Sorry, Mate, I Didn't See You: A Plausible Scientific Expalnation

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ABSTRACT

The excuse "Sorry, mate, I didn't see you" is so familiar to motorcyclists and cyclists that its acronym 'SMIDSY' is entering common usage. A recently conducted Google search for 'SMIDSY' produced 39,200 hits, a number of which were Web addresses incorporating the acronym. As well as failing to notice cyclists and motorcyclists, drivers can fail to notice almost any other relevant component of the road scene, such as traffic lights, pedestrian crossings, cars and even parked semi-trailers. At the broadest level, there are two types of cause for a failure to notice something: 'internal' visual/psychological causes and 'external' environmental causes (such as poor road lighting). Both types of cause will normally be involved in any instance of a failure to notice something. This selective review of the literature will focus on one type of *internal* cause: the looked-but-failed-to-see error. It is difficult to believe that a responsible driver can look-but-fail-to-see a motorcyclist or cyclist before it is too late to avoid a collision. This paper proposes a plausible scientific explanation for that failure. In the first section, it is noted that crash investigators are beginning to accept the reality of the looked-but-failed-to-see error. In the second section, the findings of recent vision research on 'inattentional blindness' and 'change blindness' are summarised. In the third section, it is proposed that 'genuine' looked-but-failed-to-see errors could be instances of inattentional/change blindness.

SECTION 1: THE REALITY OF THE LOOKED-BUT-FAILED-TO-SEE ERROR

Olsen (1989) noted that there was a ten-fold over-representation of motorcycles as the 'through' vehicle in daytime motorcycle-car crashes at intersections in Texas where the two vehicles approached the intersection from opposite directions with one continuing straight ahead and the other turning across its path. He observed that there were at least three possible factors that could be involved:

1. Car drivers fail to notice the motorcycle *despite its presence in the driver's field of view.* Olsen referred to this explanation as the 'conspicuity hypothesis'.
2. Because motorcycles are smaller than most other vehicles, they are easily *blocked* from a driver's view by other vehicles in the traffic stream, road-related hardware and even things associated with the vehicle such as the roof-support pillars
3. The speed or distance of the approaching motorcycle might be difficult to assess, such that the turning driver picks a smaller gap than would normally be the case

Olson pointed out that advocates of the 'conspicuity hypothesis' believe that there is a special problem in conspicuity for motorcycles, and support their view with the fact that the crashed drivers often state that they did not see the motorcycle. However, Olson himself was sceptical about the conspicuity hypothesis.

After analysing various patterns of motorcycle crashes in Western Australia, Cercarelli, Arnold, Rosman, Sleet and Thornett (1992, p. 363) agreed with Olson's (1989) assessment that the conspicuity hypothesis "lacks empirical support".

The conspicuity hypothesis is now usually described in terms of 'looking-but-failing-to-see' (e.g., Brown, 2005; Herslund & Jorgensen, 2003; Langham, Hole, Edwards & O'Neil, 2002). The current consensus seems to be that looking-but-failing-to-see is *real* and *prevalent*. For example, Clarke, Ward, Bartle and Truman (2004) recently conducted in-depth investigations of over 1000 motorcycle crashes, and concluded (p. 22):

> Over 65% of right-of-way-violation accidents where the motorcyclist is not regarded as 'to blame' involve a driver who somehow fails to see the motorcyclist who should be in clear view, and, indeed, frequently *is* in view to witnesses or other road users in the area. (Failures of observation that involve drivers failing to take account of restricted views of one kind or another, or failing to judge the approach speed and/or distance of a motorcyclist are *not* included in this category.)

Clarke et al. (2004, p. 46) went on to calculate that if all looked-but-failed-to-see (LBFS) errors were somehow eliminated, there would be "a fall of slightly over 25% in the *total* motorcycle accident rate".

Herslund and Jorgensen (2003) conducted in-depth investigations of ten self-reported 'near accidents' that involved a driver (who was supposed to give way) apparently looking-but-failing-to-see a cyclist at a priority intersection or roundabout. They concluded (p. 886):

> In-depth interviews of both car driver and cyclist prove indirectly that in some give-way situations car drivers look in the direction where cyclists are, without perceiving them. It is plausible to suggest that the looked-but-failed-to-see error does *not* arise due to the physical environment but as a result of the drivers' visual search strategy and/or mental processing.

