When Perception is not Reality –

Using the Principles of Driver Perception to Make Your Case

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I. Introduction.

As plaintiff lawyers, we often handle cases that leave us wondering why someone did not perceive a hazard in time to avoid it. Juries, already suffering from defensive attribution,[1] are often eager to find fault with a plaintiff who failed to see an object or vehicle in time to effectively avoid it. By understanding the science of how people perceive and respond to hazards, we can better explain to juries how these incidents occur and why our client is not at fault.

A. Scope of Article.

It is my intent that this paper be a brief, very informal, discussion of some of the principles of driver perception-response and how such principles can be used by plaintiff lawyers in furtherance of their client's case. It is not meant to be a comprehensive study of any one area of human factors or trial practice, but rather, a general overview of some of the more common issues involved with addressing driver perception-response in personal injury cases.

If you are in need of a thorough, heavily annotated, treatise on the subject of driver perception-response, this is not your resource. On the other hand, if you are interested in a casual, practical and realistic discussion about how to address driver perception-response issues in your personal injury cases, it is my hope this paper will benefit you.

B. No-Legalese Disclaimer.

I have stolen most, if not all, of my ideas and strategies from various authors, lawyers, friends and clients over several years. If I can recall who taught me a specific method or gave me an idea, I will credit them appropriately. If you are one of the people who gave me an idea and I fail to properly credit you, you have my word that I will share all the royalties I earn from this paper with you.

II. Perception-Response Time (PRT)

A. Basic Anatomy

To understand hazard perception, we must understand the basic anatomy of the human eye. The cornea is the outside of the front of the eye where light enters. The pupil is the dark circle in the center of the eye. The iris is the colored portion of the eye that controls how big the pupil is, which determines how much light is allowed to pass through the lens. The retina is the area on the inside of the back of the eye. As light enters, the lens focuses light onto an area of the retina called the fovea.

The retina has two types of receptor cells: rods and cones. Rods, which are present everywhere in the retina except in the fovea, function primarily in low-light situations and do not provide color vision. Cones are found mostly in the fovea, operate

[1] Studies indicate that jurors will more often look to the plaintiff's conduct as a way to separate themselves from the plaintiff's plight and resolve their discomfort with the notion that bad things can happen to good people. This phenomenon is termed "defensive attribution." Jurors will compare the plaintiff's conduct with what jurors believe they would have done in the same position. When making the comparison, jurors seem not to ask whether they have ever acted the same as the plaintiff did, but rather, whether hypothetically they would have acted the same way under the same circumstances. If the juror can conclude that the plaintiff was irresponsible in some way and brought the harm on himself, then the juror can maintain their belief that life is fair. N. Feigenson, *et al*., *Effects of Blameworthiness and Outcome Severity on Attributions of Responsibility and Damage Awards in Comparative Negligence Cases*, 1(6) LAW & HUM. BEHAV. 597 (Dec. 1997).

in situations where more light exists, and provide color vision.

The fovea covers a very small area of the total field of vision, so most of a person's vision is peripheral. For this reason, a hazard usually is initially *detected* within the periphery and then *identified* when the person's eyes shift and the object falls within the area covered by the fovea. But to cause this shift, the object must be conspicuous enough to attract the person's attention. In general, the farther away the object is from the foveal area, the harder it is to detect.

B. Perception

A discussion about driver perception-response might begin with driver perception, however, that is not really the beginning. Perception is actually the end of a process that starts with sensation. Sensation provides the data and information that is then used by the brain to create the viewer's perception or conscious experience of the outside world. Therefore, much of what we "see" is not provided by the sensory process, but rather, supplied by our brains. The fact that we see objects in our dreams with perfect clarity proves that we do not need the information provided by our eyes to see. In other words, what we see is just what we think we see, which may or may not be consistent with reality

Now, to be sure, when we are consciously perceiving, we are using the data and information provided by the sensory process. But the 2D images projected on our retinas do not tell us what we need to know about speed, distance, size, and form. These gaps in information are filled by our brain combining these present sensations with memories and expectations to create our conscious experience of the outside world.

