CHILDREN FORGOTTEN IN HOT CARS: A HYBRID MENTAL MODELS APPROACH FOR IMPROVING PUBLIC HEALTH MESSAGING

by

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(Under the Direction of Andrew J. Grundstein)

ABSTRACT

On average, in the United States, 37 young children die every year due to vehicular heatstroke. While various governmental and child safety advocacy groups have worked to raise awareness about these tragedies, rigorous studies have yet to be conducted that examine the current understanding and effectiveness of public health and child advocacy group messaging. This thesis uses a hybrid mental models approach, using structured questions guided by the Health Belief Model to identify discrepancies that may exist between experts' and parents'/caregivers' knowledge surrounding the topic of children forgotten in hot cars. A comparative analysis revealed two key differences between these mental models: 1) their primary source of information and 2) an increased risk attributed to lifestyle factors. Finally, this thesis discusses the applicability of these results for future public health messaging, to emphasize that all parents/caregivers of young children are equally susceptible to forgetting their child in a hot car.

INDEX WORDS: heatstroke, children, vehicle, mental model, health belief model, risk communication

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

1.1 Overview and Project Motivation

In the United States alone, on average, 37 young children die every year due to vehicular heatstroke (Null 2016). Further, these incidents involve a parent or caregiver forgetting a child in a hot car (54% of cases), children trapped in vehicles/trunks (29%), and children intentionally left in a vehicle (17%; Null 2016). Unfortunately, the current pediatric vehicular heatstroke statistics may not accurately reflect the number of children affected annually. The current and only database, created by Null (2016), solely relies on the news media to report a hot car death. As a result, there are several circumstances in which a hot car death may not be added to the database: 1) if a story does not get picked up, 2) if an incident does not get reported to the news media, or 3) if a bigger story is dominating on the day of the report. Therefore, even though this has been a prevalent health issue in the news media over the past years, it is likely that these incidents are underreported. Another concern associated with vehicular heatstroke, involves the link between heat and health in a changing climate. With climate change increasing both average and extreme temperatures, this will lead to a future that is more favorable of heat-related illnesses and death (Mills et al. 2015; Sarofim et al. 2016). Additionally, this will alter the geographic vulnerability of many and increase the risk for vehicular heatstroke incidents beyond the summer months (Duzinski et al. 2013) and

climatologically warmer regions of the United States (Grundstein et al. 2011) Although vehicular heatstroke lies at the intersection of public health, injury prevention, and atmospheric sciences, a large portion of the research literature heavily focuses on questions driven by the physical sciences. For example, the major topics include: understanding the microclimate conditions in the vehicle (Roberts and Roberts 1976; Zumwalt and Petty 1976; King et al. 1981; Surpure 1982; Gibbs et al. 1995; McLauren et al. 2005; Grundstein et al. 2009; Grundstein et al. 2010; Duzinski et al. 2013; Grundstein et al. 2015) and examining the characteristics of past incidents (Guard and Gallagher 2005; Booth III et al. 2010; Grundstein et al. 2011; Ferrara et al. 2013). However, researchers have slowly begun to take notice and realize that this scientific perspective is only one side of the solution.

In order to effectively communicate scientific and public health information and the results from previous studies in this area, it is imperative to better understand how to improve and promote future public health messaging. Guard and Gallagher (2005) were the first researchers to suggest that a multifaceted approach, involving communication, policy, and technological interventions, may be necessary in helping parents and caregivers prevent vehicular heatstroke. While many researchers have offered advice and suggestions for reducing vehicular heatstroke incidents, rigorous studies have yet to be completed evaluating the effectiveness of current messaging or parents'/caregivers' awareness and behavior. Various governmental and child safety advocacy groups have worked to raise awareness about these tragedies; however, the degree of awareness and perceived susceptibility of parents and caregivers remains unknown. To fill this gap in the literature, this study will examine awareness and perceptions on the topic of children

forgotten in hot cars. The incidents involving a child being forgotten in a hot car have been chosen because they represent over 50% of past cases, and they provide an opportunity to explore the psychological characteristics associated with the issue. Moreover, risk communication and health behavior theoretical models will be used to explore this health topic.

Without an empirical understanding of parents' and caregivers' knowledge, risk perceptions, beliefs, and opinions, it is difficult to understand their current decision-making processes. To address this missing element, a mental models approach to risk communication will be utilized (Morgan et al. 2002). Mental model studies are useful in determining the type of knowledge and understanding that currently exists among a group of individuals (e.g. parents and caregivers) on a particular issue. Because the knowledge of experts and laypeople often differ, mental model studies help identify the differences between these groups in order to achieve improved risk communication materials that more closely align with the knowledge of a lay audience. While this is a new approach for the field of heatstroke prevention, this framework has been used to obtain a better perspective on the lay public's understanding of several meteorological communication issues such as flood risk (Wagner 2007), climate change (Bostrom et al. 1994; Lowe et al. 2007), and the creation of hurricane forecasts and warnings (Bostrom et al. 2016).

In the sections that follow, this thesis will outline the current literature surrounding the topic of pediatric vehicular heatstroke. In the second chapter, a hybrid mental models approach will be employed, using elements of the Health Belief Model, to guide interviews with 25 parents/caregivers and 7 experts. Further, this chapter will tackle the first two steps of the mental models approach by examining the mental models

of both experts and parents/caregivers surrounding the issue of children forgotten in hot cars. Additionally, the results of the interviews will be presented, followed by a discussion around 1) the similarities and differences that were observed between the expert and parent/caregiver mental models, 2) an in-depth examination of parent/caregiver responses using the Health Belief Model, and 3) the implications of this study for future public health messaging. This thesis will conclude with a chapter that summarizes the results, provides suggestions for future public health messaging, and discusses future research using the mental models approach for vehicular heatstroke prevention.

1.2 Literature Review

This literature review discusses previous research in the area of pediatric vehicular heatstroke. However, due to this area of research being predominantly examined from a physical science perspective, literature from the fields of pediatric injury prevention, epidemiology, health communication, and risk communication are outlined to better guide this work. This interdisciplinary literature review begins by exploring previous vehicular heatstroke research associated with characteristics of hot car deaths, the physics of a car environment, and alternative prevention strategies. The review will then shift toward investigating the risk perceptions of heat-related incidents and the difficulties in communicating this information to vulnerable groups. Next, risk and health communication literature will be examined and theoretical frameworks often used in injury prevention studies will be discussed. Finally, several studies from the pediatric injury prevention literature that incorporate the Health Belief Model will be

used as a reference to better understand the current knowledge and risk perceptions of parents and caregivers.

1.2.1 Previous Child Hyperthermia Characteristics

Previous literature involving pediatric vehicle-related hyperthermia (PVRH), also known as pediatric vehicular heatstroke, has investigated the characteristics and different variables associated with incidents. These cases were examined in order to determine if any similarities and/or differences exist. Three articles (Guard and Gallagher 2005; Booth III et al. 2010; Grundstein et al. 2011) have summarized PVRH cases using analyses of newspaper and media articles (Table 1.1). These studies have come to similar conclusions, finding that 1) children younger than the age of five make up 91-95% of all PVRH cases and 2) that demographic variables do not appear to have any relationship with the victims of vehicular heatstroke. The circumstances in which these incidents occurred has also been examined, with a majority of these cases involving a parent/caregiver forgetting a child in a hot car (54%), a child getting trapped in the trunk/car (29%), or a child being intentionally left in a vehicle (17%; Null 2016).

Another important aspect to examine when exploring previous vehicular hyperthermia cases involves the use of geographical data. Regional differences in climate lead to individuals and children, in some parts of the country, being more at risk for heat-related incidents. According to the records provided by Null (2016), fatalities most often occurred in the southern region of the United States (58.6% of cases; Figure 1.1). Based on the number of cases in the South (Figure 1.2) and the persistence of heat conditions associated with the climatology of this region, perhaps more vigilant messaging could be

implemented to better educate parents/caregivers about the processes that lead to extreme temperatures in the car environment.

1.2.2 Physics of Vehicular Heatstroke

The extreme temperature risk, commonly associated with vehicular heatstroke, is a result of the greenhouse effect taking place in the car environment (Figure 1.3; Roberts and Roberts 1976; Grundstein et al. 2009; Grundstein et al 2010; Grundstein 2011). Vehicle temperatures begin to rise once solar radiation, also known as short-wave radiation, enters the vehicle and is absorbed by various objects inside the car (e.g. seats, dashboard, etc.). When those objects release long-wave radiation, some of that energy becomes trapped inside the vehicle resulting in increased temperatures. Moreover, these oppressive conditions are intensified due to a lack of ventilation and movement of air inside the vehicle. In addition to the physics of heat transfer, certain meteorological conditions can increase the occurrence of a heat-related hazard. Previous experiments have investigated the impact of temperature, wind speed, cloud cover, and solar angle on the maximum temperature and overall heating rate of a vehicle (Roberts and Roberts 1976; King et al. 1981; Surpure 1982; Gibbs et al. 1995; McLauren et al. 2005; Grundstein et al. 2009; Grundstein et al. 2010; Grundstein et al. 2011; Duzinski et al. 2013). Additionally, several studies have attempted to determine the maximum cabin temperature, with a worst-case scenario ranging from 58°C (137°F) to 78°C (172°F; Roberts and Roberts 1976; King et al. 1981; Surpure, 1982; McLauren et al. 2005; Grundstein et al. 2009; Duzinski et al. 2013).

To better understand the transfer of energy and the resulting temperatures, previous work has examined the effects of cosmetic variables on the microclimate of a vehicle. One of the initial studies in this area of research attempted to determine if a temperature difference existed for different colored vehicles. Zumwalt and Petty (1976) concluded that a difference in color did not result in a significant temperature change in the main cab of the car; however, the color affected the temperature inside the trunk. The authors suspected that the lack of windows, and the inability for long-wave radiation to escape, led to this significant difference in observed temperature inside the trunk.

Another variable frequently researched in previous literature involved the state of a vehicle's windows (i.e., rolled down, halfway rolled up, or completely rolled up). When the windows were completely rolled down, this resulted in the car experiencing decreased temperatures due to additional ventilation and air circulation. Alternatively, the worst-case scenario occurred when the windows were completely rolled up and a lack of ventilation, in addition to the greenhouse effect, generated the most extreme temperatures. Roberts and Roberts (1976) surveyed 50 young mothers outside of a shopping center to ask them 1) how often they left their children in an unattended vehicle and 2) if they provided any ventilation when they left them. Only two mothers admitted to leaving their child in an unattended car; however, others stated they "rarely" left their child in the car and that they would frequently "crack" the windows when they left them. Using this information, Roberts and Roberts (1976) conducted a vehicle experiment measuring the maximum temperature inside a vehicle with the windows rolled down two inches. The authors then compared these results to the maximum temperature of another

vehicle with the windows rolled up, and no significant differences were observed (Roberts and Roberts 1976; King et al. 1981).

In addition to the heating processes of the car environment, the underdeveloped thermoregulatory system in young children increases their risk for vehicular hyperthermia (Zumwalt and Petty 1976; Duzinski et al. 2013). Hyperthermia, a condition associated with having a higher than normal body temperature, occurs when a greater amount of heat is being generated by the body than can actively leave (Axelrod and Diringer 2008). Within the closed environment of the vehicle, a greenhouse effect and a lack of evaporation increases the likelihood that an individual will experience a heatstroke (Roberts and Roberts 1976). While an adult would be able to effectively lower their temperature in a car, a child has difficulty due to their inability to remove excess clothing and/or escape the car seat. (Roberts and Roberts 1976; Naughton and Carlson 2008; Grundstein et al. 2010). When a child is left in an enclosed car environment, their thermoregulatory heat loss mechanisms continue to work, however, they are not able to effectively lower their body temperature because: (1) they have a larger surface to body ratio, (2) they produce more metabolic heat, and (3) they have a lower sweating capacity (Zumwalt and Petty 1976; Naughton and Carlson 2008; Duzinski et al. 2013). Although complicated, the physics of a car environment answer the question that many parents continue to ask: "why does a car get so hot?" Therefore this information should be used, with the help of public health professionals, to educate parents and caregivers on the "greenhouse effect" and the vulnerabilities of children.

1.2.3 Educational, Technological, and Policy Interventions

To reduce the number of incidents, researchers have begun offering prevention strategies and called for health professionals to partner with childcare providers to increase awareness of pediatric vehicular heatstroke (Guard and Gallagher 2005; McLauren et al. 2005; Grundstein et al. 2010 Grundstein et al. 2011). Guard and Gallagher (2005) suggested a multifaceted approach involving education, technological, and policy interventions. The educational components of heatstroke prevention include education on heat vulnerability, involvement of child advocacy groups, and offering suggested injury prevention notification systems for businesses. The authors suggested that parents should be educated on heat vulnerability and the concept of the "greenhouse effect," which occurs in motor vehicles. Several child advocacy organizations are also working to educate parents on the risks of vehicular heatstroke (e.g. Safe Kids, National Highway Traffic Safety Administration, Kids and Cars, Ray Ray's Pledge, etc.) using outreach activities and informative materials. Some states have even adopted campaigns and public service announcements (PSAs) in an attempt to reduce the number of children affected annually (Texas, Georgia, etc.).

