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The Young Novice Driver Brain

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Introduction:

Driving requires the constant management of speed and direction to avoid a crash. Models of driver behaviour have neglected to take into account the role of the developing brain in understanding the critical skills required for safe driving – until recently. How the brain functions when anticipating the threat from unfolding hazards is starting to be recognized as one of the main factors that may be responsible for the differences in crash risk between an experienced and a novice driver.

The Developing Brain:

The adult human brain is more complex than even the most sophisticated of computers - but the brain doesn't start out that way. In fact the brain doesn't fully develop until around the age 25, maturing in stages starting from the back and then working its way to the front. First our ability to process visual stimuli is developed and then motor control and then finally a particularly clever part of the brain responsible for higher order cognitive skills called the frontal lobe **(see figure 1)**.

Brain maturation takes place developmentally as a child learns. When new associations are made, neural networks are formed as brain cells connect.

Research has shown that if you tap your finger on the table as fast as you can for five minute each day - after just two days you are able to tap significantly faster. This is because the brain cells in the motor cortex responsible for executing movement are now more connected.

As we learn, there are physical changes in the brain. The surface and dendrites of the brain's neurones become covered in synaptic junctions connecting them with other neurons as pathways formed with each new association **(see figure 2).**

Fig 1: **The human brain**

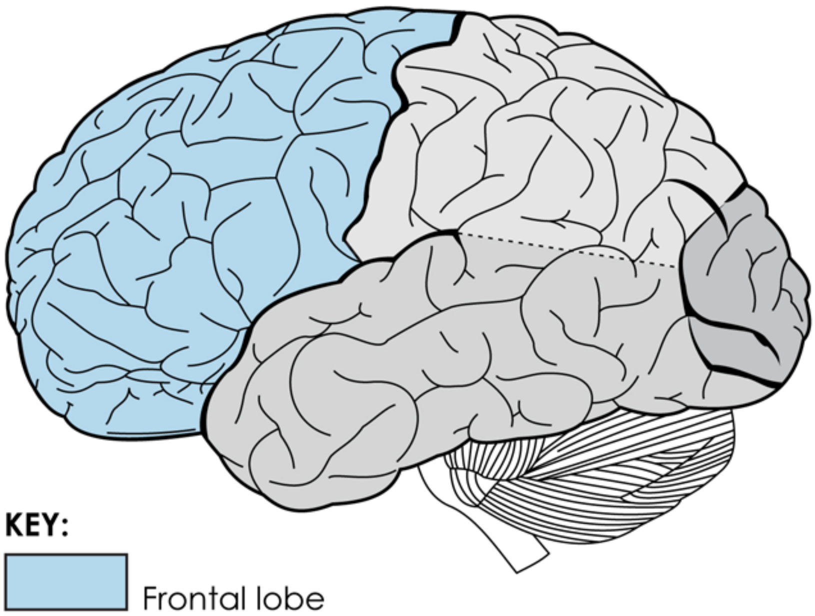
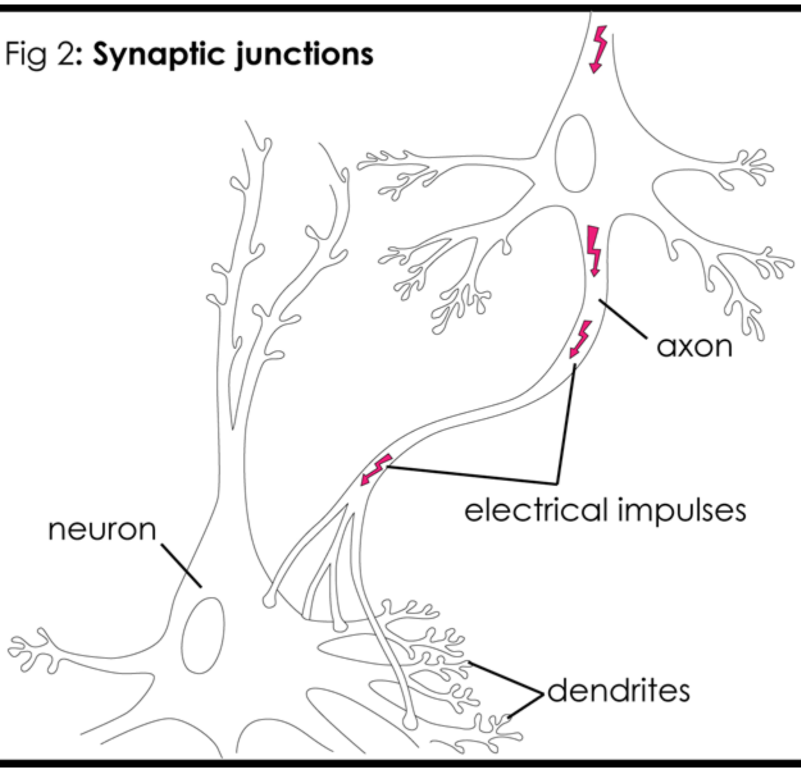