Why is it important for us to recognize the distinction between sensation and perception? It is important because we need to ensure that we, and the experts who may be testifying in our cases, are asking and answering the right questions. Too often, when trying to determine whether something was "visible," an expert will simply determine a driver's line of sight and measure the first point at which driver could have observed a hazard. That procedure ignores the fact that just because something was within the driver's visual field does not mean that it was "seen," considering that truly seeing the hazard is a process that occurs in the individual viewer's brain based on his memories and expectations.

C. Stages of Driver Perception-Response

Most literature on the subject of driver perception-response breaks the process into four stages; (1) detection, (2) identification, (3) decision and (4) response. Notwithstanding there being four individual stages, the process should be viewed as a single event. The line between each stage is often blurred and can overlap. Depending on the circumstances, certain steps may be skipped entirely, or may take an extended period of time.

1. Detection

This stage typically begins when the hazard enters the driver's visual field and lasts until the driver develops a conscious awareness that some object is present.

2. Identification

The identification stage is where the driver accumulates sufficient information about the object ahead in order to determine that it is something to which the driver wants to respond. The driver may still not know exactly what the object is, other than it is something to which the driver must respond. In this stage, the driver is also determining what the object may be doing or capable of doing in order to predict its future movement or position.

3. Decision

During this stage, the driver, armed with the information he has accumulated during the detection and identification phases, as well as the knowledge and experience of the capabilities of his vehicle, is evaluating available options and determining the best course of action.

4. Response

In this stage, the driver's brain sends commands to the driver's body to carry out whatever action the driver deems appropriate, if any. This stage ends when the driver has begun to take action, such as a steering input or stepping on the brake. The time it takes for the action to be completed is not normally included when computing the driver's perception-response time.

In this stage, the brain is a serial processor, meaning it can process only one thing at a time. In short, a person can be aware of many things at once, but can only react to one at a time.

III. Statistics

This author is aware that many lawyers picked their profession because they had an inability or unwillingness to perform math or work with numbers. Notwithstanding, a brief discussion of statistics and how they are used to try to define "reasonableness" is necessary.

A. Mean and Median

The average or "mean" is the sum of all data points in a distribution divided by the number of data points. The median, by contrast, is the point along the distribution where half of the data points lie above and half lie below. In an exact "bell shaped curve" or normal distribution, the median and the mean will be the same.

B. Variability

It might seem logical to a lay juror that if a driver's perception-response was "below average" when compared to other drivers, that driver must have not been acting reasonable. But, the average tells us nothing about the spread of the distribution, the shape of the distribution or how one distribution relates to other distributions. So, the average is a useless figure and may very well be misleading.

There is a high degree of variability when measuring the abilities of a single person or a collection of humans. This is especially true when measuring peoples' ability to respond to a certain stimuli. While there are physical limitations that make it impossible for a human to respond quicker than a certain amount of time, there is no limitation on how long it can take. Therefore, the distribution of response times will necessarily be positively skewed. And, in a skewed distribution, the average is significantly affected and becomes less useful as a measure of central tendency.

Because of the importance of variability, human factor scientists use percentiles to convey the position of a result on a distribution. For example, if a person's response was equal to or better than 85% of the other data points, they would be at the 85^{th} percentile. In traffic engineering, it is common to use the 85^{th} percentile for describing reasonable behavior. In other areas of study, the 90^{th} and 95^{th} percentiles are used.

When using statistics of a population of individuals to judge whether the conduct of a particular person was "reasonable," the question is not how that person's response compares to the "average" response, but rather, whether that person's response falls within the range of responses associated with the representative population performing the same task.

IV. Investigating the Incident

A. Reconstructing the Scene

Before we can evaluate a driver's perception-response, we need to reconstruct the collision. This is typically done using an expert. These experts use three categories of information when reconstructing a collision: physical evidence, eyewitness testimony and behavioral data.

Because these accident reconstruction experts typically produce impressive reports with lots of numbers and charts and diagrams showing the path of the vehicles before and after impact, many lawyers and jurors believe that these experts' conclusions are objective fact. In reality, their conclusions are only as good as the information and assumptions they are inputting into their computer or mathematical formula.

For example, physical evidence can consist of tire marks, debris, vehicle damage, black box data and the resting position of the vehicles. While physical evidence can seem very objective and straight-forward, using it to reconstruct a collision still requires the expert to make choices and interpret results. A simple tire mark on a road may require the expert to use judgment on where exactly the mark began, whether it was a skid or yaw mark, and whether the mark was left by a vehicle involved in the collision.