Technological devices, another suggestion provided by the authors, are another important avenue to explore for reducing vehicular heatstroke incidents. A study was conducted to investigate the effectiveness of the technological interventions on the market (e.g. heat stroke devices, pad sensing devices, harness clip devices, etc.) through the summer of 2011 (Arbogast et al. 2012). The preliminary results revealed inconsistencies between trials of the products and with synchronizing devices during the drive. For example, none of the heatstroke devices were completely reliable in their

ability to register a child based on their weight. Likewise, several pad sensing devices registered the weight of the child, while others had too much padding to effectively distribute the load for sensor activation. Overall, these devices required practice and effort from the parent/caregiver to ensure effective operation (Arbogast et al. 2012). Recently, several smartphones applications have been developed to remind parents of their children in the back seat; however, research into their popularity and/or effectiveness has not been conducted.

Lastly, Guard and Gallagher (2005) suggested implementing legislation and criminal charges to incentivize parents and caregivers to stop intentionally leaving children unattended in motor vehicles. Armagost (2001) discussed the states that currently have statutes in place, and others who have proposed them. After reviewing the article by Armagost (2001) and the website by Jan Null (Null 2016), an investigation to discover the past, present, and proposed policies in the southern states was conducted (Table 1.2).

At present, eight southern states have laws related to children being left unattended in vehicles: Texas (1984), Florida (1985), Kentucky (2000), Louisiana (2005), Tennessee (2007), Oklahoma (2008), Maryland (2008), and Alabama (2013). Of these laws, only Kentucky's statute addresses the death of a child. In Kentucky, the law states that a person is guilty of manslaughter in the second degree when "leaving a child under the age of eight years in a motor vehicle… causing the death of a child" (National District Attorney Association 2014). Although Kentucky is the only state that specifically addresses the death of a child, each policy varies in the age which a child can be left alone. For example, in Louisiana, it is "unlawful for any driver or operator to leave a child or children under the age of six years unattended and unsupervised in a motor

vehicle" (National District Attorney Association 2014). Previous vehicular heatstroke research has mentioned the creation of these state policies and educational interventions as helpful preventative measures; however, studies have yet to be conducted that examine if legislative strategies have reduced the number of heat illnesses and injuries per year.

1.2.4 Heat Warning Injury Prevention

As the morbidity and mortality rates continue to rise for heat-related events, more research is being conducted to better understand the public's understanding of heat-health warning systems (Sampson et al. 2013). Although not as publicized or well-known as the dangers of severe convective weather, extreme temperatures are the number one cause of meteorological death in the United States (CDC 2006; NOAA 2011). With this "silent killer" going unnoticed, it is imperative that resources be devoted to education, outreach opportunities, and research endeavors attempting to understand the societal implications of heat-related incidents (NOAA 2011). One such attempt to better communicate these risks, involves the introduction of heat warning systems in cities across the United States.

Heat warning systems provide hyper-local instructions that use specific communication and injury prevention techniques to mitigate the dangers and harms of extreme temperatures (Toloo et al. 2013). Although heat warning systems differ between cities, most involve active alerts, advisories, and safety tips for reducing the number of individuals affected by heat-related illnesses (heatstroke, heat syncope, heat cramps, etc.).While Toloo et al. (2013) attempted to evaluate the effectiveness of these systems; it is difficult to measure the injuries or deaths that were successfully prevented. The authors also noted that the need exists for heat warning systems to be effectively evaluated, to

ensure the best mitigation strategies are shared with cities across the country. For example, increased temperatures affect individuals differently; therefore, these heat warning systems must contain a communication strategy that specifically informs vulnerable populations (e.g., elderly, children, and disabled individuals) of 1) the risks associated with extreme temperatures and 2) behaviors to mitigate those risks.

Several groups are classified more frequently in the heat-health literature due to their increased vulnerability during heat events. The most vulnerable groups as identified by Toloo et al. (2013) are elderly individuals, children, and people with pre-exiting health conditions. Other research evaluating heat warning systems reiterates the importance of specifically reaching out to these targeted groups during a heat-related event and including a plan in their heat warning system (Sheridan 2007; Kalkstein and Sheridan, 2007; Richard et al. 2011; Ibrahim et al. 2012). Future research studies should continue to evaluate other vulnerable populations and their understanding of heat-related injury prevention.

In a study by Sheridan (2007), several researchers investigated the societal impacts and the public's understanding of these heat warning systems. The author began by attempting to discover the public's perception and response to heat warnings in various cities across the United States and Canada. His research found that knowledge of a heat event is widely known and understood, however, the survey sample had difficulty differentiating between an excessive heat warning and advisory (Sheridan 2007). While the participants were familiar with the heat warning, the specific details involving the messaging and injury prevention strategies were less understood. Interestingly, many of the elderly respondents (65 years and older) did not perceive themselves to be more

vulnerable to heat-related illnesses and thus did not believe that the heat warning messages were intended for them. In order to increase awareness and educate individuals on the risks associated with heat-related illnesses, especially in vulnerable populations, it is imperative to focus on increasing their overall perceived risk to encourage a heat-health behavior change.

The societal impacts of heat events and their relationship with behavioral change are discussed at length by Kalkstein and Sheridan (2007). The authors attempted to understand the perceived impact of an extreme heat event within different neighborhoods in Phoenix, AZ. Kalkstein and Sheridan (2007) hoped to obtain an understanding of the social response to the heat warning system in Phoenix, which could then be extrapolated to other cities across the country. Their survey results revealed that a majority of the sample were aware of the issuance of excessive heat warnings/advisories, with individuals over the age of 65 reporting the highest level of awareness. Although this indicates that some vulnerable populations are aware of warnings/advisories, less than 50% of these individuals changed their behavior (e.g., stay indoors, stay hydrated, use air conditioning, open windows if using a fan, move to a cooler location, etc.) as a result of the warning/advisory. With this low reported behavior change, perhaps the integration of behavior change theories could potentially further develop behavioral research studies for heat-related events.

By introducing behavior change theories, commonly used in health and risk communication, into the field of heat-related behavioral studies, more information can be obtained that highlights the benefits and barriers to heat-related behavior change. Toloo et al. (2013) suggests that the field of health communication, and its theoretical

frameworks, could "enhance our interpretation and understanding of human behavior." The authors acknowledged that the Health Belief Model and the Precaution Adoption Process could be viable frameworks to assess behaviors commonly associated with excessive heat events. Further, Toloo et al. (2013) mentioned that during their review of heat warning systems, only one study used a health communication theoretical framework to guide the design of their survey. This research article, Ibrahim et al. (2012), used the Health Belief Model to examine health professionals' understanding of heat illness knowledge and their perceived risks. The authors found that the health professionals possessed a high level of awareness for heat-related events; however, a lack of knowledge involving the risks to elderly individuals was observed. Although this result cannot be generalized to the public, the inclusion of a health communication theoretical framework provides an example for future studies seeking to research excessive heat events.

1.2.5 Application of Health and Risk Communication Theories to Injury Prevention

While most of the previous literature on excessive heat events has focused around research questions driven by the physical sciences, health and risk communication theories have the potential to strengthen this area of research in both understanding current injury prevention behaviors and the promotion of health behavior change. To initiate research into this interdisciplinary field, a mental models approach to risk communication is suggested to obtain current knowledge and risk perceptions associated with excessive heat events. A mental model is used to describe a person's knowledge, perceptions, beliefs, and other information used to reach a conclusion (Morgan et al.

2002). Mental model studies are useful in determining the type of knowledge and understanding that currently exists among a group of individuals on a particular issue. Because the knowledge of experts and laypeople often differs, mental model studies closely examine the differences between these groups in order to develop risk communication materials that better align with the lay audiences. While this is a new approach in the domain of excessive heat events and heatstroke prevention, this framework has been used to obtain a better perspective on the lay public's understanding of other issues associated with the atmospheric sciences (Bostrom et al. 1994; Lowe et al. 2007; Wagner 2007; Bostrom et al. 2016).

A variety of studies have been conducted examining the knowledge of experts and the lay public on several meteorological topics, in order to address any misconceptions in future risk communication materials. Previous work using the mental models approach has been used to examine hurricane forecasts and warnings (Bostrom et al. 2016), global climate change (Bostrom et al. 1994; Lowe et al. 2007), and the risk perceptions of flooding events (Wagner 2007). To explore the decision-making process associated with the issuance of hurricane warnings, the authors conducted 19 mental model interviews with individuals from the National Hurricane Center, Miami-South Florida Weather Forecast Office, media broadcasters, and public officials (Bostrom et al. 2016). After evaluating across the professional groups, several shared similar perceptions; however, there were also some significant differences. Therefore, to improve future weather event forecasting it is imperative to better understand "the interpretation and representation of uncertainty within the hurricane forecast and warning system" (Bostrom et al. 2016). In another study, the mental models approach was used to examine global climate change.

Most of the misconceptions revolved around the causes of climate change, which varied from the over usage of aerosol sprays (chlorofluorocarbons [CFCs]) to the unknown relationship between ozone and carbon dioxide (Bostrom et al. 1994). Additionally, Lowe et al. (2007) focused on expert testimony and discovered varying opinions on the role of humans in a changing climate, the impacts of climate change on the natural world, and difficulties conveying mitigation measures to the lay public. Finally, Wagner (2007) examined the risk perceptions of residents and obtained a mental model for flash flood and landslide risks. This study interviewed 24 people, from flood-prone areas, to better understand their current knowledge and to determine if any discrepancies existed between the two mental models. The authors were able to identify common concepts that participants associated with flash flood and landslide risk, in addition to gaps in knowledge. For example, interview participants lacked an understanding of the flood risks associated with thunderstorms, with some believing the sole risk revolved around long-lasting rainfall events (Wagner 2007). The mental models approach is useful for addressing the differences in knowledge between experts and the lay public; however, this theoretical framework is not designed for evaluating future behavior change among participants. Therefore, to greatly enhance the behavioral information obtained during the mental model interviews, the inclusion of a behavior change theory can better structure this risk communication framework to measure behavior change.

With a variety of health communication theories, specifically behavior change theoretical frameworks, available to incorporate into heat-related injury prevention studies, it is imperative to examine the benefits and limitations of each framework. Many theoretical perspectives exist in order to research prevention behaviors and they include:

The Health Belief Model, Theory of Reasoned Action, Transtheoretical Model, Protection Motivation Theory, Social Learning Theory, Social Cognitive Theory, and many others. For example, the Theory of Planned Behavior was created to understand the relationship between attitudes and immediate behaviors (e.g., protection from infectious diseases, voting, etc.). On the other hand, the Transtheoretical Model prioritizes the maintenance of actions, with less of an emphasis on perceived risk (e.g., dietary changes and actions involved with keeping the weight off). Finally, the Health Belief Model has been used to research disease prevention and has been suggested as an optimal behavior change theoretical framework for exploring injury prevention problems associated with extreme temperature events (Toloo et al. 2013).

While many behavior change models exist in the health communication literature, the Health Belief Model most closely aligns with the mental models approach in its pursuit to assess an individual's risk perceptions using six cognitive variables (Glanz 2008). Additionally, the Health Belief Model provides the necessary assessment of current behaviors and uses the six cognitive variables to measure behavior change and/or willingness to change health behaviors, which is absent from the mental models approach. Therefore to better understand the threat perceptions and behaviors associated with excessive heat events, structured questions measuring the cognitive variables associated with the Health Belief Model will be infused into the mental models approach to create a hybrid mental models approach.

1.2.6 Health Belief Model

The Health Belief Model (HBM) is a behavior change theory that has been used to assess injury prevention behaviors, in addition to studies examining the actions of parents and caregivers. The Health Belief Model (Figure 1.4) was initially developed by a group of social scientists in the early 1950s, and uses Social Cognitive Theory as its main theoretical framework. The HBM has two conditions: (1) "an individual desires to avoid illness (if ill, get well) and (2) an individual believes that a specific health action will prevent (or ameliorate) disease" (Riekert et al. 2014). Applying this framework to forgetting a child in a hot car, (1) a parent would desire to avoid leaving their child/children in a hot car, so (2) they should take preventative actions to reduce their risk of occurrence. Additionally, the Health Belief Model employs several cognitive variables (perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy) in order to better access an individual's likelihood of adopting a new behavior (Table 1.3).

To thoroughly illustrate the cognitive variables of the Health Belief Model and their relationships with one another, the injury prevention scenario of vehicular heatstroke will be used as an example. The first cognitive variable is perceived susceptibility, or the likelihood of contracting a problem condition. For example, a researcher would want to ask parents to state the likelihood that they could forget their own child in a hot car. Previous literature examining heat warning systems and excessive heat events have found that most people in at-risk groups do not feel susceptible to heat; therefore, this is an important aspect of the HBM to investigate (Sheridan 2007; Richard et al. 2011).

The next cognitive variable, perceived severity, is another core component of the Health Belief Model and possesses a synergistic relationship with perceived susceptibility. Perceived severity (i.e., relative seriousness of the consequences of contracting the problem condition) measures the seriousness of an injury or issue to an individual. For instance, when applied to vehicular heatstroke a researcher may ask: do parents believe it is a serious risk to themselves and others? With little research on the perceived severity of excessive heat events and vehicular heatstroke from the general public, it is another important aspect to further examine.