Fig 2: **Synaptic junctions**



The Frontal Lobe and the Amygdala:

In evolutionary terms, the frontal lobe **(see figure 1)** develops last of all because it control the more advanced aspects of human thought and abilities - referred to as executive functions. The frontal lobe is considered to be our emotional control centre and home to our personality. Most importantly, it controls the critical executive functions for driving - interpreting feedback from the environment. The frontal lobe also governs our ability to recognise future consequences from current actions, anticipation, emotion regulation and reasoning. These executive functions are required to choose between good and bad actions, override and suppress unacceptable responses to events and determine similarities and differences between things or events.

Given that the cells in the frontal lobe are not fully developed until around the age of 25 this has important implications for young novice drivers. Lack of brain maturity may be one of the main reasons why novice drivers are at much higher risk of being involved in a crash. They simply haven't developed the brain functions required to respond to hazards and manage risk appropriately. Not only is the frontal lobe not fully developed, but there is some evidence that there is a poor link between the frontal lobe and another brain structure responsible for providing an instant response to the threats from the road environment - the amygdala.

The amygdala **(see figure 3)** is a brain structure that sits a few inches from either ear. In contrast to the frontal lobe, the amygdala is a very old structure in evolutionary terms and seems to be primarily involved in survival. An important feature of the amygdala is that it contains nerves that connect it to a number of important brain centres, including the neocortex (the outer layers of the brain involved in higher functions) and the visual cortex (the part of our brain that interprets what we see). The amygdala has long been linked with a person's mental and emotional state and is critical in both regulating emotion and in guiding emotion-related behaviours (i.e. reflex movements) based on perceived environmental threats.

The amygdala is a kind of emotional computer resting quietly until it perceives a threat. When it determines that danger is present, it gathers the brain's resources in an effort to protect you from harm. In other words, the amygdala can instantly respond to any sensory input that indicates danger because it connects directly into the brainstem of the body where all of our instinctual responses and reflexive responses are stored. The information received by the amygdala then, is unfiltered and biased toward action.

Taking this into the context of driving - you instantly brake when a pedestrian steps out in front of you - even with just a hint of movement caught in your peripheral vision. Your brain doesn't waste time telling the thinking part of your brain that the pedestrian is about to step into the path of your car and that you should brake. Your visual cortex feeds information into the brainstem and sends information via the neural networks to the part of the brain that controls movement and your foot instantly depresses the brake. This is an emotionally-driven automated response based on past experience of potentially unpredictable pedestrian behaviour. It's thought that our brain leaves a 'marker' whenever it encounters threatening information, allowing it to respond more quickly when that same kind of scenario occurs again.

Repeated exposure to on road hazards is likely to develop an automated emotionally-driven brain process via neural connections in the brain. This automated response is advantageous because it allows the driver to react earlier in order to predict and alter their driving behaviours and is a process that only seems to be acquired with experience of different types of hazards and road situations.

