

Cognitive and Neurobiological Perspectives on Why Parents and Caretakers Lose Awareness of Children in Cars

Background and Historical Perspective

One aspect of my research program is the study of how normal (i.e., attentive and loving) parents and caretakers, without evidence of abuse or neglect of children, and without evidence of drug abuse or organic brain dysfunction, *unintentionally and unknowingly*, leave children in cars. Under conditions in which the ambient temperature is warm enough and the car is exposed to direct sunlight, heat builds within the car and the child may die or become brain damaged as a result of hyperthermia. It is difficult to understand how a person can leave a child in a car, and yet, it appears to occur at an alarmingly high rate. A survey of 1000 parents which was presented at the National Lifesavers Conference on Highway Safety Priorities in 2014 reported that approximately 25% of all parents with children under 3 reported that at some time during a drive they had forgotten that their child was in the car with them (<http://www.safekids.org/press-release/new-study-14-parents-say-they-have-left-child-alone-inside-parked-vehicle-despite>).

Research indicates that children have been forgotten in cars by non-parental caretakers and mothers and fathers at all levels of socioeconomic status and education, including well-educated and highly responsible people, such as a physician, teacher, news reporter, judge, prosecutor, pediatrician, firefighter, dentist, hospital administrator, daycare owner and professors. Children dying in hot cars has been discussed in the media, including an article in the Washington Post which won the Pulitzer Prize: (http://www.washingtonpost.com/wpdyn/content/article/2009/02/27/AR2009022701549_pf.html). Considering how widespread, fatal and tragic this phenomenon is, it is important to understand it from a scientific perspective, and more importantly, to prevent it from occurring.

Cognitive and Neurobiological Perspectives

When I began studying forgotten children in cars in 2004, over 100 children had already died after being left in hot cars (www.KidsandCars.org/statistics.html; www.noheatstroke.org). Since that time, over 300 more children have died or suffered brain damage from heat stroke after being forgotten in hot cars. As a behavioral neuroscientist I have studied this phenomenon from neurobiological and cognitive perspectives. The hypotheses and conclusions I have developed are based on my scientific background, in conjunction with interviews with parents, reading of police reports, media reports and my service as an expert witness in civil and criminal cases.

My hypothesis as to how children have been unknowingly and unintentionally left in cars is described at length in my publication entitled “**When a Child Dies of Heatstroke after a Parent or Caretaker, Unknowingly, Leaves the Child in a Car: How Does it Happen and is it a Crime?**” in *Medicine, Science and the Law* (DOI: 10.1177/0025802419831529). In this peer-reviewed publication, I explained that children forgotten in cars results from: a) the driver loses awareness of the presence of the child in the car; 2) the driver exhibits a failure of the brain’s “prospective memory” system; 3) intervening events during the drive, including stressors and strong

distractions, may contribute to the cause of the failure of “prospective memory”; competition between “habit” and “prospective memory” systems.

Based on my research into these cases and my expertise in the study of the brain and memory, I have concluded that all of these cases all involve the failure of the brain’s prospective memory system. Psychologists define prospective memory by its three features: (1) the person has an intention to perform an action at a later time when circumstances permit; (2) there is a delay between forming and executing the intention, a delay which typically is filled with activities not directly related to the intended action; and (3) there is typically an absence of an explicit prompt indicating that it is time to retrieve the intention from memory—the individual must “remember to remember.” In the current context, prospective memory refers to the plan to transport a child to a location, typically daycare or to return home, which can occur during the course of a multi- or single-stop drive, or to retrieve a child from the car at the termination of a drive.

Habit memory, by contrast, refers entirely to actions going on in the present. Habit memory involves tasks with repetitive actions which are performed automatically, as in driving from one location to another, such as from home to work with minimal conscious effort. The habit memory system has been referred to as our brain’s “autopilot” system.

I also discussed the capacity for interactions between our prospective and habit memory systems to produce catastrophic outcomes in my article published in *The Conversation*, entitled: “[An epidemic of children dying in hot cars: a tragedy that can be prevented](#)”. In that article I explained how people lose awareness of children in cars and the brain memory systems that are involved in this process. Specifically, there are two independent brain memory systems with structures that are involved in prospective and habit-based memory processing. The prospective memory system involves two brain structures, the hippocampus (HC) and prefrontal cortex (PFC), which work together to optimize the conscious planning of future activities and memory multi-tasking. The habit-based memory system is based on the functioning of the basal ganglia (BG), a brain structure that enables people to accomplish well-established routine behaviors with minimal conscious effort.

