

MODULE 09A

FOR B1 & B2 CERTIFICATION

HUMAN FACTORS

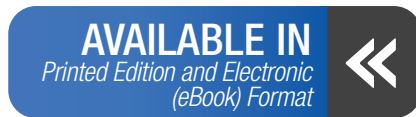
Aviation Maintenance Technician Certification Series



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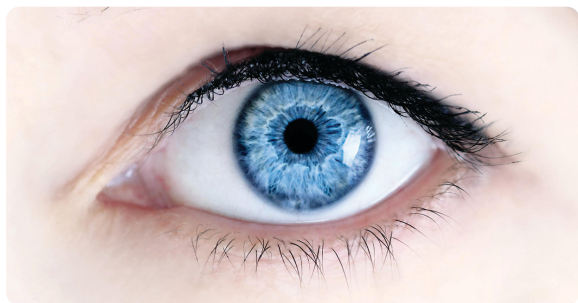
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- **Focused Attention:** the skill of focusing one's attention upon a single source and avoiding distraction.
- **Sustained Attention:** the ability to maintain attention and remain alert over long periods of time, often on one task.

Attention is influenced by arousal level and stress. This can improve attention or damage it, depending on the circumstances.



PERCEPTION

Perception involves the organization and interpretation of sensory data in order to make it meaningful, discarding irrelevant data. Perception is a highly sophisticated mechanism and requires existing knowledge and experience to know what data to keep and what to discard, and how to associate the data in a meaningful manner.

Perception can be defined as the process of assembling sensations into a usable mental representation of the world. Perception creates faces, melodies, works of art, illusions, etc., out of the raw material of sensation.

Examples of the perceptual process:

- The image formed on the retina is inverted and two dimensional, yet we see the world the right way up and in three dimensions.
- If the head is turned, the eyes detect a constantly changing pattern of images, yet we perceive things around us to have a set location, rather than move chaotically.

Having recognized coherent information from the stimuli reaching our senses, a course of action has to be decided upon. In other words, decision making occurs. Decision making is the generation of alternative courses of action based on available information, knowledge, prior experience, expectation, context, goals, etc., and selecting one preferred option. It is also described as thinking, problem solving and judgment.

This may range from deciding to do nothing, to deciding to act immediately in a very specific manner. A fire alarm bell, for instance, may trigger a well trained sequence of actions without further thought. Alternatively, an unfamiliar siren may require further information to be gathered before an appropriate course of action can be initiated.

Finally, once a decision has been made, an appropriate action can be carried out. Our senses receive feedback of this and its result. This helps to improve knowledge and refine future judgment by learning from experience.

If a task is performed often enough, it may eventually become automatic and the required skills and actions are stored in long term memory. These are known as motor programs and are ingrained routines that have been established through practice. The use of a motor program reduces the load on the central decision maker. An often quoted example is that of driving a car: at first, each individual action such as shifting is demanding, but eventually the separate actions are combined into a motor program and can be performed with little or no awareness.

These motor programs allow us to carry out simultaneous activities, such as having a conversation while driving. Although not shown explicitly in *Figure 2-10*, the process of attention, perception and judgment should result in awareness of the current situation.

Illusions of Perception

There are many well known visual 'illusions' which illustrate the limits of human perception. *Figure 2-11* shows how the perceptual system can be misled into believing that one line is longer than the other, even though a ruler will confirm that they are exactly the same. *Figure 2-12* illustrates that we can perceive the same thing quite differently (i.e. the letter "B" or the number "13"). This shows the influence of context on our information processing.

It is often necessary to consult documents with which the technician can become very familiar. It is possible that to scan a document and fail to notice that subtle changes have been made. You will only see what you expect to see. To illustrate how our eyes can deceive us when quickly scanning a sentence, read quickly the sentence in *Figure 2-13*.

At first, most people tend to notice nothing wrong with the sentence. Our perceptual system subconsciously rejects the additional "A".

