the general aviation population to complete the training to obtain data and report more generalizable results. In addition, more fine-tuning of the scenarios to maximize the effectiveness of the vestibular illusions can be done to ensure participants get the most of out of the experience. Lastly, other VR headsets with higher resolution can be tested to determine how headset resolution affects scores.

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Conclusion

The study demonstrated the potential of motion-based visual and vestibular illusion training in promoting learning outcomes, as evidenced by improved knowledge and self-efficacy scores. The minimal occurrence of simulator sickness further strengthens the argument for the feasibility and acceptability of this training approach. These findings contribute to the growing body of research on immersive VR training methods and highlight their value in enhancing educational experiences and minimizing adverse effects. Future research could delve deeper into optimizing specific training elements to maximize their effectiveness while maintaining a favorable participant experience.

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Appendix A: Pre and Post Training Self-Efficacy Survey

Please rate your degree of confidence by recording a number from 0 (no confidence) through 10 (absolute confidence) of how confident you think you are at the following items relating to illusions.
Rate each of the 3 statements for all 12 illusions

1. Runway Width
2. Coriolis
3. Sloped Runway
4. Leans
5. Black Hole
6. Graveyard Spiral
7. False Horizons Day
8. Nystagmus
9. False Horizons Night
10. Oculogyral
11. Autokinesis
12. Somatogravic

1. I can define the illusion.
2. I can recognize the illusion in flight.
3. I describe how to prevent/mitigate the effects of the illusion.

Appendix B: Pre and Post Training Knowledge Test

VRAIT Pre-Training Knowledge Test (22 Questions)

1) A wide runway width compared to a normal runway width will give the pilot the illusion of being:
   a) Higher than actual altitude
   b) Lower than actual altitude
   c) No illusion will be felt

2) Runway width illusions are least prevalent:
   a) At 300 feet on final approach
   b) Just before touchdown
   c) During the flare

3) A down sloping runway (when compared to a non-sloped runway) will make the pilot feel like they are_on the approach.
   a) High
   b) Low
   c) Fast

4) The down sloping runway illusion is dangerous because it could lead the pilot to:
   a) Make a long landing
   b) Land short of the runway
   c) Approach faster than expected

5) What danger can pilots face when trying to align themselves with stars or the shoreline?
   a) Encountering icing
   b) The shoreline or stars not being level with the actual horizon
   c) Getting too close to the clouds while flying in VFR

6) What should pilots avoid using for aligning themselves with the horizon?
   a) The PFD Attitude Indicator
   b) The shoreline or other prominent landmarks
   c) The Standby Attitude Indicator

7) The Autokinesis illusion is least likely to occur when flying:
   a) During the dark
   b) During the day
   c) At night

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8) The Autokinesis illusion causes a nearby light to appear to
   a) Blink
   b) Move
   c) Dim

9) While performing an approach into an unlit area, the pilot is more susceptible to:
   a) Landing short of the runway
   b) Making a long landing
   c) Flying a faster approach

10) Where would a pilot be least likely to experience the Black Hole Illusion?
    a) In a highly populated city at night
    b) In a sparsely populated city during the day
    c) In a sparsely populated city at night

11) Which action will result in a pilot experiencing the Coriolis Illusion:
    a) Rapid descent
    b) Takeoff
    c) Extended turning

12) Coriolis illusion is felt when the fluid in the inner ear:
    a) First starts moving
    b) The fluid moves at the same speed as the turn
    c) The fluid changes direction

13) A pilot will experience the leans under what type of turning conditions:
    a) Gradual and prolonged
    b) Sudden and abrupt
    c) Slow and coordinated

14) When a pilot levels the wings after experiencing the leans it will feel like they are:
    a) Banking in the direction of the turn
    b) Banking in the opposite direction of the turn
    c) Pitching up

15) Which conditions increase the likelihood of entering a graveyard spiral:
    a) Night or IMC
    b) Clear VFR days
    c) Turbulent air

16) What should pilots rely on to prevent a graveyard spiral:
    a) Sight picture
    b) Instruments
    c) Proprioception

17) Abrupt or extreme movements that cause the eyes to have trouble focusing is:
    a) Nystagmus
    b) Graveyard spiral
    c) The leans

18) To recover from Nystagmus you should:
    a) Continuously scan your field of vision
    b) Look outside till the sensation is gone
    c) Focus on aircraft control

19) The oculogryal illusion occurs when a pilot perceives:
    a) A stationary object turning with the aircraft
    b) A stationary object constantly moving
    c) A stationary object disappearing from horizon