A relatively benign example of BG domination over the HC-PFC system is when a person has the plan (prospective memory) to stop at a store for groceries on the way home from work. However, the person drives right past the store, oblivious to the plan to stop there for groceries. An explanation for this type of memory error is that the habit-based memory system (BG) suppressed the prospective (HC-PFC) memory system from interrupting the drive home to stop at the store. The memory of the plan to stop at the store is reactivated only when the person is exposed to a distinct cue, such as an empty refrigerator, upon returning home. The person reports that during the drive, he/she had lost awareness of the plan (and therefore forgot) to stop at the store on the way home.

The importance of prospective memory failures, however, is not always as benign as forgetting to buy groceries. There are documented examples of prospective memory-related fatal or potentially fatal tragedies: airline pilots and ground flight crew memory

errors have caused the loss of life in plane crashes, police officers have forgotten their loaded guns in public restrooms and dogs have died of hyperthermia after they were forgotten in cars.

Cases of forgotten children in cars involve a failure of the prospective memory system to function properly. An explanation for this failure is that the parent's habit memory system outcompetes their brain's prospective memory system. In all of the cases I've studied, the parent begins the drive with the plan to bring the child to a destination, but at some point during the drive the parent reports having lost awareness of the child in the car. In these cases the parent travels directly to the final destination (typically home or work), and in the process, exits the car without awareness that the child is still in the car.

Features in Common in All Cases: Impaired Prospective Memory When a Parent Loses Awareness of the Child in the Car

Although each case involves different circumstances, they share elements in common. The primary feature which is common to all cases is that the route the person took on the day in which the child was forgotten overlapped with similar routes the parent had driven previously, or, in a subset of cases, the parent had never before driven on that route with the child. Therefore, the most important feature of these cases is that the parent depended solely on his/her prospective memory to distinguish the drive with the child on that day from similar routes the parent had driven on other days that did not include the child.

There are three categories of driving routes in cases of forgotten children in cars. The first category is a multi-stop route, in which the parent had planned on making more than one stop during a drive, one of which was to take the child to a daycare provider. In some cases, the parent/caretaker stopped to take one child to daycare, but then lost awareness of another child in the car during the next leg of the drive. Typically, the parent follows a well-traveled route to take an older child to daycare, and then follows the well-travelled route to work, and in the process, loses awareness of the second, younger, child in the car. The second category is a single-stop route, typically to take a child to a daycare provider, and then the parent had planned to drive to another destination, typically where the parent was employed. The third category is a non-stop route, in which the parent had a single destination, such as to go home or shopping, with the plan to retrieve the child from the car upon arriving at the destination. The common factor in all of these cases is that at a critical choice point along the drive, whether it was a multi-, single- or non-stop drive, all parents/caretakers report having lost awareness that the child was in the car.

Factors That Contribute to the Loss of Awareness of a Child in the Car

I have studied the conditions that appear to increase the likelihood that a child will be forgotten in a car. The following are categories of influences that would impair prospective memory and would also increase the dominance of habit memory over prospective memory:

- 1) Many, but not all, of the parents report that they had a strong stress or a highly distracting experience prior to or during the drive. Neuroscience research has shown that stress has a selective adverse effect on prospective, but not habit, memory. Although not

obligatory, the stress or distracting experience helps us to understand why a subset of parents lost awareness of the child in the car.

2) As with stress, many, but not all, of the parents report that they had interrupted sleep on the night before the incident. Sleep deprivation has a selective adverse effect on prospective, but not habit, memory. Although not obligatory, sleep deprivation helps us to understand why a subset of parents lost awareness of the child in the car.

3) There is often a change in the driving route on the day of the incident that reduces the parent's awareness of the child in the car. For example, a parent may typically drive straight from home to daycare to work, but on the day of the incident, the parent changed the route, to drive, for example, from home to a fast food restaurant (for breakfast). As a result of the change in route, in conjunction with a sleeping child, the basal ganglia triggers an autopilot response to take the person directly from the fast food restaurant to work, bypassing the planned route to daycare.

4) Parents that have forgotten children often report that they had routinely interacted with their child during a typical drive, but on the day of the incident the child was unusually quiet (presumably sleeping). The change in the interpersonal dynamics between the parent and child would be identified by the basal ganglia as a day in which the child was not present in the car. Therefore, the "autopilot system" would recognize the drive with a quiet child as one without the child; in the absence of child-specific cues, the basal ganglia would direct the parent to go directly to work, rather than to daycare.

Factors That Reduce the Likelihood a Child Will Be Forgotten in a Car

As noted above, approximately 25% of all parents with children under 3 reported that at some time during a drive they had forgotten (lost awareness) that their child was in the car with them. If so many parents lose awareness of children in cars, why are hot car deaths of children not more common? There are numerous factors that can interfere with the process by which a child is left in a car, or if left in a car, will reduce the likelihood the child will be harmed by heat stroke. I have observed the following influences which have been reported by parents that had lost awareness of their child during a drive, but no harm had come to the child:

1) After losing awareness of the child, parents have reported the presence of a cue, a specific reminder, that the child is in the car. The child may make a sound, or something may be in the car, such as an item, such as a diaper bag, that needs to be retrieved in the front or back seat, which jogs a parent's awareness of the child in the car.