In order to fill in the gaps left by the physical evidence, these experts may rely on eyewitness testimony. Humans are notoriously bad at estimating speed, distance, and duration of time, and even worse at recalling such estimates years later in a deposition or trial. And, if witnesses contradict each other, the experts will need to reconcile this or put more weight on one witness than another.

Finally, in order to come to conclusions about how the collision occurred, the expert must make certain assumptions about driver behavior. For example, the expert may assume that the driver identified the object as a hazard within a certain period of time, say, 1.5 seconds after the hazard entered the driver's visual field. Then, the expert may assume that as soon as the driver identified the hazard, the driver applied full braking. Of course, neither of these assumptions may be accurate, but they certainly affect the expert's conclusions about a driver's behavior prior to impact.

B. Factors to Evaluate when Assessing PRT

Besides reconstructing the collision, we also need to evaluate whether any factors were present at the time of the collision that might have affected any of the driver's behavior. These factors come in three different categories; environmental, human and hazard-related factors. Some of the main factors to examine are the following:

1. Environmental Factors

a. Darkness

Generally, the less light available, the more difficult it is to perceive and react to a stimulus. This is especially true for older drivers.

b. Weather

Weather conditions affect light traveling through the atmosphere. This can negatively affect, not only visual range, but also contrast detection which results in lower visibility and causes misjudgments of speed and distance. In fact, even after rain has stopped, a wet road will appear significantly darker than a dry road and will increase headlight glare from oncoming vehicles.

Additionally, rain and snow can affect not only the driver's ability to perceive and react, but also the vehicle's ability to execute the driver's intended maneuvers.

c. Roadway-created Illusion

Sometimes the way the road, intersection or construction zone is laid out or marked can create an illusion for the driver or cause the driver to become confused as to his position in space.

d. Background Effects

Objects behind or around the hazard can create visual clutter that may obscure the hazard's visibility to a driver.

2. Human Factors

a. Age

Generally speaking, older drivers have more difficulty than younger drivers perceiving and reacting to hazards. While older drivers may have more driving experience, younger drivers often have better vision and quicker response times.[2]

b. Gender

While gender alone cannot predict or explain a driver's performance, in general, women typically perform worse on perception-reaction tests than men do.[3]

c. Vision

Historically, a person's vision has been tested by measuring their visual acuity. The test for visual acuity is the Snellen Test that we have all taken in our optometrist's office looking across the room at a chart with letters. More recently, however, research has shown that visual acuity is not the best test for measuring visual performance in real-world situations. Researchers know now that, especially at night, regardless of visual acuity, in order for an object to be seen it needs to be sufficiently brighter or darker than its background. So, doctors now are adding a contrast sensitivity test to give a more comprehensive assessment of a driver's visual function for lower light levels.

d. Expectancy

The less a driver expects to encounter the particular hazard at that time, the longer it will take them to recognize the object as a hazard and respond. A pedestrian or stopped vehicle on a residential street is more expected than these objects in the middle of an interstate freeway. Because

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[2] Der, G. & Deary, I., *Age and Sex Differences in Reaction Time in Adulthood: Results from the United Kingdom Health and Lifestyle Survey,* 20 PSYCHOL. & AGING 62 (2006).

[3] Adam, J., *et al., Gender Differences in Choice Reaction Time: Evidence for Differential Strategies,* 42 ERGONOMICS 327 (1999).

perception takes place in the brain and not the eyes, it will take the driver longer to "see" a stopped vehicle when it is located in a place that is unexpected.

e. Disease

There are numerous physical conditions or illnesses related to the driver's eyes or other areas that can affect the driver's ability to perceive and respond.[4]

f. Fatigue

Driver fatigue will lengthen perception-response time. Studies have shown that sleep deprivation affects drivers' perception-reaction time as much as intoxication does.[5]

g. Stress

While low levels of stress can increase attentiveness, high levels of stress due to a particularly threatening or urgent situation will typically lengthen perception-response time.[6]

h. Chemicals

Not surprisingly, intoxication due to alcohol or other substances will diminish a person's ability to perceive and react to an object. Many other types of medications, however, may also have the effect of lengthening a person's PRT.[7] If a driver is on any medication, we should get the drug's fact sheet to see what side effects are disclosed.

