A Fighter Pilot's Guide to Surviving on the Roads...

What's wrong with you - are you blind?!!

John Sullivan is a Royal Air Force pilot with over 4000 flight hours, and a keen cyclist. He regards himself as 'a simple fighter-pilot' and in this article he describes why collisions can occur and, in layman's terms, how some of the techniques of flying fighters can be used to increase your chances of survival on the roads. All proceeds from this article are going to charity.

Who hasn't formed these thoughts, or similar, at some point while cycling or driving? Probably in response to a vehicle that had just moved directly into your path - and you might congratulate yourself that only your alertness and superior reactions saved the day. If you were cycling then I expect that you may have even shared your thoughts, loudly, with the offending driver, and if you were driving then I imagine that there would have been some accompaniment from the horn section. Hopefully you were able to prevent the collision.

Now, before we go on, who can say that, at some point in their own driving history, they have not been about to manoeuvre - pull out from a T-junction, etc - when a car or bike seemed to come out of nowhere? Hopefully, it was just a close shave, and no doubt quite frightening. You may have wondered how you failed to see it, and probably concluded that they must have been driving 'far too fast' or you would have seen them. Perhaps, on such an occasion, you were the recipient of that loud and urgent query, 'Are you blind?!!'

Well, here's the bad news - yes, you are. For small but significant periods of time you are completely incapable of seeing anything at all. Most of the time, as I shall explain, this is not a problem. But if it means that you fail to see a vehicle that is just about to occupy the same point in space and time as you are - then this is a big problem!

The good news is that understanding why we sometimes do not see things allows us to adopt some defensive strategies that tip the odds back in our favour. This article then, is a fighter pilot's survival guide to avoiding collisions...

Fighter pilots have to cope with closing speeds of over 1000 mph, and they don't always get it right! But crashes are always analysed carefully to learn the lessons that might prevent future accidents. This article reveals the hard-won techniques that fighter pilots are trained to use.

First some background. We all inhabit bodies that have evolved over hundreds of thousands of years to our environment. We are highly adaptable, omnivorous creatures, which is why we have prevailed when other species, those suited to specific environments, habitats or diets, have not. We learned how to grow crops but we started off as hunter/gatherers - we have eyes in the front of our heads which gives us binocular vision for judging distance to prey, or threats.

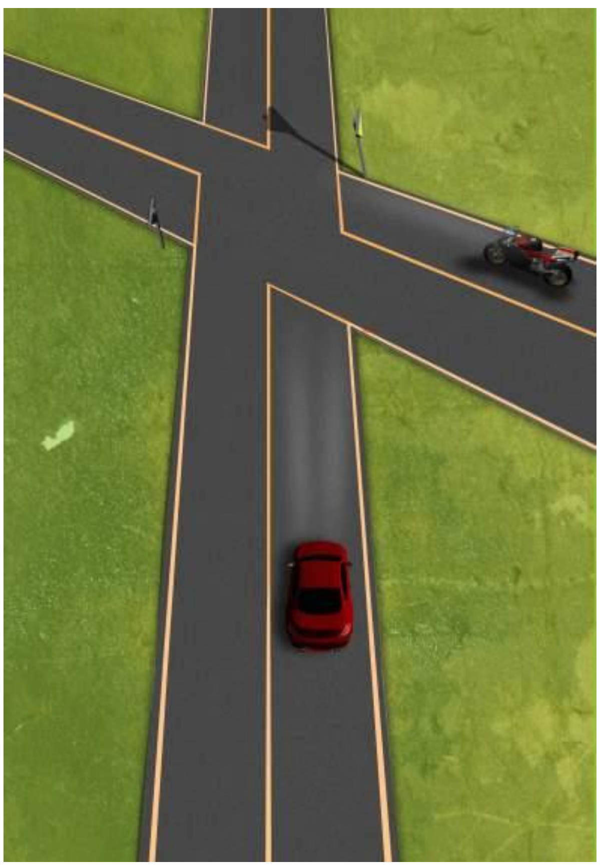
Our eyes, and the way that our brain processes the images that they receive, are very well suited to creeping up on unsuspecting antelopes. We are even pretty good at spotting sabre-toothed tigers creeping up on us! We are, however, rubbish at spotting vehicles that hurtle towards us at high speed.

Let me explain why...