2) Environmental conditions are highly important. The greenhouse effect (whereby the interior of a car can be 30-40 degrees hotter than the exterior) is dependent on a car having full sun exposure on a sufficiently warm day, for a sufficient period of time. There are reports of children which were unharmed after being left in cars on days that were not warm enough to cause hyperthermia. In related observations, parents have reported leaving their child in a car in a covered parking facility, which therefore would leave the car's internal temperature equal to the ambient temperature in the parking structure.

3) Timing is important. If the ambient temperature is warm enough and the car is left in full sun exposure, a child may not develop hyperthermia if a parent returns to the car in a short period of time. There is an interaction among the ambient temperature, degree of sun exposure of the car and the time a person is away from a car before the interior of the car is sufficiently hot to cause harm to the child.

4) Oftentimes the parent that had lost awareness of the child was not alone, and one or more passengers may have taken note of the presence of the child. There are documented cases, however, in which two individuals both lost awareness of the presence of the child in a car, resulting in the child dying in a hot car.

5) There are numerous reports of bystanders who removed a child from a hot car. In my experience this has happened far more often when cars are parked in high pedestrian traffic areas, such as retail shopping parking lots, than when cars are parked at home or the parent's place of employment.

Universal Observation of a False Memory

An important and universal observation of the reports from these parents and caretakers is based on their activity during the day after the child is left in the car. These parents go about their daily routine, sometimes for an entire day's work and they even use the car (with the deceased child in it) during the day, without the parent having any awareness the child is in the car. These people universally report having complete confidence that the child was safe, at the location where the parent had intended on taking the child. Indeed, many parents return to the daycare expecting to retrieve their child, only to be told that the child did not arrive at daycare that day. These individuals are then horrified to learn that their child spent the entire day in their car, with fatal consequences.

It is potentially of scientific value to explore the process by which the brain somehow creates the false memory that the person has fulfilled his/her task of bringing the child to daycare, or that the child was at home. It is notable that everyday routine activities that may involve the child, such as discussing the child with others, or having a picture of the child at the parent's workplace, do not serve as reminders that the child is in the car since the brain has provided the person with the false memory that the child is safe at home or at daycare. With the false memory in place, any reminders of the child during the day are considered a routine part of a normal day. The only cues that would be relevant to reactivating the prospective memory must be cues that would specifically indicate that the child is in the car, such as a phone call from a daycare employee inquiring as to why the child had not come to daycare that day.

Expert Witness Testimony and Service as a Science Advisor in Legal Cases

Service to the Defense or State in an Advisory Role

January, 2008

Defense Expert Consultant on Brain, Memory and Stress to Zwerling, Leibig & Mosely, P.C.

Charge: Manslaughter

Commonwealth of Virginia v. Balfour

A child died when his mother forgot him in a hot car

September, 2010

Consultant to a Prosecutor (Ron O'Brien; Columbus, Ohio) on the Brain and "Forgotten Baby Syndrome" to aid in the determination of charges (no charge, manslaughter or murder)

A child died when his mother forgot him in her car

September, 2010

Defense Team Expert Consultant on Brain Functioning to Captain Elizabeth A. Ramsey, US Army Trial Defense Services

United States v. Sergeant Tina M. Laboy

A child died when parents did not notice that their child drowned in a pool

August, 2014

Consultant to a District Attorney (Brock Belnap; St. George, Utah) on the Brain and "Forgotten Baby Syndrome" to aid in the determination of charges (no charge, manslaughter or murder)

A child died when her mother forgot her in her car

February, 2016

Defense Expert Consultant on Brain, Memory and Stress to Stephen Butcher

Royal Society for the Prevention of Cruelty to Animals v Patrick Shaddock

Charge: Animal Cruelty

A guide dog died when his caretaker left him in his car

September, 2016

Defense Expert Consultant on Brain, Memory and Stress to Dawn Priestman

State of Arizona v. Jared Ledo, Tucson, Arizona

Charge: Manslaughter

A child died when his father forgot him in his car

October, 2016

Defense Expert Consultant on Brain, Memory and Stress to Maddox Kilgore

State of Georgia v. Ross Harris

Charge: Murder

A child died when his father left him in his car

October, 2016

Defense Expert Consultant on Brain, Memory and Stress to Steven Secare

State of New Jersey v. Karen Gruen

Charge: Negligence

A parent left a child in hot car while shopping. The child was unharmed.