The final four components of the HBM consist of perceived benefits, perceived barriers, cues to action, and self-efficacy. Perceived benefits and barriers oppose one another; while one provides incentives for changing behaviors (perceived benefits), the other inhibits the adoption of a new behavior (perceived barrier). For example, the availability of an expensive device (free device) that would assist parents/caregivers with remembering their child is in the vehicle would be a perceived barrier (perceived benefit). Another cognitive variable commonly associated with technological devices and other stimuli that prompt behaviors, is known as cues to action. These may include physical cues (i.e., leaving your briefcase/purse in the backseat of the car as a reminder) and/or non-physical cues (i.e. policies/laws or public health messaging associated with forgetting a child in a hot car). Both types of environmental cues can assist with stimulating an injury prevention response, and potentially reduce the number of children affected annually. Self-efficacy, the final cognitive variable, refers to an individual's confidence to take action and is a relatively recent addition to the HBM (Glanz 2008). In

addition to the cognitive variables of the Health Belief Model, the relationships between variables play a major role in understanding how to change health behaviors.

When using the Health Belief Model as a theoretical framework, it is imperative to understand the connections associated with the cognitive variables. The Health Belief Model defines the overall risk of a health-related problem, in this case children forgotten in hot cars, as a function of both perceived severity and susceptibility (Brewer and Rimer 2008; Glanz 2008). Alone, perceived susceptibility is not a powerful predictor of health-related behaviors; however, combined with a heightened state of perceived severity it becomes a better predictor. Like perceived susceptibility and severity, perceived benefits and barriers rely on a high level of perceived threat in order to be an effective predictor of new health behaviors. Lastly, self-efficacy and cues to action are the least studied factors of the HBM. Little is known regarding the predictability power of the two factors; however, self-efficacy *should be* a strong predictor of many health behaviors that require specific skills (Glanz 2008).

To further demonstrate the applicability of the Health Belief Model for heat-related scenarios, Richard et al. (2011) provides an example of this framework. The study examined the predictive components of the Health Belief Model for air conditioning practices of vulnerable groups, in hopes of being able to shed light onto heat-related behaviors. As with previous studies involving vulnerable populations, particularly elderly individuals, a lack of perceived susceptibility was observed. More specifically, people in vulnerable populations recognize and understand the excessive heat advisories/warnings being issued; however, they do not appear to be altering their behavior. Further, the author revealed that an individual's sensitivity to heat was a positive predictor for heat-

related behavior change. Other cues to action, such as advisories/advice from medical professionals, did not prove significant. In his concluding statements, Richard et al. (2011) suggests that an alternative communication strategy should be developed; however, it should not focus on convincing at-risk individuals of their vulnerability, especially when they do not identify as a member of a "vulnerable population". Instead, the study reveals that the messaging should elaborate on personal perceived susceptibility and severity to increase the overall perceived threat of these vulnerable groups. As mentioned previously in the HBM, the other cognitive variables become more robust and predictive when combined with a higher level of perceived threat. Therefore, future public health initiatives should assess elements of the HBM, especially perceived susceptibility and severity, to determine whether the proposed communication strategy effectively encourages behavior change among individuals who may not identify as "vulnerable."

1.2.7 Pediatric Injury Prevention Studies using the Health Belief Model

While the use of the Health Belief Model is a new approach for the field of vehicular heatstroke prevention, a variety of studies examining pediatric injury prevention can be drawn upon for guidance. A majority of previous research in this area targets a specific injury prevention issue; however, a recently published article by Cheraghi et al. (2014) describes the effects of educating mothers on all hazards. Using the Health Belief Model, the authors sought to evaluate the attitudes and willingness of parents to adopt injury prevention techniques associated with pediatric poisoning and falls through the use of an education program. The research design consisted of two groups: a control and

intervention group that measured the various constructs of the HBM through a pre/post-test methodology. The three-part survey assessed parents' demographics, knowledge of injury prevention, as well as any recent injuries their children had received. The results of the study revealed that the educational intervention had an impact on the knowledge, practices, and behaviors of mothers with children less than five years of age. All of the pre/post-test results were significant, with the questions associated with perceived severity, perceived barriers, and cues to action being the most predictive of future behavior change. Additionally, the participants specifically mentioned that medical visits and medical professionals provided important cues to action for preventing pediatric injuries (Cheraghi et al. 2014).

Another study, by Rosenberg et al. (2011), explored parents' risk perceptions and knowledge for preventing pediatric poisoning using the Health Belief Model as a guiding construct. The authors acknowledge the lack of behavior theoretical frameworks in previous injury prevention literature and their importance because "people's attitudes and beliefs about an issue are not synonymous with factual knowledge… and knowledge alone may not adequately explain parental responses to childhood poisoning prevention" (Rosenberg et al. 2011). In order to assess parents' knowledge of this issue, determine their preferred locations for storing potentially poisonous substances, and to identify practices for keeping such products out of reach from children, a telephone survey of 200 households was used. The results, when broken down into specific HBM constructs, revealed that a parents' willingness to place a product out of reach, depended on their perceived susceptibility and severity of that item. For example, items considered to be very dangerous by parents (i.e., garden chemicals) were more likely to be locked up than

those considered less harmful (i.e., over-the-counter medicines). This result reveals the predictive power of perceived susceptibility and severity, and the importance of using the Health Belief Model to better understand parents' risk perceptions (Rosenberg et al. 2011).

Unlike the other studies involving pediatric injury prevention and the Health Belief Model, the article by Witte et al. (1993) specifically focuses on the relationship between cues to action and bicycle helmet practices. Recall that cues to action, or a trigger used to execute a behavior, are thought to influence decision-making and the overall perceived threat of injury. In order to assess the effects of cues to action, the authors selected parents with children aged 5 to 18 years of age to take part in a brief telephone interview. The interview consisted of questions designed to measure parents' perceived susceptibility, perceived severity, attitudes, intentions, behaviors, and cues to action. In order to gauge the effects of several cues to action, the researchers created an experimental condition that involved six different environmental cues (special community event, PSA, physician counseling, direct mailings, telephone calls, and helmet coupons), which were randomly assigned to participants of the previous interviews. A follow-up interview was conducted to assess whether their perceived threat of bicycle injury had increased due to the cues to action provided. Even though five of the six experimental conditions positively affected the risk perceptions of parents, a relationship between cues to action and a change in behavior was not found. This result suggests that cues to action can be a successful tool for increasing the overall perceived threat; however, there may not be a direct link to a change in behavior. Although not a perfect relationship, these studies provide support for using the Health Belief Model to

examine the knowledge and risk perceptions of parents and caregivers surrounding the issue of pediatric vehicular heatstroke.

Using the previous literature and the studies incorporating the Health Belief Model, pediatric vehicular heatstroke will be examined in this thesis from an interdisciplinary perspective to better understand the current knowledge and attitudes of parents/caregivers. Although a large portion of the research literature is driven by the physical sciences, the scientific perspective is only one side of the solution. The next step toward preventing these tragedies is to connect this scientific information to improve and promote more effective public health messaging. It is my hope that this thesis and the provided suggestions will assist public health and medical professionals in their efforts to educate parents/caregivers about the dangers posed by extreme temperatures.

Table 1.1. A comparison of pediatric vehicular heatstroke deaths by age

Age:	Guard and Gallagher (2005): 1995-2002		Booth et al. (2010): 1999-2007		Grundstein et al. (2011): 1998-2008		1998-2016: Data from Null (2016)	
0-11 months	59	(34%)	68	(35.4%)	129	(31.2%)	208	(32.0%)
12-23 months	40	(23%)	116	(60.4%)	88	(21.3%)	146	(22.0%)
24-35 months	39	(23%)			84	(20.3%)	131	(20.0%)
36-47 months	25	(15%)			50	(12.0%)	84	(13.0%)
48-59 months	8	(5%)			25	(6.1%)	41	(6.0%)
60-71 months			8	(4.2%)	13	(3.1%)	23	(4.0%)
>72 months					25	(6.0%)	27	(3.0%)
TOTAL:	171	(100.0%)	192	(100.0%)	414	(100.0%)	662	(100.00%)

Table 1.2. Status of statutes related to children left unattended in vehicles, Southern United States. (National District Attorney Association, 2014)

State	Year(s) of Statute or Proposed Statute
States with Current Statutes	
Alabama	2013
Maryland	2008
Oklahoma	2008
Tennessee	2007
Louisiana	2005
Kentucky	2000
Florida	1985
Texas	1984
States with Proposed Statutes that did not pass	
North Carolina	2009
West Virginia	2002, 2008, 2009
Virginia	2004, 2007, 2009
Mississippi	2005
Georgia	2004
South Carolina	1985
States/Territories without Statutes	
Arkansas	N/A
Delaware	N/A
Georgia	N/A
Mississippi	N/A
North Carolina	N/A
South Carolina	N/A
Virginia	N/A
Washington, D.C.	N/A
West Virginia	N/A

Table 1.3. Key concepts and definitions of the Health Belief Model (Glanz 2008)

Concept	Definition	Application
Perceived Susceptibility	One's assessment of chances of getting a condition or being affected by a threat/risk	Define population(s) at risk, risk levels Personalize risk based on a person's characteristics or behavior
Perceived Severity	One's assessment of how serious a condition and its sequelae are.	Specify consequences of the risk and the condition
Perceived Benefits	One's assessment of the efficacy of the advised action to reduce risk or seriousness of impact	Define action to take: how, where, when; clarify the positive effects to be expected
Perceived Barriers	One's assessment of the tangible and psychological costs of the advised action	Identify and reduce perceived barriers through reassurance, correction of misinformation, incentives, assistance
Cues to Action	Strategies to activate one's "readiness"	Provide how-to-information, promote awareness, employ reminder systems
Self-efficacy	One's confidence in one's ability to take action	Provide training, guidance in performing action Use progressive goal setting

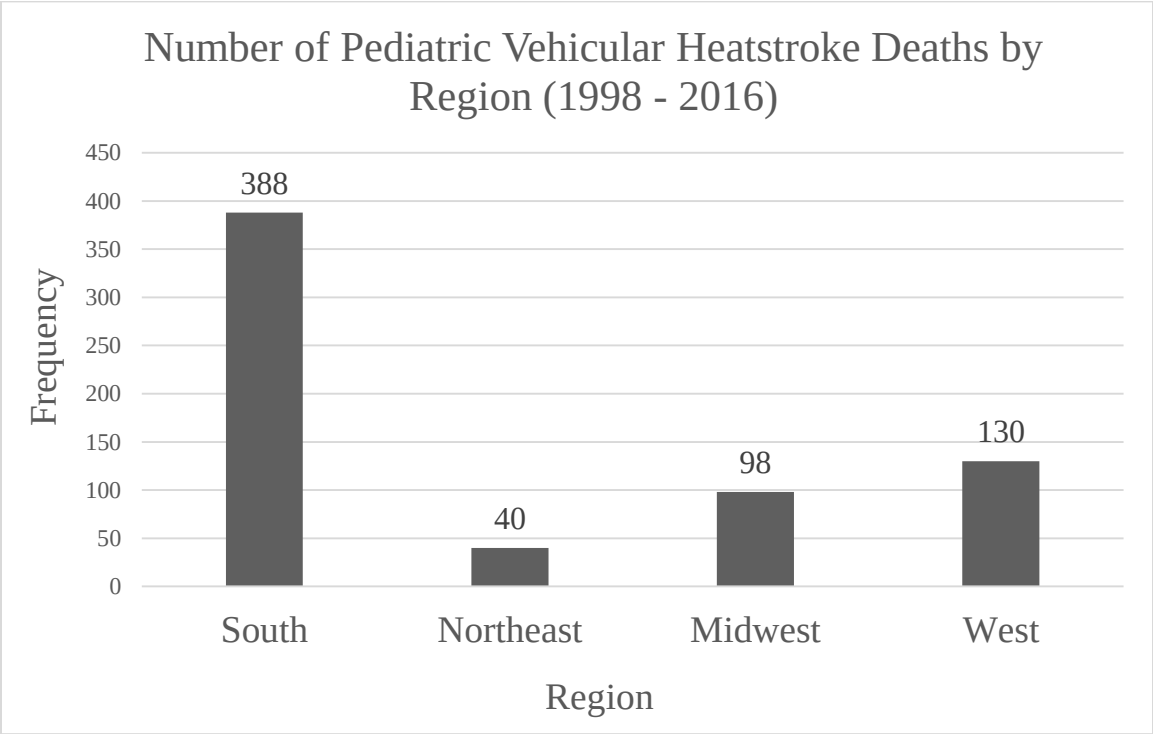

Figure 1.1. Bar graph describing the number of pediatric vehicular heatstroke deaths by region. Data provided from Null 2016, and consists of the years 1998-2016.