3. Hazard-related Factors

a. Contrast

Visibility really boils down to the driver's ability to sense contrast. "Contrast detection is the basic task from which all other visual behaviors are derived."[8] So, regardless of how much light is present, if the object in question lacks contrast with its background, it will be more difficult to detect.

b. Reflectance

Most of what we see originates from light being reflected off of an object as opposed to light arriving directly from a light source. So, depending on an object's texture, it can reflect light in different amounts at different angles and different wavelengths. A smooth surface like a mirror reflects light in a single direction. But, a textured object like clothing reflects light consistently in all directions. A retroreflector reflects light in the same direction from where it came. Some objects may have many different properties, so its reflectance would depend on what angle the viewer is to the light source.

c. Headlight Glare

Headlight glare can be a major problem for nighttime drivers, especially older drivers. How much it will affect a particular driver depends on the strength of the light, the spread of the beam, the aim of the beam and the wavelength. New LED headlights have increased glare as compared to older halogen lamps.

d. Speed

Depending on their speed, moving objects can be easier to detect than stationary objects. But, the direction of the movement is also important. For example, drivers are typically not very good at detecting closing speed on a stationary object. They are also not very good at detecting potential hazards

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[4] Weintraub, L., *Systemic Diseases and Highway Safety*, FORENSIC ASPECTS OF VISION AND HIGHWAY SAFETY 241 (1996); Weintraub, L., *Eye Disease and Highway Safety*, FORENSIC ASPECTS OF VISION AND HIGHWAY SAFETY 251 (1996).

[5] Powell, N., *et al., A Comparative Model: Reaction Time Performance in Sleep-Disordered Breathing Versus Alcohol-Impaired Controls*, 109 LARYNGOSCOPE 1648 (Oct. 1999).

[6] Welford, A., *Choice Reaction Time*, REACTION TIMES 73-128 (1980).

[7] Weintraub, L., *Drugs and Alcohol Affecting Highway Safety*, FORENSIC ASPECTS OF VISION AND HIGHWAY SAFETY 261 (1996).

[8] Kaufman, J. & Hayes, H., *IES Lighting Handbook*, NEW YORK: ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (1981).

approaching from the side as it involves detection in the driver's periphery where visual acuity is poor. Depending on the bearing angle, an object approaching from the side may not move across the visual field, but rather, simply grow in size. By the time it reaches a more central location and becomes more visible, it is too late to avoid.

e. Window Tint

The presence of windshield tint reduces visibility as compared to clear glass. The SAE standard for windshields is that they shall transmit not less than 70% visible light. Most tinted windshields, especially when tested at an angle as opposed to vertically, fail to meet this standard.[9]

V. PRT Studies

After reconstructing the collision and considering all of the factors that could affect the driver's behavior, the next step is usually to attempt to find research that measures PRT in similar situations as existed in the real-world case. As will be more fully explained below, this is an extremely difficult task and, accordingly, often results in experts misapplying studies to try to promote their client's arguments.

A. Study Characteristics

Some of the more important elements of PRT studies to examine are the following:

1. Clock Starting Point

Most studies will start the PRT clock at the point the hazard came into the driver's visual field, regardless of whether the hazard was perceived. This is not terribly helpful, however, because it just tells us when it was *possible* for a driver to sense the hazard. It does not, however, tell us when it was *probable* for a reasonably prudent driver to perceive the hazard.

It makes much more sense to start the clock when a hazard is perceived, but because perception occurs in a person's brain, it is impossible to know when it occurred with precision. In the laboratory where the stimulus is clear and the response is straight-forward, perception will occur very close in time to when the stimulus appeared to the test subject. In the real world, this is seldom the case.

2. Clock Stopping Point

Different studies use different events to stop the PRT clock. Some studies stop the clock when the test subject lifts off of the accelerator, some stop the clock when the subject touches the brake pedal or starts to turn the steering wheel, and others don't stop the clock until the brakes have been engaged. Obviously, depending on which clock stopping event is used, the PRT results can vary dramatically.