December, 2016

Defense Expert Consultant on Brain, Memory and Stress to Ron Hanes

State of Florida v. Troy Whitaker

Charge: Manslaughter

A child died when her father left her in his car

December, 2017

Defense Expert Consultant on Brain, Memory and Stress to Jennifer Moster

State of Florida v. Steven Lillie

Charge: Manslaughter

A child died when her father left her in his car

October, 2018

Defense and Prosecution Expert Consultant on Brain, Memory and Stress to David Terry/Richard Wesenberg, Jr.

State of Florida v. Nicole Engler

Charge: Manslaughter

A child died when her mother left her in his car

February, 2019

Defense Expert Consultant on Brain, Memory and Stress to Tye Harmon

State of New Mexico v. Sandi and Mary Taylor

Charge: Manslaughter

One child died and another became brain damaged when daycare providers left the children in their car

Service to the Defense as an Expert Witness in a Criminal* or Civil Trial

July, 2009

* **State of Pennsylvania v. Rimma Shvartsman**

Charge: Manslaughter

A child died when a caretaker forgot him in a hot car

January, 2010

Harrison v Division of Child Services (State of Virginia)

The State of Virginia sought to block the adoption of an infant by a father who forgot his child in a car

February, 2013

* **State of Wyoming v. Kaleb Laatsch Gillette, Wyoming**

Charge: Criminal Negligence

A child suffered brain damage when his father forgot him in his car

June, 2014

- * **Public Prosecutions v. Jayde Poole
Bendigo, Victoria, Australia**

Charge: Manslaughter

A child died when her mother forgot her in her car

September, 2015

- * **State of Texas v. Wakesha Ives
El Paso, Texas**

Charge: Manslaughter

A child died when her mother forgot her in her car

August, 2016

- * **State of Arkansas v. Wade Naramore
Hot Springs, Arkansas**

Charge: Manslaughter

A child died when his father forgot him in his car

October, 2016

- * **State of Arkansas v. Wade Naramore
Hot Springs, Arkansas**

Charge: Negligence

A child died when his father forgot him in his car

December, 2016

- * **State of Iowa Child Protective Services v. Trent Steinhart
Des Moines, Iowa**

Charge: Child Abuse

A parent left a child in hot car while shopping. The child was unharmed.

August, 2017

- * **State of Iowa v. Lance Williams**

Charge: Manslaughter

A child died when his father forgot him in his car

July, 2018

- * **State of Texas v. Raymond Licon, Jr.
El Paso, Texas**

Charge: Criminal Negligence

A child drowned when his father forgot him in the bathtub

July, 2018

- * **State of Texas v. Michael Thedford
McKinney, Texas**

Charges: Criminally Negligent Homicide, Tampering with evidence

A child died when his father forgot her in his car

November, 2018

- * **Commonwealth of Pennsylvania v.
Brittany Borgess, Williamsport, Pennsylvania**

Charges: Manslaughter, endangering a child, reckless endangerment

A child died when her caretaker forgot her in her car

October, 2019

- * **State of Tennessee v. Jade Phillips**
Sevierville Tennessee
Charge: Reckless Endangerment
A child died when the father forgot him in a car

Cases Pending

- ***State of Texas v. Franke**
Charge: Murder
Two children died of heatstroke when a mother left them in a car
- ***State of Florida v. St. Charles**
Charge: Aggravated manslaughter
A child died of heatstroke in a daycare transport van
- ***State of Arizona v. Holly**
Charge: Child neglect
A child was forgotten in a car, but was not harmed
- ***State of California v Melendez**
A driver (Melendez) was charged with manslaughter after leaving a dependent passenger in a car

Service as an expert in cases involving PTSD litigation

Huber v. Granby Ranch

Charge: Negligence

A Colorado ski resort has been charged with negligence in causing the death of a ski lift rider, which resulted in PTSD in the child passengers

Wills v. Imperial Industrial Supply Co.

Charge: Faulty Product leading to traumatic injury

Robert Wills was severely burned and developed PTSD following use of a generator manufactured by Imperial Industrial Supply Co.

Outcome: settled out of court, 2019

Conference Presentations on the Neuropsychology of How Children are Forgotten in Cars

March, 2018

2018 Lifesavers National Conference on Highway Safety Priorities
“Neurobiological Perspective on How Parents Lose Awareness of Children in Cars”

September, 2019

National Highway Traffic and Safety Administration/ Department of Transportation Child Safety Passenger Safety Forum
Lecture: “Neurobiological Perspective on Children are Forgotten in Cars”

October, 2019

Office of Criminal Conflict and Civil Regional Counsel, Central Florida
Lecture: *Legal and Neuropsychological Perspectives on Catastrophic Memory Failures*

March, 2020

Faculty of Forensic Psychiatry Annual Conference, Liverpool, England
Keynote Lecture: Neuropsychological and legal perspectives on tragic memory errors

March, 2020

2020 Lifesavers National Conference on Highway Safety Priorities
Tampa, Florida
Neuropsychology of Tragic Memory Failures