Fig 1: **The human brain**

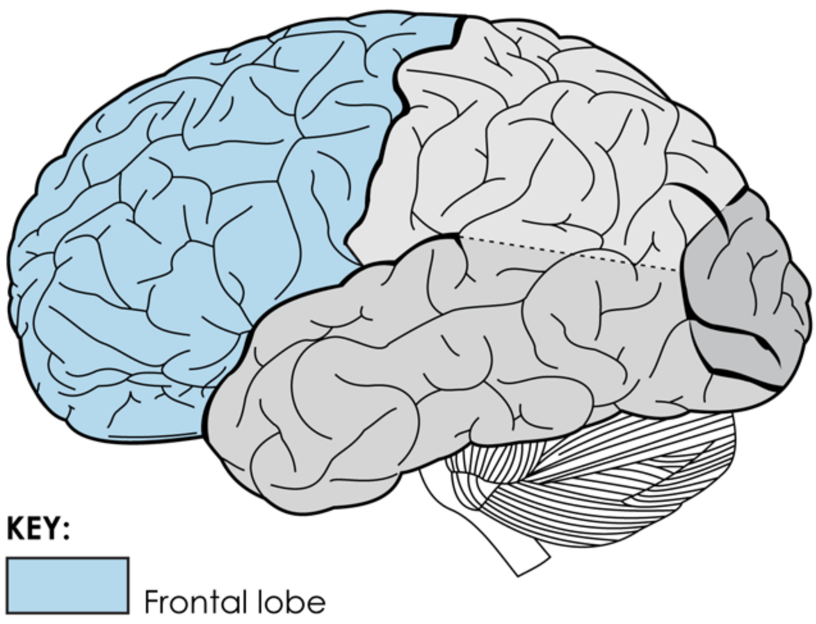
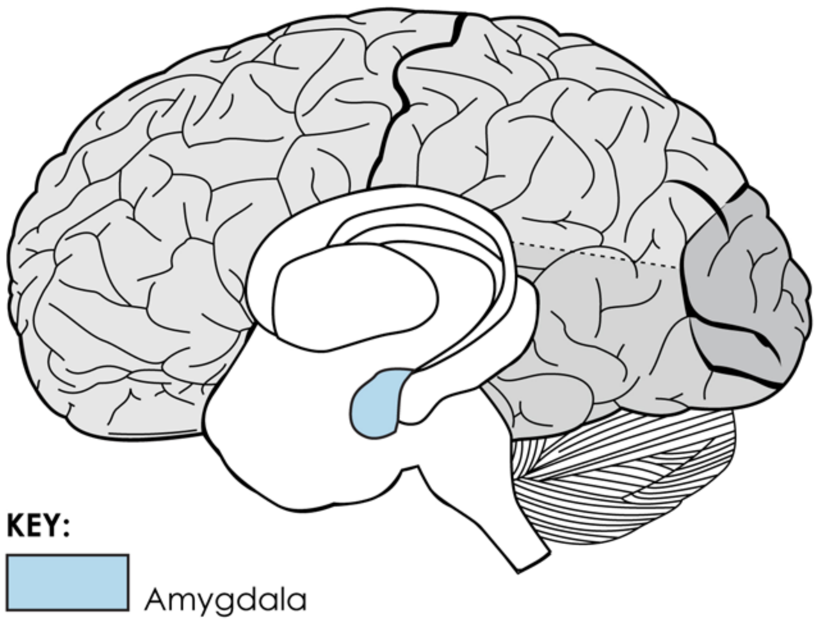


Fig 3: **The human brain**



Implications for Young Novice Driver Behaviour:

It is possible that automated responses to hazards only develop after the neural pathways are laid down after repeated associations between a hazard and a threat and results in an experienced driver avoiding risky situations more efficiently than an inexperienced driver. As neural pathways develop, drivers demonstrate an anticipatory response bypassing any cognitive appraisal. In other words, their feelings of risk guides decision making via a previous 'marker' laid down when that threat was encountered on some earlier occasion. Recent research suggests that novice drivers rely on a more conscious appraisal of risk rather than the emotionally-driven automated process demonstrated by experienced drivers (Fuller, et al, 2008).

To develop executive functions in learner drivers, education and training needs to ensure that the development of higher order skills to the level of an experienced driver takes place before driving solo. The development of neural networks linking the amygdala and the frontal lobe seem to be particularly critical - novice drivers just don't seem to consider hazardous events as dangerous (Fuller et al, 2008) suggesting the networks between the amygdala and the clever parts of the brain have not been fully developed by the time young novice drivers take to the road.

Making the connection:

A method of accelerating the development of the frontal lobe and developing connections via the amygdala is to educate learners about visual search strategies and increase awareness of the dangers of driving. Research by Dr Robert Isler at Waikato University has investigated the benefits of new training methods exclusively available from a²om.

The training tasks encourage active visual search, road commentary and an appreciation of potential danger using feedback techniques and video clips of real driving scenes depicting views from ahead and in the rear view mirror and side mirrors. After undertaking training, the results showed that novice driver hazard detection improved to the level of experienced drivers. In particular, road commentary training tasks in combination with hazard anticipation and visual search training tasks improved visual search behaviour amongst novices. One possible interpretation of the outcome of this research is that this kind of training educates novices to shift their attention towards processing the threat posed by hazards as they unfold.

It's only when drivers process the emotionally relevant aspects of hazards that our brain will lay down the foundation for the development of those important neural networks between the clever parts of the brain and our emotional computer. Recent research seems to suggest that these networks can be established and strengthened by a²om's new training methods.