Regardless of what clock stopping event is used, however, the studies do not address the effect of a driver releasing the accelerator and then not braking for a few seconds while they attempt to identify the hazard, or when the driver does not fully lock up the brakes for fear that they will lose control of their vehicle. These differences illustrate the difficulty in using study results to judge the actions of an individual driver performing in a much more complicated environment.

3. Time of day

The time of day that the subjects were tested can influence their performance.

[9] Allen, M., *Visual Problems in the Automobile*, FORENSIC ASPECTS OF VISION AND HIGHWAY SAFETY 127 (1996).

For example, subjects who are tested in the early morning will typically perform slower than subjects tested at other times.[10] This is not surprising when one considers that the time of day is a bigger predictor of a collision than the driver's amount of sleep.[11]

4. Participant instructions

Many studies claim the simulated hazard was "unexpected" to the test subjects. But, it is important to know exactly what instructions were given to the subjects. For example, was the participant given any advance warning at all? Did the participant know that a hazard would appear at some point, but they just didn't know where or when? Was the participant told what the hazard would be? Was the participant told what they were supposed to do once they saw the hazard?

If test subjects are told that they will experience a hazard, what that hazard will be or what they should do when responding to the hazard, they will necessarily have a shorter PRT than drivers experiencing an unexpected hazard in the real world.

5. Amount of time driving

The amount of time the test subject drove before experiencing the hazard can influence their PRT. Subjects who drive less than 30 minutes before experiencing the hazard perform better and are more alert than those who drive longer.[12] This is not surprising considering that duration of time driving is correlated to a decrease in driving performance – the longer the subject drives the longer his PRT.[13]

6. Arousal or alertness

Test subjects are, obviously, aware that their performance is being monitored. They are in an unusual situation making them more aroused or alert than drivers in the real world who are not driving down the road expecting something to happen at any moment.[14] Therefore, test subjects will likely record shorter PRTs than drivers in the real world.

7. Hazard ambiguity

Not all hazards are alike. In general, the more unusual or unexpected a hazard is, the longer it will take a driver to respond. As mentioned above, perception occurs in the brain, not the eyes. So, if the situation is clear, it takes very little cognition. If, however, the hazard has never been seen before by the driver or is highly unusual, the more evidence the driver will require before recognizing the stimulus as a hazard.[15]

In many studies, the "hazard" may not be a hazard at all, but rather, a light or sound acting as the stimulus to the driver to perform some function. Subjects that are responding to very clear and unambiguous stimuli will post lower PRTs than drivers encountering unexpected hazards in real life.

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[10] Corfitsen, M. T., *Tiredness and visual reaction time among young male nighttime drivers: a roadside survey*, ACCIDENT ANALYSIS & PREVENTION, 26 (5), 617-624 (1994).

[11] Wylie, C. D., et. al., *Commercial motor vehicle driver fatigue and alertness study; Project report*, TECHNICAL REPORT FHWAMC-97-002, Federal Highway Administration (1996).

[12] Mackworth NH, *The breakdown of vigilance during prolonged visual search*, QUARTERLY JOURNAL OF EXPERIMENTAL PSYCHOLOGY, 1, 5-61 (1948).

[13] Green, M., ROADWAY HUMAN FACTORS: FROM SCIENCE TO APPLICATION, 425 (2018).

[14] Prynne, K. & Martin, P., *Braking behavior in emergencies*, SAE TECHNICAL PAPER 950969 (1995).

[15] Näätänen, R. & Summala, H., ROAD USER BEHAVIOR AND TRAFFIC ACCIDENTS (1976).

8. Environmental conditions

It is important to know what the environmental conditions were when the study was done. Any sort of weather condition, low light, lack of contrast, condition of the road surface, etc. will all effect a driver's PRT.

9. Speed

Most studies are performed at relatively low speeds. This eliminates the risk of losing control if the test subject takes extreme driving or braking maneuvers. Real-world drivers, on the other hand, must evaluate the risk of losing control when they are formulating their response to a hazard. This can cause their PRT to be longer.[16]

10. Driver stress

Test subjects have the benefit of performing in an environment where they can be confident they are not going to suffer harm. Drivers in the real world who experience an unexpected hazard, on the other hand, must deal with the emotional effects that accompany fear of death or harm.[17]

11. Sample demographics

It is important to ensure that the studies being used include test subjects that share the same attributes as your client. For example, the age and gender of the test subjects in the study can be important. People's driving performance tends to degrade with age, especially when dealing with complex situations.[18] Additionally, women tend to do slightly worse than men in PRT tests.[19] Lastly, one should examine what screening efforts were made before the study that could have resulted in a population of test subjects that were in better health than the norm.