Light enters our eyes and falls upon the retina, whereupon it is converted into electrical impulses that the brain perceives as images. Clever stuff. Only a small part of the retina, in the centre and called the fovea, can generate a high-resolution image. This is why we need to look directly at something, by moving our eyes, to see detail. The rest of the retina contributes to our visual experience by adding the peripheral detail - hence peripheral vision. Peripheral vision cannot resolve detail, which prevents the brain from being overloaded with too much information, but it is very good at detecting movement. Any movement, such as the twitch of an antelope's ears or the swish of a tiger's tail, immediately alerts us to something of interest which we can then bring our high-resolution fovea to bear upon. And our eyes move fast, really fast - no doubt spurred on by the motivation to see the slavering chops of our sabre-toothed friend in glorious techni-colour detail with enough time to do something about it.

So what?

Well, first, it is an unfortunate fact that if you are going to collide with another moving object, and assuming that you are both traveling in a straight line, then there is no *apparent* movement between the occupant of either vehicle. That is, to the driver of each vehicle, the other will remain in exactly the same position in the windscreen up to the point of impact. There is no *relative* movement - so our peripheral vision is not suited to detecting it. For completeness, this does not mean that you cannot hit a vehicle that is turning, but as the other vehicle adopts a path that will lead to collision then it will cease to move *relative* to you - it will become stationary in your windscreen.



Whether they are on the road or in the air, vehicles traveling at a constant speed will stay in the same position relative to each other as they approach a point of collision.

In the illustration left, a car is approaching a cross-roads but it is on a collision course with a motorcycle approaching from the right. The car is going faster, and so at any one point in time it is further from the collision point - but they will get there at the same time!

To the driver of the car, the motorcycle is about 30º right, or in his 1 o'clock, and the motorbike will stay in exactly that same relative position in the windscreen until impact.

To the motorcyclist, the car is 90º left, or in her 9 o'clock, and it will also remain in exactly that relative position until impact.

Remember, our peripheral vision is not good with detail - in fact, just 20º away from your sightline your visual acuity is about one tenth of what it is at the centre. Not convinced? Well, the standard eyesight requirement for driving in the UK is to read a car number plate at 20m. Go outside, now, and stand just 10m from a car, look just one car's width to one side, and try and read the number plate - *without* moving where your eyes are looking! Try again from 5m. Clinically, you are blind in your peripheral vision.

That's not to say that we cannot see something in our peripheral vision - of course we can. As you approach a roundabout you would be hard pressed not to see a dirty great articulated lorry bearing down upon you, even out of the corner of your eye - obviously, the bigger the object, the more likely we are to see it. But would you see a motorbike, or a cyclist?

To have a good chance of seeing an object on a collision course, we need to move our eyes, and probably head, to bring the object into the centre of our vision - so that we can use our high-resolution foveal vision to resolve the detail.

Now for the really interesting part. When we move our head and eyes to scan a scene, our eyes are incapable of moving smoothly across that scene and seeing everything. This makes perfect sense, just like trying to take a picture without holding the camera still, the image would be blurred. So, our clever brain overcomes this by moving our eyes (really fast, remember) in a series of jumps (called saccades) with very short pauses (called fixations), and it is only during the pauses that an image is processed. Our brains fill in the gaps with a combination of peripheral vision and an assumption that what is in the gaps must be the same as what you see during the pauses. This might sound crazy, but your brain actually blocks the image that is being received while your eyes are moving, which is why you do not see the sort of blurred image that you see when you look sideways out of a train window.

Unless you are tracking a moving object, such as an antelope, then the human eyes are incapable of moving smoothly across a scene; they jump and pause occasionally to take a 'snapshot' of the scene.

Definitely not convinced? Okay, go to a mirror, now, and look repeatedly from your right eye to your left eye. Can you see your eyes moving? You cannot. Now have a friend or partner do the same thing while you watch them. You will see their eyes moving quite markedly. You couldn't see your own eyes move because your brain shuts down the image for the instant that your eyes are moving. Experiments have shown that it is impossible to see even a flash of light if it occurs within a saccade.

The saccade/fixation mechanism has always served us rather well, and means that we can creep up on antelopes without being overloaded by unnecessary detail and a lot of useless, blurred images.

But it does present us with some shortcomings now that we routinely climb into metal boxes and hurtle towards each other. Our eyes and brains are just not designed for this - our world has changed far faster than our bodies can adapt.

So what?