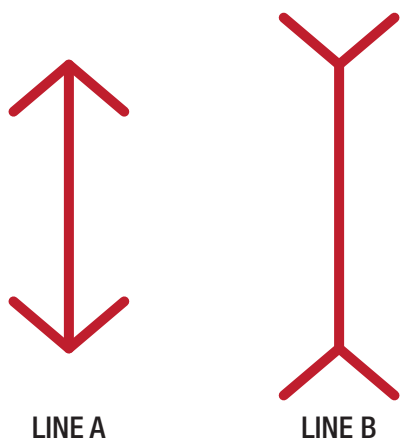


Figure 2-11. The Muller-Lyer Illusion.



Figure 2-12. An example of perception.



Figure 2-13. The effects of expectation.

As an illustration of how expectation can affect our judgment, the same video of a car accident was shown to two groups of subjects. One group was told in advance that they were to be shown a video of a car crash; the other was told that the car had been involved in a 'bump'. Both groups were asked to judge the speed at which the vehicles had collided. The first group assessed the speed as significantly higher than the second group.

Expectation can also affect our memory of events. The study outlined above was extended such that subjects were asked, a week later, whether they recalled seeing glass on the road after the collision. (There was no glass). The group, who had been told that they would see a crash, recalled seeing glass; the other group recalled seeing no glass.

Attention and perception shortcomings can clearly affect decision making. Perceiving something incorrectly may mean that an incorrect decision is made, resulting in an inappropriate action. *Figure 2-13* also shows the dependence on memory to make decisions. Sensory and short term memories have limited capacity, both in terms of capacity and duration. It is also important to bear in mind that human memory is fallible, so that information:

- May not be stored;
- May be stored incorrectly;
- May be difficult to retrieve.

The points above can be referred to as forgetting, which occurs when information is unavailable (not stored in the first place) or inaccessible (cannot be retrieved). Information in short term memory is particularly susceptible to interference, an example of which would be trying to remember a part number while trying to recall a telephone number.

Maintenance personnel must use manuals and temporary aides rather than to rely upon memory, even in circumstances where the information to be remembered or recalled is relatively simple. For instance, an AMT may remember a torque setting without writing it down, but between consulting the manual and walking to the aircraft (possibly stopping to talk to someone on the way), may forget the setting or confuse it (possibly with a different torque setting appropriate to a similar task with which he is more familiar). Additionally, if unsure of the accuracy of memorized information, you should seek

to check, even if this means going elsewhere to do so. Writing something down temporarily can avoid the risk of forgetting or confusing information. However, the use of a personal note book to capture such information on a permanent basis can be dangerous, as the information in it may become out of date.

Situation Awareness

Situation awareness is the synthesis of an accurate and up to date 'mental model' of one's environment and state, and the ability to use this to make predictions of possible future states. Situation awareness has traditionally been used in the context of the flight deck to describe the pilot's awareness of what is going on; for example, where are we geographically, what is our orientation in space, what mode is the aircraft in, etc.

In the maintenance technician's context, it refers to:

- The perception of important elements, for example, seeing loose bolts, missing parts, leaking fluids, and hearing information passed verbally.
- The comprehension of their meaning, for example, why is it like this? Is this how it should be?
- The projection of their status into the future, for example, future effects on safety, schedule, and airworthiness.

Situation awareness for an AMT can be summarized as:

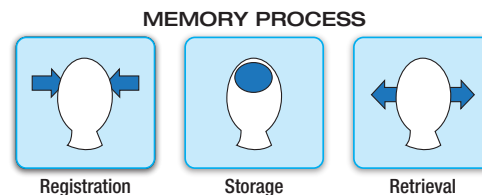
- The status of the system that is being worked on.
- The relationship between the reported defect and the intended rectification.
- The possible effect on this work on other systems.
- The effect of this work on that being done by others and the effect of their work on this work.