12. Level of urgency

Test subjects responding to hazards that are farther away will typically do so slower than subjects reacting to hazards nearby.[20] This is especially true for vehicles approaching a stationary object. Most drivers are not capable of appreciating the fact the object is stopped until the object is much closer than when the driver first senses the object in his field of vision.[21] On the other hand, hazards that appear suddenly and are conspicuous evoke faster responses from subjects than hazards in the distance that develop slowly.

13. Response conflict

Response conflict refers to the various contingencies facing the driver once he has perceived the hazard. When humans are offered the choice between two good

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[16] Chryler, S., *et. al.*, *Driver workload at higher speeds* (No. FHWA/TX-10/0-5911-1) TEXAS TRANSPORTATION INSTITUTE (2010).

[17] Dilich, M., *et. al.*, *Evaluating driver response to a sudden emergency: Issues of expectancy, emotional arousal and uncertainty*, SAE TECHNICAL PAPER, 01-0089 (2002).

[18] Edwards, C., *et. al.*, *Older and younger driver performance at complex intersections: implications for using perception-response time and driving simulation.* Presented at the Second International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design (2003).

[19] Adam, J., *et al.*, *Gender Differences in Choice Reaction Time: Evidence for Differential Strategies*, 42 ERGONOMICS 327 (1999).

[20] Pierce, R. S., & G. J. Andersen, *The effects of age and workload on 3-D spatial attention in dual-task driving*, ACCIDENT ANALYSIS & PREVENTION, 67, 96-104 (2014).

[21] Markkula, G., *et. al.*, *A farewell to brake reaction times? Kinematics-dependent brake response in naturalistic rear-end emergencies*, ACCIDENT ANALYSIS & PREVENTION, 95, 209-226 (2016).

things, they can often respond quickly and easily. Do you want cake or ice cream for desert? But, when the choice involves bad things, or when the alternatives have both good and bad attributes, the choice is more difficult.[22] Do I avoid the hazard by steering right and going off an embankment or do I steer left into oncoming traffic, or do I just brake and hit the hazard at a lower speed?

Situations that involve response conflict will cause longer PRTs. In fact, sometimes drivers can become so overwhelmed with the decision, they end up not responding at all. In those cases where there was no driver response, then obviously, the PRT is irrelevant.

14. Amount of cognitive load required

Cognitive load refers to the demand made by the situation on the driver's attention. Most test subjects participating in a driving test are driving on a level, straight road or track without other traffic. Often, they are told exactly where to drive and how to drive, regardless of whether that is how they would normally drive. The environment around them is usually very simple, without the typical challenges facing drivers in the real world such as congestion, complicated intersections, road surface changes, sharp turns, interfering passengers or vehicle technology, etc. Therefore, with less cognitive load, test subjects will often perform better than drivers in real life.

15. Location of hazard in the visual field

As discussed above, if a hazard is located in the center of the visual field, it can be identified easier than if it is viewed in the driver's periphery. So, if a study presents the hazard in the middle of the driver's visual field, the test subjects will post shorter PRTs than drivers who are confronted by hazards located in their periphery.

B. Variability

When trying to use data from studies to define whether driver conduct is "reasonable," the question is not just to assign a measure of central tendency, but rather, a range of normal times. So, the "scatter" of the PRTs in a particular study is extremely important to know, not just an average or median response time.

But, even when we know the variability of data in a particular study, it likely still does not accurately represent the real world. As mentioned above, when conducting studies, researchers screen drivers and give them instructions on their task. These two factors alone will greatly reduce the variability of results as compared to the real world.

How the study is conducted may further reduce the variability of results. For example, the subjects may get to view the scene or practice the task before being tested, or certain outlier results where a driver fails to respond or responds outside of the study protocol may be discarded as not compliant. These are things to examine when evaluating the applicability of a particular study.