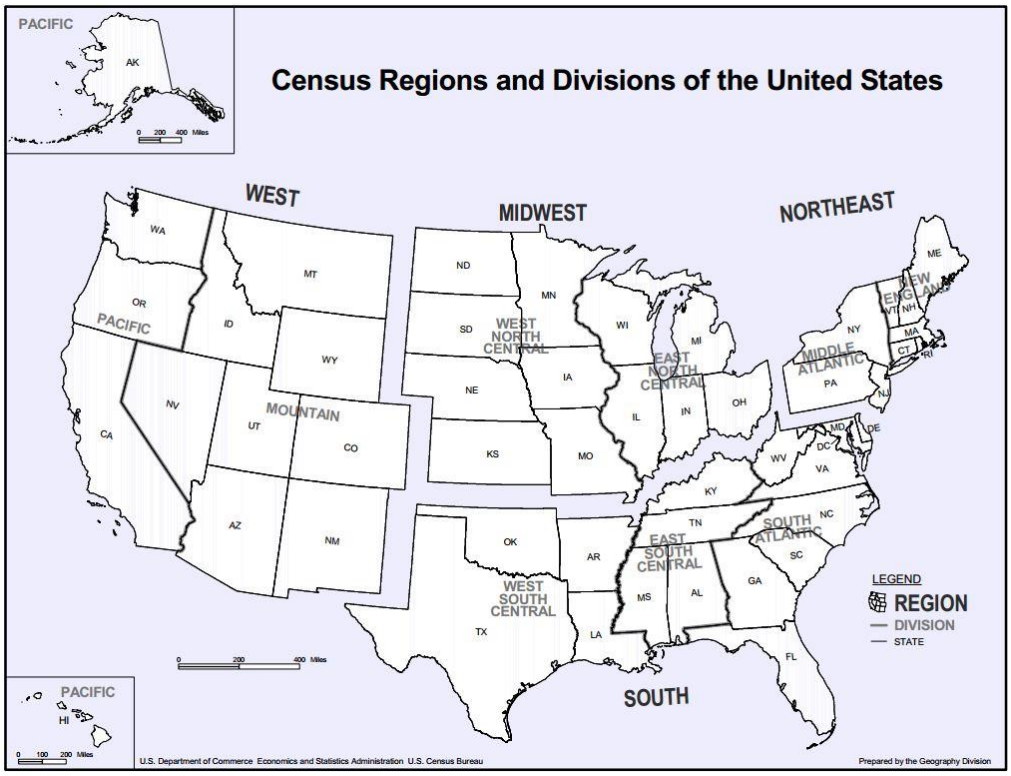

Figure 1.2. Map of the CDC regions to explain the division of regional data. Source: http://www.cdc.gov/surveillance/nrevss/rsv/region.html#west

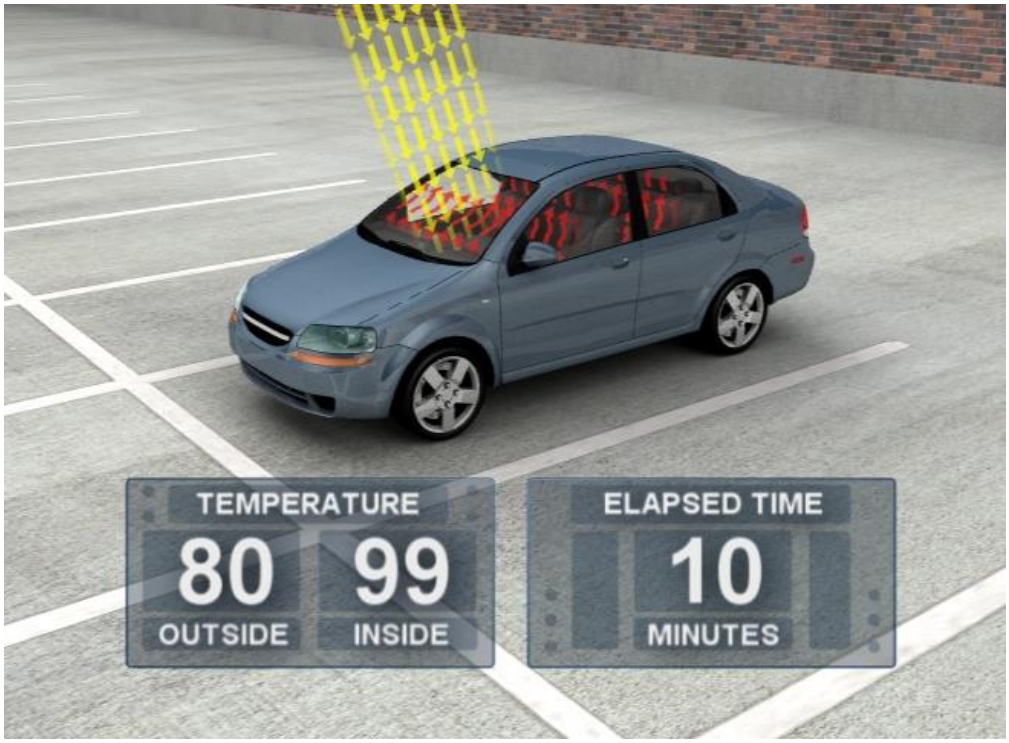

Figure 1.3. The greenhouse effect inside a car. The yellow arrows represent short-wave radiation, and the red arrows represent long-wave radiation getting trapped inside the vehicle. Courtesy of Null 2016 and General Motors.

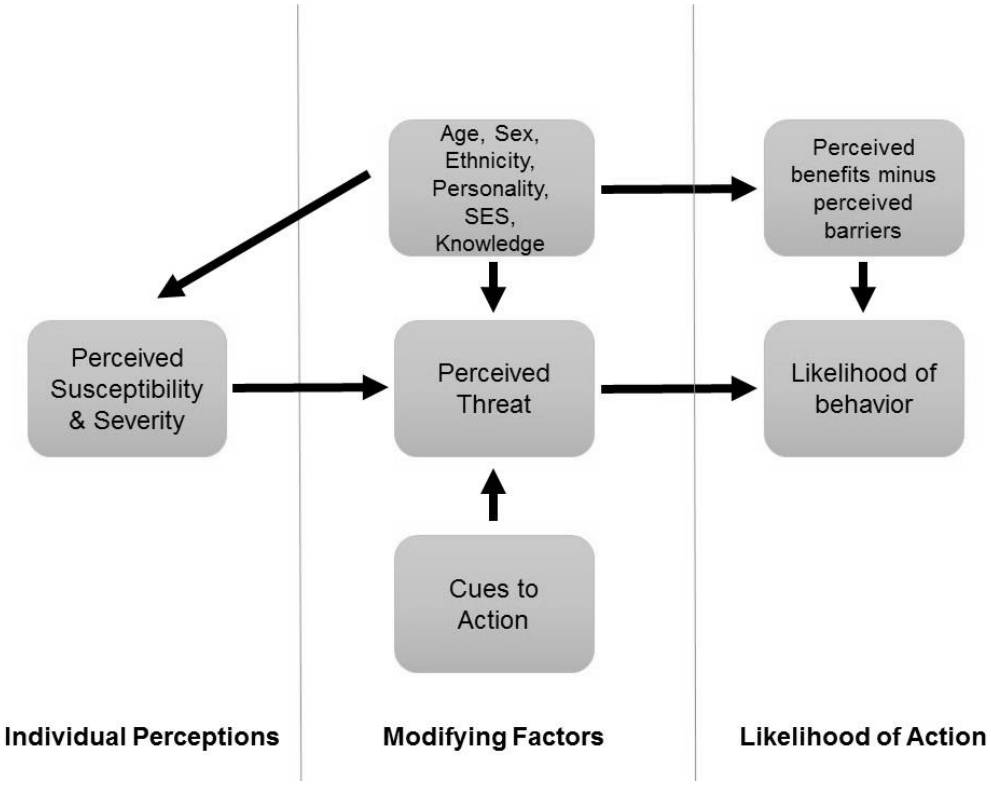

Figure 1.4. The Health Belief Model framework depicted as a diagram. Information courtesy of Rosenstoke 1974.

CHAPTER 2

CHILDREN FORGOTTEN IN HOT CARS: CURRENT UNDERSTANDING AND RISK PERCEPTIONS FOR IMPROVING PUBLIC HEALTH MESSAGING[1]

[1] Williams, C.A. and A.J. Grundstein. To be submitted to *Risk Analysis.*

Abstract

On average, in the United States, 37 young children die every year due to vehicular heatstroke. Additionally, over half of these incidents occur when a parent/caregiver forgets their child in a vehicle. While various governmental and child safety advocacy groups have worked to raise awareness about these tragedies, rigorous studies have yet to be conducted that examine the current understanding and effectiveness of this public health messaging. Therefore, this study will employ a hybrid mental models approach in order to identify differences that exist between experts' and parents'/caregivers' knowledge and beliefs surrounding the topic of children forgotten in hot cars. We interviewed a diverse set of 25 parents/caregivers and seven experts using questions guided by elements of the Health Belief Model, in order to construct and explore these mental models.

A comparative analysis was conducted, and two key differences were observed between these mental models. Unlike the experts, the parents/caregivers in the study emphasized perceived lifestyle factors (e.g. single parent, low-income parent, etc.) as important elements in increasing an individual's likelihood of forgetting a child in a hot car. Importantly, the parents/caregivers primarily obtained information from news reports, while experts believed public health campaigns would reach more parents and caregivers. Lastly, while many parents/caregivers considered this a serious hazard, most did not believe they could forget their own child in the back seat of a car. To confront this lack of perceived susceptibility, the vehicular heatstroke prevention community must strive to engage all parents/caregivers and address these differences in future public health messaging.

2.1 Introduction

In the United States alone, on average, 37 young children die every year due to vehicular heatstroke (Null 2016). Further, these incidents involve a parent or caregiver forgetting a child in a hot car (54% of cases), children trapped in a car/trunk (29%), or children intentionally left in a vehicle (17%; Null 2016). Unfortunately, the current pediatric vehicular heatstroke statistics may not accurately reflect the number of children affected annually. The current and only database, created by Null (2016), solely relies on the news media to report a hot car death. As a result, there are several circumstances in which a hot car death may not be added to the database: 1) if a story does not get picked up, 2) if an incident does not get reported to the news media, or 3) if a bigger story is dominating on the day of the report. Therefore, even though this has been a prevalent health issue in the news media over the past years, it is likely that these incidents are underreported. Another concern associated with vehicular heatstroke, involves the link between heat and health in a changing climate. With climate change increasing both average and extreme temperatures, this will lead to a future that is more favorable of heat-related illnesses and death (Mills et al. 2015; Sarofim et al. 2016). Additionally, this will alter the geographic vulnerability of many and increase the risk for vehicular heatstroke incidents beyond the summer months (Duzinski et al. 2013) and climatologically warmer regions of the United States (Grundstein et al. 2011)

Although vehicular heatstroke lies at the intersection of public health, injury prevention, and the atmospheric sciences, a large portion of the research literature heavily focuses on questions driven by the physical sciences. For example, the major topics include: understanding the microclimate conditions in the vehicle (Roberts and Roberts

1976; Zumwalt and Petty 1976; King et al. 1981; Surpure 1982; Gibbs et al. 1995; McLauren et al. 2005; Grundstein et al. 2009; Grundstein et al. 2010; Duzinski et al. 2013; Grundstein et al. 2015) and examining the characteristics of past incidents (Guard and Gallagher 2005; Booth III et al. 2010; Grundstein et al. 2011; Ferrara et al. 2013). However, researchers have slowly begun to take notice and realize that this scientific perspective is only one side of the solution.

The next step in the process of understanding these tragic incidents is to connect this scientific information to improve and promote more effective public health messaging. Guard and Gallagher (2005) were the first researchers to suggest that a multifaceted approach, involving education, policy, and technological interventions, may be necessary when attempting to reduce the number of children affected annually. While many researchers have offered suggestions for approaching this problem from different perspectives, rigorous studies have yet to be completed evaluating the effectiveness of the current messaging and the awareness of parents/caregivers on this issue. Various governmental and child safety advocacy groups have worked to raise awareness about these tragedies, but little is known regarding parents'/caregivers' awareness and perceptions regarding pediatric vehicular heatstroke.

This study seeks to address this gap in the literature by examining parents'/caregivers' awareness and perceptions on the topic of children *forgotten* in hot cars. These incidents have been selected because they represent over 50% of vehicular heatstroke cases, and they provide the unique opportunity to further explore the vast psychological characteristics associated with this issue. To accomplish this task, risk communication and health behavior theoretical models will be employed to better

understand the risk perceptions and behaviors of parents and caregivers. Due to the lack of information and understanding of parents' and caregivers' knowledge, risk perceptions, beliefs, and other information used to make decisions, a mental models approach to risk communication will be utilized (Morgan et al., 2002). Mental model studies are useful in determining the type of knowledge and understanding that currently exists among a group of individuals (e.g. parents/caregivers) on a particular issue. Because the knowledge of experts and the laypeople often differ, mental model studies closely examine the differences between these groups in order to promote the improvement of risk communication materials that better align with the knowledge of the lay audience. While this is a new approach for the field of heatstroke prevention, this framework has been used to obtain a better perspective on the lay public's understanding of various meteorological issues such as flood risk (Wagner 2007), climate change (Bostrom et al. 1994; Lowe et al. 2007), as well as hurricane forecasts and warnings (Bostrom et al. 2016).

In the sections that follow the creation of the interview questions using the Health Belief Model as a guide will be discussed, in addition to the interview methodology and data analysis techniques. The results of the mental model interviews are then presented, followed by a discussion of: 1) the similarities and differences that were observed between the expert and parent/caregiver mental models, 2) an in-depth examination of parent/caregiver responses using the Health Belief Model, and 3) the implications of this study on future public health messaging.