A proportion of 'sensed' data may be lost without being 'perceived'. An example with which most people are familiar is that of failing to perceive something which someone has said to you, when you are concentrating on something else, even though the words would have been received by the ear without any problem. The other side of the coin is the ability of the information processing system to perceive something (such as a picture, sentence, concept, etc.) even though some of the data may be missing. The danger however, is that people can fill in the gaps with information from their own store of knowledge or experience, and this may lead to the wrong conclusion being drawn.

Once we have formed a mental model of a situation, we often seek information which will confirm this model and, not consciously, reject information which suggests that this model is incorrect.

MEMORY

Memory is critical to our ability to act consistently and to learn new things. Without memory, we could not capture a 'stream' of information reaching our senses, or draw on past experience and apply this knowledge when making decisions.



MEMORY PROCESSES

Memory can be considered to be the storage and retention of information, experiences and knowledge, as well as the ability to retrieve this information.

Memory depends on three processes:

- **Registration** - the input of information into memory;
- **Storage** - the retention of information;
- **Retrieval** - the recovery of stored information.

It is possible to distinguish between three forms of memory. (*Figure 2-14*)

- **Ultra Short Term** (or sensory storage), has a duration of up to 2 seconds (depending on the sense) and is used as a buffer, giving us time to attend to sensory input.
- **Short Term** (often referred to as working memory), receives a proportion of the information received into sensory stores, and allows us to store information long enough to use it (hence the idea of 'working memory'). It can store only a relatively small amount of information at one time, often 7+/- items of information. As the following example shows, capacity of short term memory can be enhanced by splitting information in to 'chunks' (a group of related items).

A telephone number, e.g. 03035551212, can be stored as 11 discrete digits, in which case it is unlikely to be remembered. Alternatively, it can be stored in chunks of related information, e.g. in the US, 303 may be stored as one chunk, 555 as another, and 1212 as another,

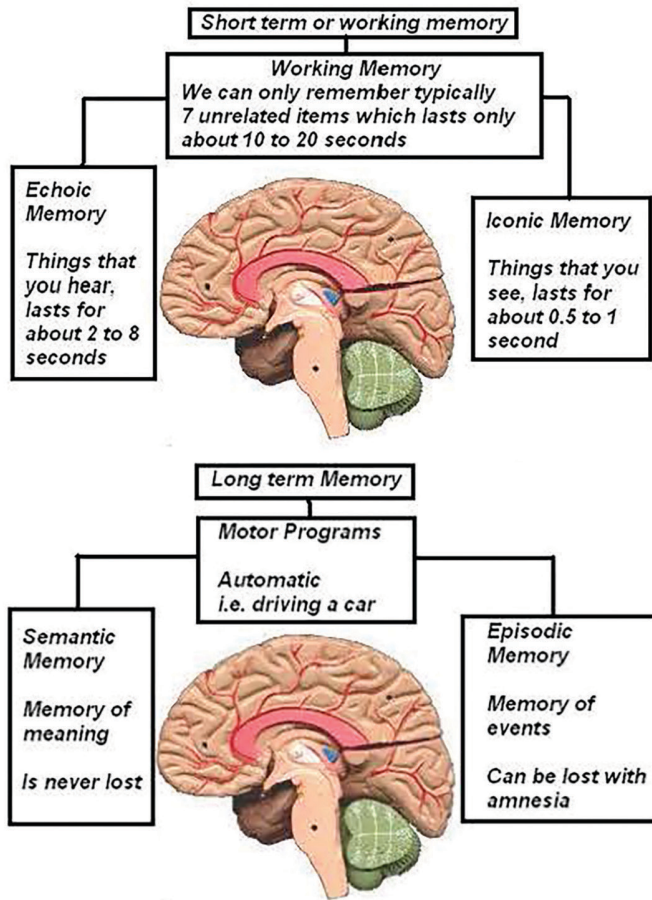


Figure 2-14. Differences between long and short term memory.

using only 3 chunks and therefore, more likely to be remembered. In mainland Europe, the same telephone number would probably be stored as 03 03 55 51 21 2, using 6 chunks. The size of the chunk will be determined by the individual's familiarity with the information (based on prior experience and context). A person from the UK might recognize 0208 as the code for London, but a person from mainland Europe might not.