None of this is really surprising when one considers the fact that researchers are trying to reduce the variables involved in a study in order to isolate and test a single thing. So, they ensure that the test environment confronting each subject is the

[22] Hogarth, R. M., *Decision time as a function of task complexity*, UTILITY, PROBABILITY AND HUMAN DECISION MAKING, 321-338 (1975).

same by employing a very simple, highly controlled, extremely detailed testing protocol. For this reason as well as for safety, almost every study involves an expectant driver responding to a clear, unambiguous hazard presented in good visibility conditions driving at low speed. None of this, of course, is similar to the environment that real-world drivers experience.

And then, of course, one must consider the natural bias of the researchers themselves. They are motivated to conduct the test so they can publish a statistically significant result. If their study produces an ambiguous result or one that is not remarkable, then it has less of a chance of being published, which may jeopardize grants or funding for future testing projects.

For these reasons, the scatter of the PRTs will be much greater than with test subjects. PRT distributions (i.e. curves) in studies, therefore, will be much steeper and skewed to the left, with a long tail toward the right (slower PRTs). This steep, irregular curve means that reporting data using standard deviation may greatly underestimate the amount of variability in the slower PRTs.

VI. Application to Real World

As demonstrated above, using the test subjects' PRTs from a study to try to judge a driver's performance in the real world is fraught with problems. The studies are, at best, inadequate and, at worst, misleading. Researchers work hard to reduce the number of variables so they can test the effect of manipulating a single independent variable on PRT. This over-simplification of the testing environment makes it extremely difficult to then apply the test results to the real world where drivers are continually facing complex situations involving rapidly changing, sometimes confusing environments with completely unexpected hazards.

It is a natural tendency for people to want to have an objective benchmark against which a driver's conduct can be measured. If the driver's PRT (assuming we were able to accurately compute it) was equal to or faster than the benchmark, the driver was "reasonable." If not, the driver was "unreasonable."

The objectiveness and certainty of such an approach seems so "scientific." The problem is, however, in order to utilize the formulas necessary to compute such a benchmark, we have to fill in the blanks with values that are purely speculative. Such an approach, of course, is not scientific at all.

In reality, we have to recognize and be able to explain to the jury that a long PRT is not the cause of anything, it is the result or symptom of something else. Collisions do not occur because of measurements or mathematical formulas. A car doesn't run out of gas because the gas gauge says the tank is empty.

So, the question of what a driver's PRT was is not the right question to ask if we are seeking to identify the cause of a collision. Instead, the question should be, "Why was the driver's PRT long?" Depending on the circumstances, it doesn't necessarily mean that the driver was not paying attention. In fact, often the most cautious drivers are the slowest to respond and apply the least amount of pressure to the brakes.[23]

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[23] Fambro, D. B., *et. al.*, *Determination of stopping sight distances.* TRANSPORTATION RESEARCH BOARD NCHRP REPORT 400 (1997).

> Some will find the conclusion that PRT isn't very important difficult to accept because it runs contrary to a strong human cognitive bias, "fundamental attribution error" (Ross 1997). When a person judges the cause of an event, he can assign it to either dispositional factors inside the person or to situational factors outside the person's control. People in our culture are heavily biased toward blaming individual disposition even though most individuals act the same way in the same situation. The fundamental attribution error is very powerful and highly resistant even to strong evidence that environmental constraints were the primary cause. It is also a prime promoter of hindsight bias.[24]

So, as trial lawyers representing an injury victim who is getting blamed by the defense for not reacting in time, what are we to do if we can't point to a study and argue that our client's conduct was, by comparison, reasonable? First of all, we must prevent the defense from using studies to misrepresent the facts or mislead our jury.

Secondly, we must focus our trial story and the jury's attention on the cause of the long PRT. Assessing cause is just a series of "why" questions. Why was our client's PRT long? Because she could not recognize the stopped 18-wheeler in the road in time to avoid it or stop. Why? Because it had deteriorated retroreflective tape on its trailer. Why? Because it had not been changed in over seven years. Why? Because the motor carrier leasing the trailer failed to maintain it. Why? Because the motor carrier had no maintenance program in place to ensure the tape was changed out regularly or on an as needed basis. And, so on.

[24] Green, M., ROADWAY HUMAN FACTORS: FROM SCIENCE TO APPLICATION 415 (2018).