2.2 Methods

2.2.1 Development of Interview Questions:

When developing the questions for the interviews, the initial methodology, commonly associated with the mental models approach involved the use of a broad question which would initiate a conversation with the participants (Morgan et al. 2002). This conversation would continue until it slowly narrowed in on assessing their knowledge, opinions, attitudes, and risk perceptions in an unstructured format. However, we also wanted to obtain specific information from each parent/caregiver in order to examine the interaction between their risk perceptions and future behaviors. To better inform the methodology associated with mental model interviews and to highlight the likelihood of behavior change among parents/caregivers, a hybrid mental models approach was implemented using a set of structured questions associated with the Health Belief Model to conclude the interview process.

The Health Belief Model (HBM; Brewer and Rimer 2008) is a health communication behavior change theory that assesses an individual's threat perceptions and behavioral intentions. While many behavior change models exist in the health communication literature, the HBM most closely aligns with the mental models approach in its pursuit to assess an individual's risk perceptions using six cognitive variables (Table 2.1). There are several inter-connected relationships among the variables associated with the HBM; however, the most important relationship exists between perceived susceptibility and perceived severity (Figure 2.1). In order for an individual to adopt a prevention behavior, that individual must feel personally susceptible (perceived susceptibility) and believe the consequences to be severe (perceived severity). Therefore,

without increased values of both perceived susceptibility and severity, the likelihood of an individual adopting an injury prevention behavior is significantly reduced. In order to further explore these cognitive variables and their relationships in the realm of heatstroke prevention, structured interview questions were developed using consistent language taken from previous HBM (Richard et al. 2011), mental model (Bostrom et al. 1992; Bostrom et al. 1994; Wagner 2007; Austin and Fischhoff 2012), and injury prevention studies (Girasek and Gielen 2003; Snowdon et al. 2006; Rosenburg et al. 2011).

Furthermore, other question themes were developed to explore the participant's demographic information, knowledge about injury prevention techniques, technological interventions, and policies associated with this health issue. Prior to interviewing parents and caregivers, a pilot study was conducted with three parents from different socioeconomic and educational backgrounds. Further revisions were made to the interview questions in order to improve clarity and remove irrelevant items associated with the HBM. An inclusive list of items associated with the semi-structured interview is provided in Appendix A.

2.2.2 Interviews with Experts:

The expert mental model, and the variables relevant in the production of messaging and materials associated with hot car deaths, was developed in collaboration with a panel of individuals with expertise on this health topic. Seven experts with backgrounds in meteorology, epidemiology, psychology, and child injury prevention were identified through their known work on the topic of vehicular heatstroke prevention. After the study was reviewed and approved by the University of Georgia Institutional Review Board in

April 2015, each of the experts was personally contacted through email and asked if they would be willing to participate in a telephone interview to discuss their knowledge on the topic. Prior to each interview, the experts were sent an electronic consent form and agreed to be audio recorded.

The open-ended interviews began with a broad question to identify their goals and priorities in preventing children from being forgotten in hot cars, and slowly narrowed down to discussing messaging, policies/laws, involvement of pediatricians/childcare providers, technology, and other topics an expert deemed important. After actively examining each of the topics and discussing the potential misconceptions associated with parents' and caregivers' knowledge on the subject, the telephone interview was concluded. Following the interviews, the audio recordings were transcribed verbatim and a summative coding analysis was used to identify consistent thoughts, phrases, and topics between experts. These results were used to develop the expert mental model, and to refine the interview questions for the parents and caregivers.

2.2.3 *Interviews with Parents/Caregivers*

2.2.3.1 Procedure

To gain access to an audience with children younger than the age of five, childcare and health facilities across Athens-Clarke County, Georgia were used to recruit participants for the mental model interviews. Prior to advertising the study to parents and caregivers, a preliminary analysis was conducted in order to ensure that the diverse range of socioeconomic status in Athens-Clarke County, Georgia was represented in the sample. First, we obtained the price of weekly fees from childcare facilities in the

surrounding area and compared them to the average weekly childcare fees for Athens-Clarke County (All GA Kids 2016). Based on the results of this analysis, five childcare facilities and one health facility were selected to act as a proxy for obtaining individuals from low- and high-income groups (Table 2.2). The selected facilities then agreed to advertise the study to parents and caregivers by placing flyers in their designated area for childcare pickup and/or through the use of social media. Prior to participating in the interview, parents/caregivers completed a signed consent form and demographic information questionnaire to acknowledge that they were an eligible participant. In this study, a participant was considered eligible if they were 1) over the age of 18, 2) had a child/grandchild younger than the age of five, and 3) owned and regularly drove a car. The semi-structured interview was then administered; however, only 23 parents/caregivers agreed to be recorded. The length of the interviews ranged from 16 to 45 minutes (*Mean [M]* = 28:45 minutes, *Standard Deviation [SD]* = 7:28 minutes), with the transcripts ranging from 1087 words to 5115 words (*M* = 2545.8 words, *SD* = 1109.35 words).

At the conclusion of the interview, the participant was debriefed on the purpose of the research study. Finally, participants were given a $25 gift card as an incentive for completing the study. The interview process began on 28 April 2015 and concluded on 27 May 2015, at which point 25 interviews had been completed. Previous ethnographic research and other mental models studies were used to select the appropriate number of participants, with these studies agreeing that "a sample of 20-30 participants should reveal all beliefs that are somewhat common" (Austin and Fischoff 2014).

2.2.3.2 Interview Questions

Prior to the start of the semi-structured interview a short demographic questionnaire was given to the participants, in order to allow the parents/caregivers to become more familiar with the interview process and to encourage a personable discussion during the interview. After the completion of this survey, the interview began with broad questions relating to their child's health, and slowly narrowed down to assessing their knowledge, opinions, attitudes, and risk perceptions surrounding the issue of forgetting children in hot cars. After exhausting the discussion on hot car deaths, we moved onto understanding their familiarity with messaging on this issue and determining their preferred media channels for receiving future information on this subject. The direction of the interview then shifted to a set of questions based on concepts associated with the Health Belief Model. This sequence of questions sought to determine participants' perceived likelihood and severity of forgetting a child in a hot car. Further, parents and caregivers were asked to describe their current knowledge of injury prevention techniques, as well as their willingness to learn and implement new strategies in the future. The interviews concluded with a discussion of their knowledge and opinions on policies associated with children forgotten in hot cars, in addition to the role of childcare facilities and pediatricians in educating parents on this topic. An inclusive list of items associated with the semi-structured interview is provided in Appendix A.

2.2.3.3 Data Analysis:

Descriptive statistics were calculated for the demographic information (gender, age, educational background, etc.), and the closed-response questions in the interview. After the interviews were transcribed verbatim, the remaining open-ended questions were

further examined via a content coding analysis. After each of the questions had been examined, the themes for each question were collected into a single document and further connections were made between the responses. A final set of codings was determined after several iterations of collapsing the thematic categories. The responses were then reanalyzed and assigned a content code from the final set of thematic categories. However, due to the complexity associated with the in-depth interviews, several questions were assigned multiple-codings when a participant mentioned several thematic categories during their discussion.

Next, a summative content analysis (Hsieh and Shannon 2005) was used to examine the occurrence of distinctive phrases and words in the parent interviews to further aid in the development of the mental model. A free, online program (Text Fixer 2016) was used to determine the frequency of specific words and phrases discovered during the content coding analysis (e.g., distracted). The most frequent words and phrases were graphically depicted using line thickness, in order to illustrate their importance in the mental model. To effectively compare the two mental models, a similar summative content analysis was conducted using the expert testimony. The expert interviews were reexamined, and the most frequent words and phrases were similarly depicted on the expert mental model. Further, this summative content analysis created a commonality between both mental models and allowed the most frequent phrases from each group to be compared with one another.

2.2.3.4 Participants

A complete list of demographic information of the 25 participants appears in Table 2.3. Participant's ages ranged from 18 to 59 years old (*SD* = 9.115), with a mean age of 33.8 years. Of the 25 participants, 4 (16%) respondents indicated they were a caregiver to a child. The sample contained more females (*n* = 20, 80%), than males (*n* = 5, 20%). Considering the small sample size, the participants exhibited a diverse ethnic background. While the majority of participants self-identified as Caucasian American (n = 15, 60%), the sample also included African American (*n* = 6, 24%), Caucasian European (*n* = 2, 8%), and Asian American (*n* = 1, 4%) parents and caregivers. Participants were asked to provide the highest educational degree they had earned, with some college credit (*n* = 5, 20%), bachelor's degree (*n* = 5, 20%), master's degree (*n* = 5, 20%), and high school graduate (*n* = 4, 16%) all being proportionately observed among the respondents. In order to assess the socioeconomic diversity in our sample, participants were asked to provide their total household income. Respondents' total income ranged from less than $10,000 to $150,000+, with a mean income of $57,800 for the entire sample. Based on the range of income level, participants were separated into either the low income (total household income less than $49,999) or high income (total household income greater than $50,000) group to access any differences associated with their interview responses. This break was based on the average income in Athens-Clarke County, Georgia ($48,421; U.S. Census Bureau 2014). A fairly even divide was observed between the income groups, with 52% (*n* = 13) of the sample belonging to the high-income group. No significant differences were observed between the demographic variables.

2.3 Results

2.3.1 Expert Mental Model

The first portion of this analysis seeks to understand the expert mental model (Figure 2.2) and the knowledge they believe parents/caregivers associate with children being forgotten in hot cars. This diagram acts as a visualization tool to illustrate the six major themes discussed during the expert mental model interviews, which can either mitigate and/or exacerbate the risk of forgetting a child in a hot car. These recurrent themes included: psychological and physiological factors, lifestyle factors, car environment, law, messaging, and technology.

Upon further examination of these themes, we are able to determine their individual impact on the likelihood that a parent/caregiver would forget a child in a hot car. For example, the messaging and law categories both act to raise awareness among parents/caregivers about the issue. Therefore, these two categories work toward decreasing the likelihood that an individual would forget a child. Alternatively, sleep deprivation and forgetfulness were associated with the psychological & physiological category. This theme, in addition to the lifestyle factors category, may increase a parent's/caregiver's likelihood of forgetting a child in a vehicle. The final two themes, car environment and technology, contain subcategories that can either increase or decrease the likelihood of this health risk. For example, technological devices can be installed to prompt a parent/caregiver that their child is in the backseat; however, these devices may also provide false reassurance to parents/caregivers. Similarly, the car environment can consist of sleeping children (increasing) or loud children (decreasing) that can affect a parent/caregiver's risk of forgetting a child. Finally, to account for the

prevalence that a topic was discussed during the interview process, the arrows in the figure have been assigned a corresponding line weight. As the weight of the arrow indicates, the most frequent topics discussed by the experts included: the importance of technological interventions (technology), the denial and distraction associated with hot car deaths (psychological & physiological factors), parents'/caregivers' focus on cases involving children intentionally left in vehicles (lifestyle factors), and the role that policy plays in the overall risk of forgetting a child (law). Finally, the media channels and key messages provided by the experts will be examined (messaging).

During the interviews, several experts emphasized the potential for technological interventions to reduce the number of children affected yearly; however, others believed that a lack of awareness and/or an incentive to purchase these devices make them less of a solution. Additionally, many experts believed the application of technology could be advantageous with the involvement and support of the automotive industry, especially in alleviating the concern of a sleeping child (car environment) or a distracted parent. In addition to this psychological concern, experts also discussed the denial that parents and caregivers express around forgetting a child. This denial is then exacerbated by the domination of cases in the media involving children intentionally left in vehicles, or as one of the experts explains, "…[they believe] that this could happen only to irresponsible parents, and that could actually be an explanation as to why a subset of parents forget their children." In order to reduce the number of incidents associated with a parent/caregiver intentionally leaving a child in a vehicle, some experts discussed the implementation of policies and laws as a solution to this problem.

The laws and policies associated with this issue were less representative in the mental model, due to their lack of applicability to children forgotten in hot cars. As one expert explains, "For the small percentage of parents that actually still intentionally leave their children in a vehicle thinking 'Oh, I'll just be gone for 20 minutes' then I think for that small percentage that policy can be effective." Therefore, while policy is an important aspect of this problem, it does not play an active role in the mental model associated with forgetting a child. Another form of policy discussed by one expert, involved the enforcement of Good Samaritan laws. These laws offer legal protection for individuals to employ all available tactics to extract a child from a hot car. While these incidents are often close calls, these news stories provide "positive messaging" and "raise awareness without the death of a child." With each of these factors affecting a parent's/caregiver's risk perceptions of forgetting a child in a hot car, what type of messaging is currently being used by the experts to raise awareness and encourage the adoption of injury prevention techniques?

While many of the experts mentioned a variety of media channels to get the information out to parents and caregivers, each had different priorities regarding the messaging associated with reducing the number of children forgotten in hot cars. A few experts discussed the use of passive messaging in childcare facilities, hospitals, and pediatrician offices for increasing awareness on the topic; however, others believed this could be a potential partnership to establish in the future. Further, the experts mentioned the use of campaign and public service announcements as a tool for raising awareness among parents and caregivers, with one expert explaining that "everybody is sort of trying to use the same sort of framework of having a slogan, raising awareness, be it

private sector or basic government… I don't know any way you could [provide messaging] short of having some sort of mandated policy."