If you get to a junction and move your head right and left to look for oncoming traffic, you need to understand that you cannot guarantee that you have seen approaching traffic. It is entirely possible for our eyes to 'jump over' an oncoming vehicle during one of the saccades. The smaller (and specifically, the narrower) the vehicle, the greater the chance that it could fall within a saccade. You are not being inattentive, you are physically incapable of seeing anything during a saccade. Remember the 'Think Bike!' adverts, where a driver pulls out into the path of a motorcycle? I am convinced that it is the phenomena of saccades and fixations that is *most likely* to lead to this sort of accident.

Motorbikes and cycles, being narrow, are more likely to fall within a saccade. This image represents a driver looking quickly left, and the approaching motorcyclist falls within a saccade and is never seen in high resolution - simulated by the toning down in this image.

It gets worse. The faster you move your head, the larger the jumps, or saccades, and the shorter the pauses, or fixations. So you are more likely to jump over an oncoming vehicle and less likely to detect any movement in your peripheral vision (because there is even less time available for slight, relative movement to become apparent).

It gets even worse. Not only can we not see though solid objects (well, opaque objects, to be more accurate) but research has shown that we tend not to look near to the edges of a framed scene. In plain language, we tend not to look at the edges of a windscreen. So not only do the door pillars of a car represent a physical blindspot, but our eyes tend not to fixate near to it, leading to an even bigger jump, or saccade, past a door pillar. This is called windscreen zoning.

One further point of interest, our ears usually contribute to the process of building up a picture of our surroundings too - the snap of a twig from an unwary paw is another prompt for us to direct our vision towards something of interest. But in our metal cocoons, with the radio or mp3 playing, this is yet another cue that we are denied.

So, consider this scenario - you approach a big roundabout or junction, looking ahead at the junction of course, and the road seems to be empty. As you get closer, you look right and left as a prudent, final check. You see no other vehicles and proceed through the junction. Suddenly, and it's your lucky day, there is an indignant blast of horn and a car flashes across in front of you, missing you by inches and leaving you thoroughly shocked, and confused. Sound familiar?

So what happened? On the approach you did not see that another car was on a perfect collision course, with no relative movement for your peripheral vision to detect - possibly compounded by being behind the door pillar. Lulled into a false sense of security you looked quickly right and left, to avoid holding up the traffic behind you, and your eyes jumped cleanly over the approaching vehicle, especially as it was still close to the door pillar in the windscreen. The rest of the road was empty, and this was the scene that your brain used to fill in the gaps! Scary, huh?

You were not being inattentive - but you were being ineffective.

Just when you thought it couldn't get any worse, there is also the phenomenon of *'expectation'* and your brain is less likely to recognise something that you are not expecting to see. This now enters territory that pilots prefer to leave to a scary breed of creature called the aviation psychologist but suffice it to say that if you *think* the road is empty, you are less likely to register that a vehicle is actually present.

So what can we do about it? Well, quite a lot actually, as forewarned is forearmed.

Drivers:

Always slow down as you approach a roundabout or junction, even if only by 20 mph or so, and even if the road seems empty. Changing your speed will immediately generate relative movement against a vehicle that was otherwise on a collision course - not only are you then more likely to see it, but you are no longer on a collision course!

Never just glance right and left - this leaves it entirely to chance whether you see an approaching vehicle or not - and if you glance quickly, the odds decrease markedly.

Always look right and left methodically, deliberately focusing on at least 3 different spots along the road to the right and 3 to the left - *search* close, middle-distance and far. With practice, this can still be accomplished quickly, and each pause is only for a fraction of a second, but this means that you are now overriding the natural limitations of the eye and brain. Fighter pilots call this a 'lookout scan' and it is vital to their survival.

Always look right and left at least twice. Not only does this immediately double your chance of seeing a vehicle, but if you repeat the same scan as you did the first time (which, when it becomes a well-practiced habit, you almost certainly will) then an approaching vehicle will have moved to a different part of the windscreen by the time you look the second time and is less likely to be masked by a saccade. Just note that this will not work if you charge into a junction at a constant speed because any vehicle on a collision course will stay in the same position in the windscreen - if you miss it the first time, you will probably miss it the second time too!

Make a point of looking next to the windscreen pillars. Better still, lean forward slightly as you look right and left so that you are looking around the door pillars. Be aware that the pillar nearest to you blocks more of your vision. Fighter pilots say *‘Move your head - or you’re dead’*.