The UK Department for Transport recently commissioned a *Review of the 'looked but failed to see' accident causation factor* (Brown, 2005). The review covered all types of crashes, and was not limited to those involving motorcyclists or cyclists. The author considered that the LBFS error was a genuine error of attention/perception/cognition in that the object collided with was visible – but did not enter consciousness as a relevant hazard. He considered that the best estimate of the prevalence of the error was available from in-depth crash investigations carried out by the UK Transport and Road Research Laboratory (TRRL) between 1970 and 1974, and concluded that the error comprised about 10% of all driver errors.

Brown (2005) used a Police crash database to explore some of the circumstances of crashes that apparently involved the LBFS error, and concluded that the error was:

- The third most prevalent 'perceptual' error after 'inattention' and 'misjudgement of path or speed'
- 62% more frequent for the 65+ age group than for the under-21s
- 17% higher for female than for male drivers

It is concluded that the LBFS error involves a genuine but mysterious perceptual phenomenon; and that LBFS errors contribute to the causation of about 10% of all crashes, and up to 25% of motorcycle-involved (and presumably also bicycle-involved) crashes.

SECTION 2: 'INATTENTIONAL BLINDNESS' AND 'CHANGE BLINDNESS'

<u>Inattentional blindness</u>. The best-known demonstration of 'inattentional blindness' (Simons & Chabris, 1999) involves subjects viewing a 75-second video clip of two 3-person teams of basketballers. One team wears white shirts and the other black shirts. Each team has its own orange basketball, which they pass amongst themselves by throwing or bouncing as they weave in and out amongst each other in a hallway. The task set for the viewing subjects is to count the number of passes between the white-shirted players. Forty-five seconds into the video, a woman dressed as a black gorilla enters the hallway from the left, walks through the mass of players, and thumps her chest before exiting to the right.

When questioned about the presence of the gorilla, about 50% of viewers do not report seeing it. When shown the video clip a second time, some of those who did not previously see the gorilla insist that the video has been altered. This demonstration of a failure to detect 'Gorillas in our midst' shows how easy it is to *not* notice a very salient object that is in the direct field of view. In a sense, this is demonstration of 'over-attentional' blindness rather than 'inattentional' blindness.

Experimentation has shown that the level of inattentional blindness depends on the difficulty of the primary task. For example, when viewers are required to keep *separate* tallies of throw-passes and bounce-passes, they are less likely to see the gorilla than if keeping only one tally of total passes. Another finding is that the black gorilla is seen more often when the viewers are asked to count the passes of the black-shirted players rather than of the white-shirted players. In other words, the gorilla is more easily seen when attention is directed to the colour that is the same as its hair colour.

<u>Change blindness</u>. A change in the visual field can be detected in either one or the other of two very different ways: through the automatic stimulation of low-level 'movement detectors' that are neurophysiologically hard-wired; or through the involvement of high-level attentional mechanisms that compare attended-to aspects of the 'before' and 'after' scenes.

If an item in the visual field changes suddenly (such as a car appearing around a corner), it will normally be automatically detected by robust, low-level movement detectors. However, the involvement of the movement detectors can be disrupted in many ways, and when that happens we have to rely on fragile attentional mechanisms. 'Change blindness' can occur if the attentional mechanisms are not 'up to the task'.

To create conditions where change blindness can occur, the *alerting* effect of the movement detectors has to be circumvented. This can be done in a number of ways. The best-known means is through the use of the 'flicker technique' (Rensink, O'Regan & Clark, 1997). This technique can be explained with reference to the two versions (A and B) of the garden scene in Figure 1. If the two versions are presented at the same location in an alternating sequence (A-B-A-B etc.) for about one second each, the fact that the shadow of the bird-bath is missing in version B is very easily detected by the low-level movement detectors (which can detect onsets and offsets as well as movement). Under these circumstances the shadow appears to flash on and off, and is usually noticed in only one alternation.

Figure 1. A garden scene with the bird-bath shadow present (A) or absent (B)

A

B

What is surprising is that a small change in the presentation technique can make it very difficult to quickly detect the difference between the two versions of the scene. The 'flicker technique' involves inserting a blank white screen for about 100 milliseconds between the two versions of the scene (A-blank-B-blank-A-blank-B-blank etc). The blank screen creates a flicker across the whole scene, which 'swamps' the movement detectors and thereby circumvents the alerting role of the particular movement detectors that would otherwise signal the presence/absence of the shadow. The shadow no longer appears to flash on and off. It is therefore much more difficult to notice that the two versions of the scene differ with respect to the presence of the shadow, and many alternations of the two versions of the scene may be required before the difference is noticed. This phenomenon is known as 'change blindness'.