At the end of the interview, the panel of experts was asked to provide three key messages that they would hope parents and caregivers would take away from their materials. Out of the six experts that provided key messages, only three offered messaging that was consistent among the expert panel. However, a variety of communication priorities were observed among the experts that mentioned these particular messages (Table 2.4). With each expert striving to prevent a different type of vehicular heatstroke (e.g. forgetting a child, trunk/car entrapment, or intentionally leaving a child), their different priorities and messages may influence the mental model of parents and caregivers.

2.3.2 Parent and Caregiver Mental Model:

The second portion of this analysis examined the parent/caregiver mental model (Figure 2.3) and the knowledge they associate with children being forgotten in hot cars. Similar to the expert mental model diagram, this figure includes the six major themes that were frequently discussed throughout the interview process: psychological and physiological factors, lifestyle factors, car environment, law, messaging, and technology. The arrows, in this figure, represent ideas parents/caregivers associated with the issue that may either increase (e.g. changing their routine) or decrease (e.g. child view mirror) their likelihood of forgetting a child. According to the arrows in the diagram, the most recurrent topics in the parent/caregiver mental model included: the denial and distraction associated with hot car deaths (psychological & physiological), lifestyle factors affecting

an individual's personal risk of forgetting a child (lifestyle factors), and the use of news reports as their major source of information on the topic (messaging).

During the interviews, a majority of the participants either mentioned the effect of denial on a parent's/caregiver's risk perception of forgetting a child or actively displayed low perceived susceptibility in their responses. Further, several parents and caregivers reasoned that lifestyle factors increased an individual's risk of forgetting a child. In this study, responses were coded as "lifestyle factors" when a parent or caregiver discussed various aspects of an individual's life. For example, participants believed that a single parent, low-income parent, working parent, and/or an unfit parent were all more at risk for forgetting a child in a hot car. Finally, all but one parent admitted that one of their major sources of information on this topic involved news and incident reports. The remaining thematic categories in the parent/caregiver mental model (technology, car environment, and laws) were discussed less frequently; however, in the sections below we explore all six themes through the comparison of the low and high income mental models of the parents/caregivers in our sample.

Lastly, to compare the knowledge and opinions of parents/caregivers based on socioeconomic status, mental models were created for low (n = 12; Figure 2.4) and high income participants (n = 13; Figure 2.5). Recall that there were a limited number of participants in each group; therefore, this must be considered when interpreting these results. The similarities across socioeconomic groups are represented in the parent/caregiver mental model as the most frequently discussed topics; therefore, the following paragraphs will highlight the differences between the mental models of low and high income parents/caregivers.

Similar to the parent/caregiver mental model, the low income parents/caregivers favored news reports as their optimal source for receiving information about this topic; however, high income participants favored online news and parenting articles. Six high income parents/caregivers explained that they "do not have cable, so [they] don't watch TV," while others mentioned they were "thinking about cutting the cord." Another difference between the two mental models involved psychological factors commonly thought to impact forgetting a child. While all parents/caregivers discussed psychological factors, the high income participants emphasized and more frequently mentioned a change in routine, stress, forgetfulness, denial, and distractions as causes for forgetting a child in a hot car. A similar trend among high income participants is observed in the lifestyle factors category, an increased risk of forgetting a child is attributed to working and/or busy parents/caregivers. On the other hand, the low income participants more frequently mentioned unfit parents and drugs/alcohol as factors that attribute to a child being forgotten in a hot car.

On the topic of technology, both groups agreed that cost efficiency would increase the likelihood that a parent/caregiver would purchase and use a technological device to remember their child was in the backseat of a car. However, high income parents/caregivers focused on incorporating this technology into pre-existing devices such as: car seats and vehicles. Additionally, the car environment can impact an individual's willingness to purchase technological devices and/or use injury prevention techniques during the drive. While both groups mentioned that sleeping children lead to a child being forgotten and/or an increased the risk for forgetting a child, high income parents/caregivers more frequently discussed this topic in the interviews. Some of the low

income parents/caregivers did not believe they needed a technological device or injury prevention technique, because "[my kids] are so loud, I know they are there." Interestingly, three low income parents/caregivers discussed a car getting stolen as a reason not to leave your children alone in a vehicle: "Your car could be carjacked with the children inside, and you could never see you kids again." Some even believed it to be a greater risk, than a child suffering from a heat illness or heatstroke in a vehicle, with one parent explaining, "I would think about a carjacking first, whether that is an accurate perception of the relative risk. Because heatstroke is something that I perceive that I have control over, so I'm less worried about it." Before alarming parents and caregivers of the dangers of heat and heat-related illnesses, especially with a number of health and safety concerns already on the minds of parents/caregivers, it is imperative to obtain the current risk perceptions of heat in relation to other safety concerns.

2.3.3 Knowledge and Opinions on Heat and Children Forgotten in Hot Cars

Prior to obtaining the participants' knowledge surrounding the issue of children forgotten in hot cars, the general safety and heat concerns of parents/caregivers were sought. To evaluate the overall safety concerns of our sample, parents/caregivers were prompted to "tell me about some of the health/safety concerns you have your kids." A majority of the parents/caregivers mentioned that car safety (n = 13, 38.2%), home safety (n = 6, 17.6%), and/or dangerous neighborhoods (n = 3, 8.8%) were among their top safety concerns. The remaining safety concerns included extreme temperatures (n = 2, 5.9%), drowning (n = 2, 5.9%), violent crimes (n = 2, 5.9%), and no concerns (n = 6, 17.6%). After determining that the threat of extreme temperatures was only mentioned by

two parents/caregivers, their level of concern regarding heat safety was gauged by asking, "how concerned are you with heat and your children's health?" Parents and caregivers provided an open-ended answer and their responses were categorized into a five-point Likert scale (*1 = not at all concerned to 5 = extremely concerned*; Likert 1932). The level of concern across the entire sample was 3.08 (*Median [Mdn] = 3, SD = 1.28*), with only 28% of parents/caregivers being moderately concerned (*n* = 1, 4%) or extremely concerned (*n* = 6, 24%) about heat.

With our sample exhibiting a moderate level of concern toward extreme temperatures, the parents'/caregivers' willingness to alter their behavior as a result of extreme heat was assessed by asking: "when you hear the temperature is going to be high (80-90 degrees), do you do anything differently?" A majority of the parents/caregivers in our sample (*n* = 22, 88%) discussed altering their behavior as a result of higher temperatures being forecast. When asked to elaborate, the parents/caregivers most often mentioned that they either dress their kids differently (*n* = 11, 40.7%), alter their schedule for being/playing outside (*n* = 8, 29.6%), and/or bring more water to stay hydrated (n = 5, 18.5%).

After generally assessing their knowledge and behaviors regarding heat, the parents/caregivers were prompted with questions to reveal their knowledge and opinions of children being forgotten in hot cars. While a large majority of the parents/caregivers were knowledgeable on the topic, several participants denied being able to forget their own child or insisted that the majority of cases involved a parent intentionally leaving a child in a vehicle. When asked "what do you know and think about kids forgotten in cars during warm season months" the parents/caregivers interviewed had an array of

responses. Ten parents (40%) used wording or phrasing that indicated they believed that these cases only occur, or that the majority occur, when a parent intentionally leaves their child in a car. For example, one parent who used such phrasing stated: "I don't care if you are running into the convenience store to pay for gas. It doesn't matter; your children should go with you especially the younger ones." The remaining parents discussed their knowledge and opinions in a frame of reference that represented the possibility of children being forgotten in hot cars. Moreover, when asked "what happens that leads to children being forgotten in hot cars" a majority of the participants were not sure (n = 6, 24%) or believed that parents were overwhelmed/distracted (n = 6, 24%). The second most common response was equally split between unfit parents (n = 4, 16%) and children being intentionally left in vehicles (n = 4, 16%). The remaining responses were evenly distributed between a change in schedule, lifestyle factors, sleeping children, and forgetful parents.

2.3.4 Perceived Susceptibility and Severity

With our sample sharing a wide-range of opinions on the ability of a parent/caregiver to forget a child in a vehicle, we wanted to measure the participants' perceived susceptibility by asking "how likely are you or your family to be affected by this issue?" Parents and caregivers gave an open-ended answer and their responses were categorized into a five point Likert scale (*1 = extremely unlikely* to *5 = extremely likely;* Likert 1932). The perceived susceptibility across the entire sample was 1.72 (*Mdn* = 1, *SD* = 1.30), with 84% of parents and caregivers believing this was extremely unlikely (n = 17, 68%) or unlikely (n = 4, 16%) to happen to them (Figure 2.6). Moreover, many of

the participants indicated they did not believe they could forget their own child in the back seat of a car. Thirteen parents and caregivers (52%) denied being able to forget their child in a hot car, by using words and phrases such as "how can you forget your child in the car? That's what I don't understand, how can you forget" or "I would never forget my grandkids in the car." Since a majority of the parents indicated a low susceptibility to forgetting a child in a hot car, participants were asked "is there a type of a parent or a quality about a person that would make them more likely to forget a child in a hot car." Overall, most of the participants (n = 21, 84%) agreed that there is a type of parent or quality that increases the risk of forgetting a child in a hot car. When asked to expand on the type of person or quality, the most frequent response was split between unfit parents (n = 7, 28%) and lifestyle factors (n = 7, 28%). The second most common response involved a parent or caregiver being overwhelmed or distracted (n = 6, 24%).

Another cognitive variable of the HBM, the perceived severity of forgetting a child in a hot car, was examined by asking parents "how serious is your concern in regard to forgetting a child in a hot car?" Similar to perceived susceptibility, the open-ended responses were classified into a five-point Likert scale from *1 = not serious at all* to *5 = extremely serious* (M = 3.60, Mdn = 4, SD = 1.50; Likert 1932). Among the parents and caregivers, 68% of the sample believed it was either a moderately serious (n = 8, 32%) or extremely serious (n = 9, 36%) concern (Figure 2.6). Additionally, parents and caregivers were asked about the impact of policies and laws on their seriousness of the issue. While most of the participants had not previously heard of laws specifically focused on forgetting children in hot cars, a majority of the respondents (n = 14, 56%) indicated that the knowledge of these laws would increase their seriousness of the issue. The remaining

parents had a different opinion and believed that “new laws would not make the issue more serious, but would raise awareness.”

2.3.5 Injury Prevention Techniques and Technological Interventions

In addition to the previous questions, participants were also asked to discuss their familiarity with injury prevention techniques commonly associated with vehicular heatstroke prevention. To gauge this knowledge, respondents were asked: “Do you know of any tips or tricks to help remember your child is in the backseat of the car? If yes, then explain the tip or trick.” There was a fairly even divide among the participants, with thirteen parents/caregivers (52%) indicating that they had previously heard of an injury prevention technique. When asked to elaborate, the respondents provided multiple answers and most frequently mentioned the use of a stuffed animal (n = 5, 17.9%) as a reminder that their child was in the back seat of the vehicle. Other techniques mentioned less frequently included: the use of technology (n = 4, 14.3%), leaving a briefcase or purse in the back seat of the car (n = 3, 10.7%), and using a child-view mirror (n = 3, 10.7%). The twelve remaining parents stated that they did not know any tips (n = 8, 28.6%) and/or did not require the use of injury prevention techniques because of their loud children (n = 5, 17.9%). Although not the most popular intervention among parents and caregivers, with an expanding market for technological injury prevention, the knowledge and willingness to purchase technological devices was sought.

To determine their awareness of technological devices, each participant was asked: “some have suggested the use of technology as a tip for remembering your child is in the back seat of the car. Have you heard of this?” More than 75% of the parents and

caregivers (*n* = 19) had not previously heard of technological interventions; however, nine parents indicated that they would be willing to purchase technological devices. Respondents were then asked to explain this decision with the question, "what is the reason that would make or prevent you from purchasing this technology?" According to the responses, parents and caregivers would be incentivized to purchase these devices if they were at a reduced cost (*n* = 8, 32%) and/or possessed passive qualities (*n* = 4, 16%). During the discussion on technology, four parents brought up the use of smartphone applications. Three of those participants discussed their willingness to use them if the application possessed passive qualities and provided them with push notifications upon arrival at a location/destination. Further, five parents discussed the possibility of technology being included in car seats and expressed a willingness to pay an additional fee for the added features: "If I'm going to buy a car seat, I'm going to pay $150 dollars anyway so I'll pay $180 dollars to have this additional feature." The remaining parents insisted that they "do not need a reminder that their children are in the back seat" or that having multiple children does not warrant the purchase of a technological device.

2.3.6 Messaging

With only half of the sample cognizant of potential injury prevention techniques, we wanted to gauge their exposure to public health messaging by asking "have you seen any ads, public service announcements, or materials involving kids being forgotten in hot cars during warm summer months?" Over half of the participants (*n* = 17, 68%) indicated that they had not seen any materials recently, with some stating that "[I] only [see them] after an incident has happened" or "maybe it hasn't gotten hot enough yet." Further, all

the parents and caregivers were asked: “Where have you seen these ads, public service announcements, or materials in the past?” The participants provided multiple responses, and overwhelmingly indicated that they learned about the issue through news and incident reports (*n* = 24, 58.6%). Additionally, sixteen parents specifically mentioned the high profile case that took place in Atlanta, Georgia during the summer of 2014. Other media that were discussed by parents and caregivers consisted of print media (newspapers, magazine articles, etc.; *n* = 7, 17%), medical and daycare facilities (*n* = 5, 12.1%), social media (*n* = 4, 9.8%), and public service announcements (*n* = 1, 2.5%).