The duration of short term memory can be extended through rehearsal (mental repetition of the information) or encoding the information in some meaningful manner (e.g. associating it with something as in the example above).

- **Long Term.** The capacity of long term memory appears to be unlimited. It is used to store information that is not currently being used, including: knowledge of the physical world and objects within it and how these behave; personal experiences; beliefs about people, social norms, and values; motor programs, problem solving skills and plans for achieving various activities; abilities such as language comprehension.

Information in long term memory can be divided into two types.

- **Semantic Memory** refers to our store of general, factual knowledge about the world, such as concepts, rules, one's own language, etc. It is information that is not tied to where and when the knowledge was originally acquired.
- **Episodic Memory** refers to memory of specific events, such as our past experiences (including people, events and objects). We can usually place these things within a certain context. It is believed that episodic memory is heavily influenced by a person's expectations of what should have happened, thus two people's recollection of the same event can differ.

CLAUSTROPHOBIA AND PHYSICAL ACCESS



Claustrophobia can be defined as abnormal fear of being in an enclosed space. There are many circumstances where people may experience various levels of physical or psychological discomfort when in an enclosed or small space. This is generally considered to be quite normal. When this discomfort becomes extreme, it is known as claustrophobia.

It is quite possible that susceptibility to claustrophobia is not apparent at the start of employment. It may come about for the first time because of an incident when working within a confined space, e.g. panic if unable to extricate oneself from a fuel tank. If one suffers an attack of claustrophobia, they should make coworkers and supervisors aware so that if tasks likely to generate claustrophobia cannot be avoided, at least coworkers may be able to assist in extricating from the confined space quickly, and sympathetically.

Team work will help in assisting one another if necessary, making allowances for the fact that people come in all shapes and sizes and that it may be easier for one person to access a space, than another.

FEAR OF HEIGHTS

Working at significant heights can also be a problem, especially when doing 'crown' inspections (top of fuselage, etc.). Some may be quite at ease in situations like these, whereas others may be so uncomfortable

that they are far more concerned about the height, and holding on to the access equipment than they are about the job in hand.

In such situations, it is very important that appropriate use is made of harnesses and safety ropes. These will not necessarily remove the fear of heights, but will certainly help to reassure the technician to concentrate on the task in hand. If one finds working high up brings on phobic symptoms (such as severe anxiety and panic), they should avoid such situations for safety's sake. However, as with claustrophobia, support from team members can be helpful.



Shortly before the Aloha Airlines accident, an inspector needed ropes attached to the rafters of the hangar to prevent falling from the aircraft when it was necessary to inspect rivet lines on top of the fuselage. Although unavoidable, this would not have been conducive to ensuring that the inspection was carried out meticulously (nor was it, as the subsequent accident investigation revealed). The National Transportation Safety Board (NTSB) investigation report stated:

"Inspection of the rivets required inspectors to climb on scaffolding and move along the upper fuselage carrying a bright light with them. In the case of an eddy current inspection, the inspectors needed a probe, a meter, and a light. At times, the inspector needed ropes attached to the rafters of the hangar to prevent falling from the airplane when it was necessary to inspect rivet lines on top of the fuselage. Even if the temperatures were comfortable and the lighting was good, the task of examining the area around one rivet after another for signs of minute cracks while standing on scaffolding or on top of the fuselage is very tedious. After examining more and more rivets and finding no cracks, it is natural to begin to expect that cracks will not be found."

One of the many functions of the supervisors should be an attempt to make the job as comfortable and secure as reasonably possible (e.g. providing knee pad rests, ensuring that staging does not wobble, providing ventilation in enclosed spaces, etc.) and allow for frequent breaks.

CONCLUSION

The technician is the key component to the aircraft maintenance system. It is imperative to have a useful understanding of how different parts of the body and mental processes function, and understand how our brain and perceptions may be "tricked". With this awareness and with proper accommodations, mistakes leading to accidents can be avoided.