The 'mudsplash technique' (O'Regan, Rensink & Clark, 1999) is an alternative to the flicker technique, wherein the brief presentation of a few small high-contrast shapes across the scene at the same time as the alternation prevents the detection of the difference between the two versions of the scene.

What is particularly worrying from the perspective of road safety is the fact that change blindness, as well as being triggered by flickers and mudsplashes, can be triggered by more mundane visual events such as eye-blinks (O'Regan, Deubel, Clark & Rensink, 2000), eye movements (Henderson & Hollingworth, 1999), and 'scene changes' - which are equivalent to glancing away from and back to a scene (Simons & Levin, 1998).

The ease with which change *blindness* can be demonstrated makes us realise that change *detection* is far more difficult for us than we might have supposed. According to Rensink (2002, p. 259) most of the findings on change blindness "can be explained by the thesis that *focussed attention* is needed to see change". It seems likely that we are capable of focusing our attention on only 4 or 5 items at a time. If so, many of the items in a typical scene are not *really* being noticed.

We do not necessarily *attend to* the things we are *looking at*. According to O'Regan et al. (2000, p. 209):

> What observers 'see' at any moment in a scene is not the *location* they are directly fixating with the eyes, but the *aspect* of the scene they are currently attending to, that is, what they are processing with a view to encoding for storage into memory. The eye's fixation location will thus be only an unreliable indicator of what is being processed.

O'Regan and Noë (2001, p. 954) have summarised the main findings from experiments on change blindness as follows:

> The results of the change blindness experiments show that in many cases the observers have great difficulty seeing changes, even though the changes are large, and occur in full view. The experience is quite contrary to one's subjective impression of richness, of 'seeing everything' in the visual field.
>
> In one experiment, observers' eye movements were measured as they performed the task (O'Regan et al., 2000). In many cases observers could be looking directly at the change, at the moment the change occurred, and still not see it. Under the usual view that one should see what one is looking at, this is surprising.

There is now a considerable body of scientific literature on inattentional blindness and change blindness. These topics have been the subjects of whole issues of scientific journals (*Visual Cognition*, 2000, Volume 7, Issues 1, 2 & 3; *Journal of Consciousness Studies*, 2002, Volume 9, Issues 5 & 6), as well as of review papers (e.g., Simons, 2000; Rensink 2002).

SECTION 3: INATTENTIONAL BLINDNESS, CHANGE BLINDNESS AND THE LOOKED-BUT FAILED-TO-SEE ERROR

Before the recent wave of vision research on inattentional blindness and change blindness, which started in the mid-1990s, researchers attempting to explain the LBFS error had little to 'hang their hats on'. Nevertheless, explanations were sometimes provided that can now be seen to be consistent with the recent vision research. For example, in his 1990 paper on *The basic driver error: late detection*, Rumar noted that the LBFS error, as a cause of crashes, "has not really been investigated" (p. 1258). He described the error as "A cognitive detection error that probably has a considerable motivational component".

The authors of two recent reports on LBFS errors (Brown, 2005; Herslund and Jorgensen, 2003) were possibly not aware of the recent research on inattentional blindness and change blindness. One of Brown's (2005) objectives in his *Review of the 'looked but failed to see' accident causation factor* was to investigate the "psychological basis" of the LBFS error (p. 4). He concluded that it was due to a "failure of selective attention" (p. 74). Despite the recent date of his report, and the compatibility of this explanation with the literature on inattentional blindness and change blindness, he did not cite any of that literature.

One of Herslund and Jorgensen's (2003) objectives in their investigation of *Looked-but-failed-to-see errors in traffic* was to find "any plausible hypotheses to explain this phenomenon" (p. 885). They concluded that such errors were due to "the driver's visual search strategy and/or mental processing" (p. 886). By 'mental processing' they seem to mean that the drivers involved had strong expectations that they might have to defer to other *cars* at the intersections. Not expecting to see *bicycles*, they failed to notice them, even when they were clearly present. Again, despite the compatibility of this explanation with the literature on inattentional blindness and change blindness, no mention of that literature was made.