With the introduction of a new public service campaign in the state of Georgia during the summer of 2013, in addition to the limited response from parents regarding the use of public service announcements to receive information on the topic, we wanted to assess the reach of the campaign by asking: “have you heard of the Look Again campaign?” Similar to the previous question, only three parents indicated they had heard of the campaign; however, none of the parents could provide any specific details about the materials. Finally, the participants were asked “if you were the spokesperson for this issue, what would you tell other parents about this topic?” A majority of parents and caregivers (*n* = 9, 36%) mentioned that their message would be “don’t leave your children in the car, not even for a minute.” The second most common message provided by participants (*n* = 5, 20%) attempted to warn that this tragedy “could happen to anyone.” The remaining parents and caregivers indicated that their messages would involve the need to keep track of your kids (*n* = 4, 16%), informing parents/caregivers of injury prevention techniques (*n* = 4, 16%), and describing the heating process and the maximum temperature in a vehicle (*n* = 3, 12%).

With the limited exposure to materials associated with pediatric vehicular heatstroke prevention, the parents and caregivers were asked, "how would you like information about this topic shared with you in the future?" The participants provided a wide range of creative suggestions; however, the use of social media outlets (Facebook, Twitter, and YouTube) was the most frequently mentioned medium. Following closely behind, television (n = 10, 28.6%) and radio (n = 5, 14.3%) were also commonly discussed by the parents and caregivers. Although not the most popular response, some individuals mentioned receiving information from childcare facilities and pediatricians. To further explore the relationship with their childcare provider and pediatrician, parents and caregivers were asked: "do you think pediatricians (childcare providers) should be involved in educating parents about this topic?" Most of the participants believed that both pediatricians (n = 23, 92%) and childcare providers (n = 22, 88%) should discuss the risks associated with forgetting a child in a hot car. For a complete list of participants' preferred media for receiving future safety information about preventing children from being forgotten in hot cars, please refer to Table 2.5.

2.4 Discussion:

2.4.1 A comparative analysis between the two mental models

By examining the similarities and differences between these two models, we can better identify common points and/or areas in need of improvement to better communicate the risks associated with this health issue. First, a comparative analysis of the mental models offers insight into how experts creating the messaging *believe* parents and caregivers are obtaining information about the issue. Unlike the parents and

caregivers (Figure 2.3), the experts (Figure 2.2) focused on campaigns and public service announcements as the optimal framework for raising awareness. However, according to section 2.3.6 of the results, only one parent acknowledged learning about the issue through a campaign and only three parents were familiar with the local campaign in the state of Georgia. This result reveals a key difference between how experts *believe* parents/caregivers obtain information and how they *actually* receive information about this issue. While the primary form of communication varied between models, both parents/caregivers and experts agreed that pediatricians and childcare facilities were a potential source of information on this topic. According to results section 2.3.1, some experts discussed the current use of posters, pamphlets, and other passive messaging currently in various healthcare facilities. Moreover, a large majority of the parents/caregivers in our sample believed that relationships with pediatricians (n = 23, 92%) and childcare providers (n = 22, 88%) could be advantageous in educating parents/caregivers of the risks associated with vehicular heatstroke.

Another similarity that existed between the two models, involved the use of laws and policies as a means to raise awareness for this health topic. Overall, both the experts and parents/caregivers agreed that laws play a larger role in preventing parents and caregivers from *intentionally* leaving children in vehicles. Therefore their sole purpose is to bring attention to the severity of forgetting a child, which the results in section 2.3.4 clearly revealed about the parents/caregivers in our sample. Interestingly, when the experts were discussing the future of policy surrounding this issue, they overwhelmingly focused on the automotive industry and the policies needed to introduce technological interventions into vehicles. Several experts discussed incorporating technology into

vehicles that would remind parents/caregivers to be aware of their car environment; however, as one expert explained "[it would be] another 20 years or so before it was standard in every vehicle." Parents and caregivers, on the other hand, frequently discussed 1) incorporating these technological advances into a car seat and 2) their willingness to pay more money for this product. Additionally, the parents/caregivers acknowledged that they would be more incentivized to purchase standalone technological devices if they contained either passive qualities or could be obtained at a reduced cost.

The final two themes, lifestyle factors and psychological and physiological factors, address the major components that both experts and parents/caregivers commonly associated with forgetting a child in a hot car. Unlike the expert mental model, the parents/caregivers in our sample emphasized that various lifestyle factors (e.g. single parent, low-income parent, etc.) increase the likelihood of forgetting a child in a hot car. However, both mental models agreed that cases associated with children intentionally left in vehicles may influence the perceived susceptibility among parents/caregivers. Lastly, even with several participants (n = 10, 40%) denying they could forget a child in a hot car, the two mental models acknowledged that denial, distracted individuals, and/or a change in routine are common psychological and physiological explanations for forgetting a child in a car. Additional circumstances for forgetting a child, commonly found within both mental models, involved a lack of visual cues in the car environment and/or a sleeping child.

Through the creation and comparison of these mental models, we have been able to identify key differences in the knowledge of parents/caregivers and experts. However, this big-picture approach does not allow us to examine the specifics associated with

promoting behavior change among parents and caregivers. Therefore by infusing elements of the Health Belief Model, we are able to further explore these key differences in hopes of better understanding their impact on perceived susceptibility and the adoption of injury prevention techniques among parents and caregivers.

2.4.2 Exploring the parent/caregiver responses using the Health Belief Model

Although the expert and parent/caregiver mental models were able to provide key differences in knowledge, the following discussion examines the responses associated with the Health Belief Model to further explore the risk perceptions and future behaviors of parents/caregivers. Even though a majority of the participants in our sample displayed moderate concern (M = 3.08) and a willingness to alter their outdoor behavior (i.e., stay hydrated, dress differently, alter schedule, etc.) for extreme temperatures, section 2.3.3 of the results reveals that most parents/caregivers only recognized heat as a health and safety concern after being prompted. Moreover, section 2.3.4 and figure 2.6 reveal that most of the parents/caregivers did not believe they could forget their own child in the back seat of a car. While the parents/caregivers did perceive this as a serious issue to themselves and others (M = 3.60), their lack of perceived susceptibility (M = 1.72) prevents a health behavior change. According to the Health Belief Model, the overall risk of a health-related issue is based upon both the perceived susceptibility and severity (Figure 2.1; Brewer and Rimer 2008; Glanz 2008). Alone, perceived severity is not a powerful predictor of health-related behaviors; however, when combined with a heightened state of perceived susceptibility it becomes a better predictor (Brewer and Rimer 2008; Glanz 2008). Therefore, increasing perceived susceptibility must be a

priority among government and child advocacy organizations to encourage parents and caregivers to adopt injury prevention techniques. Before altering the messaging strategy, it would be beneficial to better understand the origin of this low susceptibility and psychological distancing that is taking place among parents and caregivers. This lack of perceived susceptibility, according to results section 2.3.4, could be attributed to both 1) the participant's belief that particular lifestyle factors increase an individual's risk for forgetting a child or 2) the use of news and incident reports as their main source of messaging on this topic.

The discussion of lifestyle factors, in sections 2.3.2, 2.3.3, and 2.3.4 can offer insight into the parents' and caregivers' risk perceptions associated with forgetting a child in a hot car. During the open-ended portion associated with their knowledge and opinions on the issue, parents and caregivers brought up lifestyle factors when asked to elaborate about the origin of these incidents: "You are more likely to be put in a situation like this if you don't have enough money to pay for a babysitter or pay for daycare" or "I feel bad for saying this, but a working parent." Additionally, when asked if a quality existed that increased the likelihood of a person forgetting a child, the most popular response involved the "lifestyle factors" code. Recall that responses in this study were coded as "lifestyle factors" when a parent or caregiver discussed various aspects of an individual's life. Perhaps these lifestyle factors allow parents and caregivers to distance themselves from the issue, because they do not self-identify with these labels and consider others who fit the criteria to be more vulnerable. If these misconceptions were addressed in future messaging and thus eliminated from the equation, would the perceived susceptibility of parents and caregivers increase? Additional studies are needed to better

understand the low perceived susceptibility and psychological distancing associated with this issue, in order to acknowledge and/or address these missing components in future messaging.

Another possibility for the low susceptibility observed among the parents and caregivers in our sample could be the result of receiving information about this topic through news and incident reports. Although these reports bring awareness to the topic, their primary purpose does not involve educating and/or sharing injury prevention techniques with the general public. However, with our participants most frequently obtaining information from these sources, it is necessary to understand how these reports affect parents' and caregivers' risk perceptions. Evidence of the potential relationship between news reports and increased risk attributed to lifestyle factors is apparent when the mental models of parents/caregivers, in our study, are broken down by annual household income (Figure 2.4 and 2.5). The low income participants overwhelmingly reported obtaining information via news and incident reports, and also regularly discussed lifestyle factors. Conversely, the high income parents/caregivers most frequently stated that they obtained information via online parenting articles, thus lifestyle factors were not as prominent in their mental model. These observations support the possibility that a positive relationship exists between news reports and lifestyle factors.

Additionally, a majority of the parents and caregivers mentioned the high profile case that occurred in Georgia during the summer of 2014. While many respondents mentioned that this case made them "more aware of the issue," did it also impact their perceptions regarding the intentional-nature of leaving a child in a hot car? Experts have

differing opinions about the effects of news reports on the risk perceptions of parents and caregivers. While some agree that it does raise awareness, others question whether it reduces perceived susceptibility by advertising that this only happens to particular individuals exhibiting various lifestyle factors. Because of this, future studies should examine the media effects associated with hot car deaths to determine whether the takeaway message results in increased awareness via additional public health messaging or if it drastically hinders the perceived susceptibility of parents and caregivers. Until this research question has been addressed, perhaps an increase in prioritizing perceived susceptibility in heatstroke messaging would reinforce the idea that all parents and caregivers are vulnerable. Therefore, these mental models and the knowledge of their discontinuities can offer an evidence-based approach to improve future health messaging.

2.4.3 Implications for future public health messaging

While it is difficult to assess the messaging associated with hot car deaths, the mental model interviews presented the opportunity to gauge the audience and determine how to modify the current messaging strategy. After the completion of the mental model interviews, it was evident that the creation of a more relevant and engaging message should be a priority. Further, the differing messaging priorities among the experts (Table 2.4) and the inability for parents/caregivers to recall any public service announcements, clearly demonstrates the need for improvement in both reaching parents and making the message stick. Moreover, several parents mentioned the use of catchy rhymes and slogans associated with the issue, but all agree that "it didn't catch." Another parent went on to explain that "when I think about an ad or public service announcement I think of

‘Turn around, don’t drown’ or ‘Click it, or ticket.’ I can’t think of the catchy rhyme [associated with this issue].” Unlike the examples mentioned by the parent in the previous sentence, there are several different rhymes that are currently being promoted among organizations across the country (Table 2.6). With the different messaging priorities, slogan promotion, and variety of injury prevention tips, some parents/caregivers may, as one participant suggested, “get paralyzed by options.” Based on this study, it is evident that the current heatstroke prevention messaging struggles to convey the risks and susceptibility of all parents. Therefore, perhaps an alternative messaging strategy focused on either personalizing their vulnerability (e.g. it can happen to you vs. it can happen to anyone) or elevating their concern for heat as a health issue may increase perceived susceptibility and promote health behavior change among parents and caregivers.

Another suggestion for improving future health messaging, involves the use of a targeted messaging strategy. This approach could be employed through the use of focused messaging and the implementation of passive reminders, which are both currently being used by the organization Ray Ray’s Pledge (2016). They strive to focus on equal susceptibility among all individuals, while targeting their messaging during the peak hours when children are most often forgotten in hot cars: 1) dropping off children in the morning for daycare and 2) on the way home in the afternoons. This targeted messaging approach could be further expanded through the use of characteristics from previous cases. With a majority of the forgotten cases involving children less than five years of age and occurring in climatologically warmer regions of the country, these areas could be a focal point for more vigilant messaging. Additionally, the use of just-in-time

messaging via social media (i.e., Facebook, Twitter, Blogs, etc.) could be used when extreme temperatures are in the forecast. These reminders and messages prior to the arrival of extreme temperatures could further persuade parents/caregivers to alter their behavior and implement injury prevention strategies inside the vehicle (Intille 2004). Further, Ray Ray's Pledge (2016) promotes the use of an arrival and/or absence confirmation among daycare and childcare providers. This idea could be further developed to take advantage of visual and environmental cues, a topic often discussed at the intersection of public health and behavioral economics (Kessler and Zhang 2014). For example, campaigns and other child advocacy organizations could promote the use of stickers, key chains, and even small signs in drug/grocery store parking lots to provide a small nudge to parents and caregivers. According to results section 2.3.5, passive qualities and cost-efficiency in both technological devices and injury prevention techniques were highly desired. Therefore, these passive reminders, in addition to technology being offered at a reduced cost, could be something easy to implement and prompt parents to check the back seat. The future of heatstroke prevention involves the effective use of different media outlets, messaging strategies, and increasing perceived susceptibility among parents and caregivers. To increase overall awareness and effectiveness of public health messaging for this issue, we must work together as a community and incorporate the work of other disciplines.