Clear your flight path! When you change lanes, especially into a slower lane, you should, of course, check your mirrors, and will have undoubtedly been watching the road ahead of you, naturally. Your last check must be to look directly at the spot into which you are going to manoeuvre, otherwise you could easily have missed a slower motorbike or cyclist in that lane, one that was only in your peripheral vision as you looked ahead, and over which you ‘jumped’ as you looked over your shoulder or checked your wing mirror.

Drive with your lights on. Aviation research shows that contrast is the single most important factor in determining the likelihood of acquiring an object visually - this is why military aircraft camouflage is designed to tone down their contrast. On the ground, dark coloured vehicles or clothing will result in reduced contrast against most usual backgrounds, and this is why high-visibility clothing (for pedestrians, cyclists and motorcyclists) and/or bright lights are so important, in the daytime as well as at night.

While it is generally understood that a low sun can make it difficult to see, it is probably not generally understood why: driving into sun reduces contrast, especially when vehicles and pedestrians fall into the shadow of larger, up-sun objects. You must beware that even large vehicles, and especially motorbikes, cyclists and pedestrians, can become completely impossible to see under these circumstances, and you must moderate your driving accordingly. This is why fighter pilots attack from *out of the sun*!

This image is taken on an overcast day – what photographers might call a 'low-contrast day'. However, the vehicles in this scene can all be seen easily, and the light coloured top of the scooter rider provides reasonable contrast against the generally darker background. Note that the headlight is especially effective.

This image captures almost the exact same scene, but on a clear day with a low sun. Note how the contrast is much poorer, making it difficult to see the details of anything into sun. Vehicle lights provide the best defence, so turn them on - remember that the additional load on the engine, in running the alternator as it powers the headlamps, is completely insignificant as compared to the cost of an accident repair!

When objects fall into the shadow of ‘up-sun’ objects they are especially hard to see – did you see the moped coming towards you in the preceding picture, even with its light on?

Keep your windscreen clean! Seeing other vehicles can be difficult enough, without tipping the odds against you by having to look through a dirty windscreen. You <u>never</u> see a fighter jet with a dirty canopy.

And finally, don’t be a clown - if you are looking at your mobile telephone then you are incapable of seeing much else. Not only are you probably looking down into your lap, but your eyes are focused at less then one metre and every object at distance will be out of focus. Even when you look up and out, it takes a fraction of a second for your eyes to adjust - this is time you may not have.

Motorcyclists and cyclists:

Recognise that you are especially at risk - not only are you more vulnerable but the narrow profile of a motorbike or cycle makes it far more likely that you can fall into a saccade. So tip the odds in your favour - always wear high-contrast clothing and use lights. Flashing LEDs (front and rear) are especially effective for cyclists as they create contrast and the on-off flashing attracts the peripheral vision in the same manner that movement does.

In this scene the sun is partly covered by cloud but contrast is still poor and high visibility clothing, in bright colours that are not generally encountered in the background scene, will increase contrast and be detected more easily.

Give yourself a chance! Compare the visibility of the cyclists wearing bright coloured tops, as compared to the cyclist in the centre.

Did you see the moped rider in the preceding picture? Give yourself a chance!

The relatively slower speed of bicycles means that they will be closer to a point of collision if a vehicle begins to pull into their path. Turn this to advantage - when passing junctions, look at the head of the driver that is approaching or has stopped. The head of the driver will naturally stop and centre upon you if you have been seen. If the driver's head sweeps through you without pausing, then the chances are that you are in a saccade - you must assume that you have not been seen and expect the driver to pull out!

Die-hard cyclists are unwilling to compromise their training for such inconveniences as poor weather - I know. But be aware of when the odds are really stacking up against you. If you are cycling into a low sun, have a think about how difficult it is to see the vehicles in front of you. Now imagine that you are also looking through a dirty windscreen, or one with rain beating against it! Are you content that drivers approaching from behind have a realistic chance of seeing you. Maybe today is the day to take a different route - or time your journey to avoid the sun being straight into the eyes of drivers on that particularly busy stretch of road. Or take the bus. Having a really low heart rate at the point at which you go under the wheels of a truck is rather pointless. This is risk management.

So is wearing a helmet - every fighter pilot wears a helmet, even though it won't make much difference if they hit the ground at 700 miles an hour! It's about reducing the chances of less dramatic incidents causing fatal cranial injuries, unnecessarily. Go figure.