Some other authors with an interest in LBFS errors *have* been aware of the recent research on inattentional blindness and change blindness. For example, in their *In-depth study of motorcycle accidents*, Clarke et al. (2004, pp. 46) noted that published research had found that inattentional blindness could be affected by observer expectations. They speculated, "The 'expectation' factor raises the possibility that some road users have a poor perceptual 'schema' for motorcycles in the traffic scene" (p. 47). They concluded, "Safety campaigns that put the emphasis on other drivers being more vigilant regarding motorcyclists (e.g., 'Think Bike') would seem to be as relevant as ever" (p. 49).

The research discussed so far in this section has primarily focused on *road safety*, with only passing reference, by some authors, to inattentional/change blindness. In contrast, since about 2001, a body of research is evolving with a focus on *change blindness* in the context of road safety. To date, this research has concentrated on age-related differences in susceptibility to change blindness. Some of this research is discussed below. To understand the relevance of this research to the theme of this paper it is important to be aware that, as drivers age, LBFS errors become much more prevalent as causal factors in at-fault crashes (McGwin & Brown, 1999; Preusser, Williams, Ferguson, Ulmer & Weinstein, 1998). Any evidence of a link between aging and change blindness, especially if links are also made with driving impairment, is indicative of the possible role of change blindness in road crashes.

Pringle, Irwin, Kramer and Atchley (2001) investigated age-related differences in change-detection ability and in performance on a test that is widely accepted as a measure of attentional ability (the functional field of view test - FFOV). Twenty-five younger (18-33 years) and 26 older (55-80 years) drivers were tested on their ability to detect change using the flicker task, and on their 'attentional breadth' using the FFOV. Performance on the flicker task was measured using 80 pairs of driving scenes where the modified version of each scene involved a change in a single object's color, location or presence. The object changes varied along three dimensions: salience (contrast, size, etc), eccentricity (central or peripheral) and meaningfulness (e.g., as a traffic hazard). It was found that the older subjects were worse at detecting change in the flicker task and that they had a more restricted functional field of view. This correlation was taken as support for the central role of *attention* in both change blindness and performance on the FFOV. The salience and eccentricity of the changing object were strongly related to the time required to detect the change, but there was only a weak effect of meaningfulness. The aspect of this study that is most relevant to road safety is the demonstration of an age-related deterioration in the ability to detect changes in driving scenes.

Hoffman, McDowd, Atchley and Dubinsky (2005) believe that there *really is* a problem of older driver impairment, but that "there is great variability among older drivers in their rates of decline" (p. 610). Consequently, they believe that the development of reliable methods to screen for impaired older drivers is very important. The main aim of their study was to predict driving impairment from various measures of visual attention. Driving impairment was measured using a driving simulator. The main predictor variable was a measure of change detection they had devised called the 'DriverScan', which presented real-world driving scenes using the flicker task (similar to the method used by Pringle et al., 2001). The authors argued for the high face validity of the DriverScan as a measure of driver impairment: "Although DriverScan is a laboratory task, the search for change is highly applicable to real-world driving" (p. 612). The other main predictor variables were two related sub-tests that measure the size of Useful Field of View: UFOV Divided Attention and UFOV Selective Attention (Ball & Owsley, 1993). The subjects were 155 drivers aged from 63 to 87 years, who were not over-sampled for crash involvement. Raw correlations between DriverScan scores and the two UFOV subtests were 0.50 and 0.57, indicating some shared variance. The correlation between the three predictor variables and driving impairment were: 0.60 for DriverScan, 0.53 for UFOV Divided Attention and 0.41 for UFOV Selective Attention. Previous research with the UFOV had shown that it was a good predictor of older driver impairment (Clay, Wadley, Edwards, Roth, Roenker & Ball, 2005). One conclusion from the current study is that the DriverScan is probably a superior instrument to the UFOV as a predictor of driver impairment. The aspect of this study that is most relevant to road safety is the demonstration that a measure of age-related differences in the ability to detect changes in driving scenes is predictive of older driver impairment.

CONCLUSION

The implicit argument in this paper is suggestive rather than conclusive. From the field of road safety there is a mysterious type of crash where a driver looks-but-fails-to-see another road user. From the field of perceptual psychology, under the headings of 'inattentional blindness' and 'change blindness', there are counter-intuitive demonstrations of our very limited capacity to notice visually salient objects. The implicit argument in this paper is that inattentional blindness and change blindness might explain many of the crashes that involve looking-but-failing-to-see. An important applied aspect of this research has been the development of a test of individual differences in change blindness that can probably be used to measure the type of age-related driver impairment that leads to LBFS crashes.

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