20) To prevent the oculogryal illusion a pilot should:
    a) Rely on instruments only
    b) Continuously scan inside and outside the cockpit
    c) Fixate on one point outside of the cockpit

21) What should a pilot do when experiencing the somatogravic illusion after takeoff:
    a) Push the nose down
    b) Verify aircraft position with instruments and respond accordingly
    c) Pitch for straight and level

22) The feeling of having the aircraft in an excessive nose up attitude after takeoff is:
    a) Somatogravic illusion
    b) Autokinesis
    c) Graveyard Spiral

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VRAIT Pre-Training Knowledge Test Answers

1. B
2. A
3. B
4. A
5. B
6. B
7. B
8. B
9. A
10. B
11. C
12. C
13. A
14. B
15. A
16. B
17. A
18. C
19. A
20. B
21. B
22. A

VRAIT Post Training Knowledge Test (22 Questions)

1) A narrow runway width compared to a normal runway width will give the pilot the illusion of being:
   a) Higher than actual altitude
   b) Lower than actual altitude
   c) No illusion will be felt

2) Runway width illusions are most prevalent:
   a) At 300 feet on final approach
   b) During the turn from base to final approach
   c) During the flare

3) An upsloping runway (when compared to a non-sloped runway) will make the pilot feel like they are____on the approach.
   a) High
   b) Low
   c) Fast

4) The upsloping runway illusion is dangerous because it could lead the pilot to:
   a) Make a long landing
   b) Land short of the runway
   c) Approach faster than expected

5) What danger can pilots face when trying to align themselves with a cloud layer?
   a) Encountering icing
   b) The cloud layer not being level with the actual horizon
   c) Getting too close to the clouds while flying in VFR

6) What should pilots use for aligning themselves with the horizon?
   a) A wide layer of clouds
   b) The Attitude Indicator
   c) The shoreline or other prominent landmarks

7) The Autokinesis illusion is most likely to occur when flying:
   a) In fog
   b) During the day
   c) At night

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8) The Autokinesis illusion causes a distant light to appear to:
   a) Fade away
   b) Move
   c) Become brighter

9) While performing an approach into an unlit area, the pilot is more likely to:
   a) Land short of the runway
   b) Make a long landing
   c) Fly a faster approach

10) Where would a pilot be most likely to experience the Black Hole Illusion?
   a) In a highly populated city at night
   b) In a sparsely populated city during the day
   c) In a sparsely populated city at night

11) For which action is there a risk of experiencing the Coriolis Illusion:
   a) Prolonged turns
   b) Approach to land
   c) Extended climbs

12) Which illusion is the result of the fluid changing direction in the inner ear:
   a) Coriolis
   b) Graveyard Spiral
   c) Autokinesis

13) Turning in which type of conditions is a pilot most likely to experience the leans:
   a) Sudden and abrupt
   b) Slow and coordinated
   c) Gradual and prolonged

14) When recovering from the leans the pilot should be aware that they will have which sensation:
   a) Pitching up
   b) Banking in the opposite direction of the turn
   c) Banking in the direction of the turn

15) Flying at night or in IMC increases the chances of:
   a) Runway Width Illusion
   b) Runway Slope Illusion
   c) Graveyard Spiral

16) What should pilots not rely on to prevent a graveyard spiral:
    a) PFD
    b) Standby instruments
    c) Proprioception

17) Pilots feel Nystagmus when:
    a) They struggle to read or focus with their eyes
    b) Feel the illusion of pitching up
    c) Gently turning in the opposite direction
18) When experiencing the Nystagmus illusion pilots should not:
    a) Focus on flying the aircraft
    b) Make small adjustments
    c) Continuously scan surroundings till vision returns

19) Having the feeling that a stationary object is moving with the aircraft is which illusion:
    a) Oculogrycal
    b) Coriolis
    c) Leans

20) If a stationary object appears to be moving with the aircraft, the pilot should:
    a) Focus on their instruments only
    b) Continuously scan inside and outside the cockpit
    c) Keep their view outside of the cockpit
    d)
21) If a pilot suspects they are experiencing the somatogravic illusion they should:
    a) Pitch down
    b) Fly straight and level
    c) Fly based on instruments

22) Somatogravic illusion is most likely to be experienced:
    a) During takeoff
    b) During landing
    c) In turns

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VRAIT Post-Training Knowledge Test Answers

1. A
2. C
3. A
4. B
5. B
6. B
7. C
8. B
9. A
10. C
11. A
12. A
13. C
14. B
15. C
16. C
17. A
18. C
19. A
20. B
21. C
22. A