2.5 Conclusion:

Through the development of two mental models, we have determined that differences (e.g. primary source of information and increased risk attributed to lifestyle factors) exist between the experts developing the vehicular heatstroke prevention messaging and the parents/caregivers receiving that information. Although the participants in the study acknowledged the seriousness of this issue to themselves and others, a majority refused to believe they could forget their own child in a hot car. Further distancing themselves from the possibility of occurrence, many parents and caregivers explained that they believe this is either an intentional act or that particular lifestyle factors (e.g., single parent, low-income parent, or a working parent) increase a parent's/caregiver's risk for forgetting a child. Additionally, the use of news and incident reports as their main source of information may be further exacerbating the stereotypes associated with hot car deaths. Evidence of this potential positive relationship between news/incident reports and lifestyle factors was observed when the parent/caregiver mental model was isolated by annual household income. Until these *differences* are recognized and addressed in future public health messaging, the perceived susceptibility of parents and caregivers will remain in its current insignificant state.

While these mental models provide suggestions and areas of improvement for the current public health messaging, there are several limitations associated with the methodology that should be addressed. The mental models approach is designed to examine the knowledge and risk perceptions of a few individuals to identify key frameworks associated with a particular issue; therefore, we cannot accurately generalize these results across all parents and caregivers. However, this exploratory research is

needed to both inform future risk communication materials and surveys on the topic. Secondly, the participants more than likely held an opinion about the issue that prompted them to volunteer for the interview process. Additionally, the sample contained few fathers, and lacked representation from a few ethnic/racial demographics and a diverse set of caregivers (e.g., relatives, daycare providers, etc.). Future research, associated with the next step in the mental models approach, should involve the distribution of a structured survey to a larger sample of parents and caregivers. This survey will provide a more diverse sample of caregivers and fathers, as well as determine if their lack of perceived susceptibility extends broadly to extreme temperatures. Finally, two local vehicular heatstroke cases occurred during the interview process that may have influenced the level of awareness among our sample; however, some of these individuals still exhibited low perceived susceptibility toward forgetting a child in a vehicle.

To increase behavior change and the adoption of injury prevention techniques, the Health Belief Model posits that public health messaging must strive to balance both perceived susceptibility and severity. This can be accomplished by prioritizing a perceived susceptibility message within the heatstroke prevention community that aims to personalize the vulnerability of this devastating tragedy (e.g. it can happen to you vs. it can happen to anyone). Further, we hope this research will highlight the need to explore alternative messaging strategies and to not solely rely on the use of public health campaigns to inform parents about the risks associated with vehicular heatstroke. Different approaches could include the use of passive techniques (i.e., stickers, keychains, steering wheel covers, etc.) and just-in-time messaging, in order to remind a parent/caregiver without any additional effort or a major change in their everyday

behavior. In conclusion, we hope this study will act as a vital component in the refinement of current messaging to promote awareness of vehicular heatstroke prevention, inform parents and caregivers about their vulnerability, and encourage the adoption of injury prevention techniques in order to reduce the number of children forgotten in hot cars annually.

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2.7 Appendix A: Questions asked during the mental model interviews

Tell me about some of your health/safety concerns for your kids.

- Thinking about the upcoming summer months, do you have any other concerns for your kids?
- How concerned are you with heat and your children's health?
- How much attention do you pay to the heat/weather forecasts?
    - When you hear the temperature is going to be high (80-90 degrees), do you do anything differently?
    - Do you pay attention to heat warnings?
- What do you think about kids forgotten in cars during warm season months?
- Have you seen any ads, public service announcements, or materials involving kids being left alone in cars during warm season months?
    - Is there a type of media channel that you see information about this topic more frequently? (TV, Radio, Social Media, Posters)
    - How would you like information about this topic shared with you? (TV, Radio, Poster, Social Media).
- If you were the spokesperson for this issue, what would you tell other parents about this topic?

Perceived Susceptibility:

- How likely are you or your family to be affected by this issue?
- Do parents give this issue a high priority?
    - Why not?
    - What keeps it from being a high priority?

- Is there a type of parent or a quality about an individual that you believe is more likely to forget a child in a hot car?

- How do you think these cases happen?

Perceived Severity:

- For you, how serious is your concern in regard to forgetting a child in a hot car?

Prevention Measures / Self-Efficacy

- Do you know of any tips or tricks to help remember your child is in the backseat of the car?
    - Yes/No. If yes, then elaborate.
    - If you knew tips or tricks, would you be willing to use them?

- Some have suggested the use of technology as a tip for remembering your child is in the backseat of a car?
    - Have you heard of this?
    - Would you be willing to purchase these technologies and use them?
    - Do you think other parents/caregivers would use them?

- Can you envision a situation in which you would leave your child unattended in a vehicle?

- What would you do, if you saw a child alone in a car?

- What could/would you tell another parent, to make them less likely to forget their child in a hot car?

Policy:

- Do you know about children left unattended in vehicle laws?

- Does the state of Georgia have such a law?

- Some have suggested the use of laws and policies can be used as a tip or trick for remembering your child in the backseat. How do you feel about this?
    - How do you think other parents/caregivers feel about this?
    - If a law or policy existed, would that make you think this issue is more serious?

Barriers/Benefits:

- What might prevent a parent/caregiver from using tips and tricks or technologies used for remembering children are in the back seat of the car?

- What might make a parent/caregiver use tips or tricks or technologies to remember their children are in the back seat of the car?

Cues to Action:

- Some have suggested that a child's doctor or pediatrician should be involved to educate parents/caregivers about dangers of forgetting your child in the backseat of a car. Has your pediatrician or child's doctor discussed the risks of children being left alone in cars?
    - Should a doctor call attention to the dangers?
    - Should a doctor recommend a specific strategy or technology to prevent your child from being forgotten in the back seat of a car?
    - Should a daycare or child care expert discuss the risks with you?
- Have you heard of the "Look Again" campaign?

Final Questions:

- Were there any issues related to forgetting children in hot cars that you thought of but didn't get a chance to talk about? (If so) What issues?

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2.9 Tables and Figures

Table 2.1. Definitions of the cognitive variables associated with the Health Belief Model. Information courtesy of Glanz, 2008.

Concept	Definition	Application
Perceived Susceptibility	One's assessment of chances of getting a condition or being affected by a threat/risk	Define population(s) at risk, risk levels Personalize risk based on a person's characteristics or behavior
Perceived Severity	One's assessment of how serious a condition and its sequelae are.	Specify consequences of the risk and the condition
Perceived Benefits	One's assessment of the efficacy of the advised action to reduce risk or seriousness of impact	Define action to take: how, where, when; clarify the positive effects to be expected
Perceived Barriers	One's assessment of the tangible and psychological costs of the advised action	Identify and reduce perceived barriers through reassurance, correction of misinformation, incentives, assistance
Cues to Action	Strategies to activate one's "readiness"	Provide how-to-information, promote awareness, employ reminder systems
Self-efficacy	One's confidence in one's ability to take action	Provide training, guidance in performing action Use progressive goal setting

Table 2.2. A comparative analysis of average weekly childcare fees compared to the Athens-Clarke County average, in order to obtain a socioeconomically diverse sample of parents and caregivers. Average childcare values were obtained using the AllGaKids (2016) website.

Name:	Average Weekly Childcare Fees	Low or High Income?
Daycare 1	$94	Low
Daycare 2	$109	Low
Daycare 3	$136	Low
Athens-Clarke County Average Weekly Fee: $162		
Daycare 4	$170	High
Daycare 5	$265	High

Table 2.3. Descriptive statistics for the parents/caregivers in our sample.

Variable	*N*	%
Gender:		
Female	20	80
Male	5	20
State:		
Parent	21	84
Caregiver	4	16
Ethnic Identification:		
Caucasian American	15	60
African American	6	24
Asian American	1	4
Caucasian European	2	8
Other	1	4
Educational Background:		
High School Graduate	4	16
Some College Credit	5	20
Associate Degree	1	4
Bachelor Degree	5	20
Master's Degree	5	20
Professional Degree	2	8
Doctoral Degree	3	12
Total Household Income :		
Less than $10,000	3	12
$10,000 to $19,999	3	12
$20,000 to $29,999	2	8
$30,000 to $39,999	3	12
$40,000 to $49,999	1	4
$50,000 to $59,999	0	0
$60,000 to $69,999	3	12
$70,000 to $79,999	1	4
$80,000 to $89,999	3	12
$90,000 to $99,999	1	4
$100,000 to $149,999	2	8
$150,000+	3	12

Table 2.4. Key messages provided by the expert panel during the mental model interviews. A bolded key message means that it was most frequently discussed among the experts.

Expert	Key Message 1	Key Message 2	Key Message 3
Expert 1	A	B	C
Expert 2	D	E	C
Expert 3	F	G	H
Expert 4	I	H	C
Expert 5	I	J	K
Expert 6	C		

A. The scope is greater than most people realize.
B. Hot car deaths have occurred with temperatures in the upper 60s.
C. This can happen to anyone.
D. Hot car deaths are preventable.
E. Over half of parents unwittingly forget their children in the vehicle.
F. Create an arrival confirmation and absent verification safety net.
G. Always lock your car and keep your keys out of reach.
H. Call 911 if you see a child unattended in a car.
I. Never leave the child alone in a vehicle, even for a minute.
J. Always check the back seat before leaving your vehicle.
K. Create a reminder to check the back seat.

Table 2.5. Statistics regarding participants' preferred medium for receiving safety information in the future.

Preferred Medium	***N***	**%**
Social Media	12	34.3
Television	10	28.6
Daycare/Medical Facilities	3	8.6
Online Articles/Blogs	2	5.7
Newspaper	1	2.9
Radio	5	14.3
Mobile Messaging	2	5.7
Note: Respondents could indicate multiple preferred media channels.		

Table 2.6. Current vehicular heatstroke slogans and rhymes in use throughout the United States

Organization	Slogan or Rhyme
National Highway Traffic Safety Administration	"Where's baby? Check for baby"
National Weather Service	"Beat the heat, check the backseat"
Safe Kids Worldwide	**A**void leaving your child alone in a car, not even for a minute **C**reate reminders **T**ake Action
Kids and Cars	"Look before you lock"
Department of Early Care and Learning (DECAL) of Georgia	"Look again"

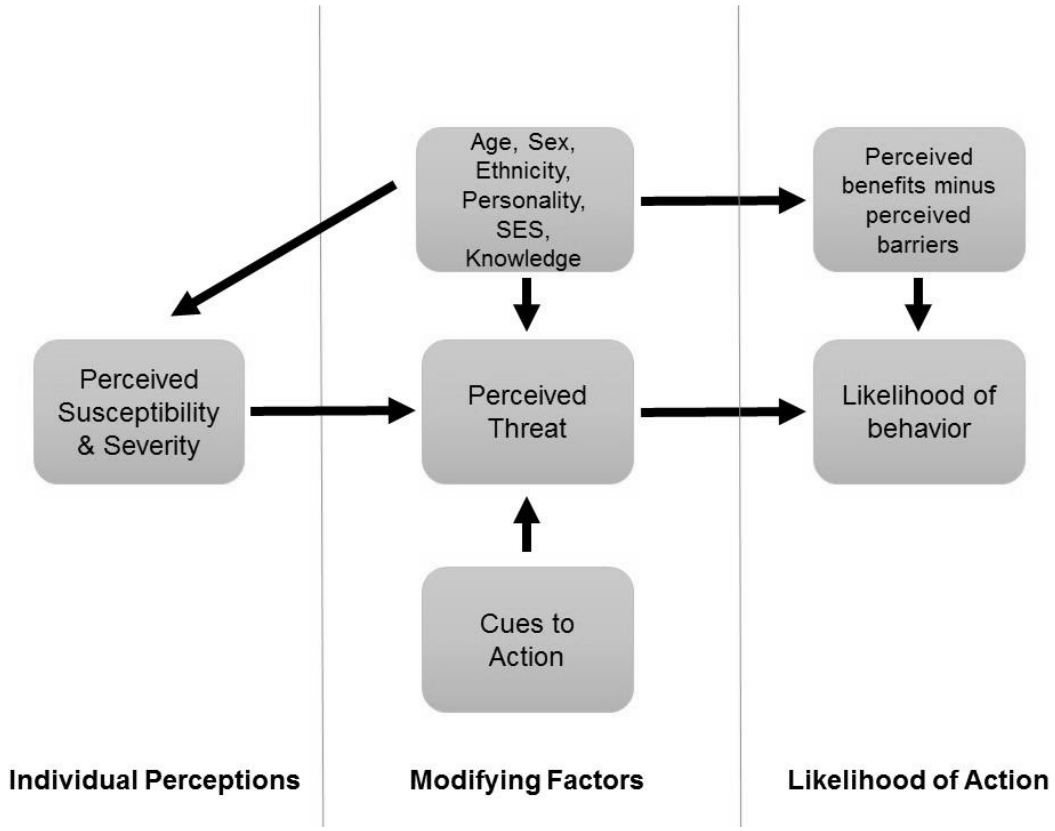


Figure 2.1. The Health Belief Model framework depicted as a diagram. Information courtesy of Rosenstoke, 1974.

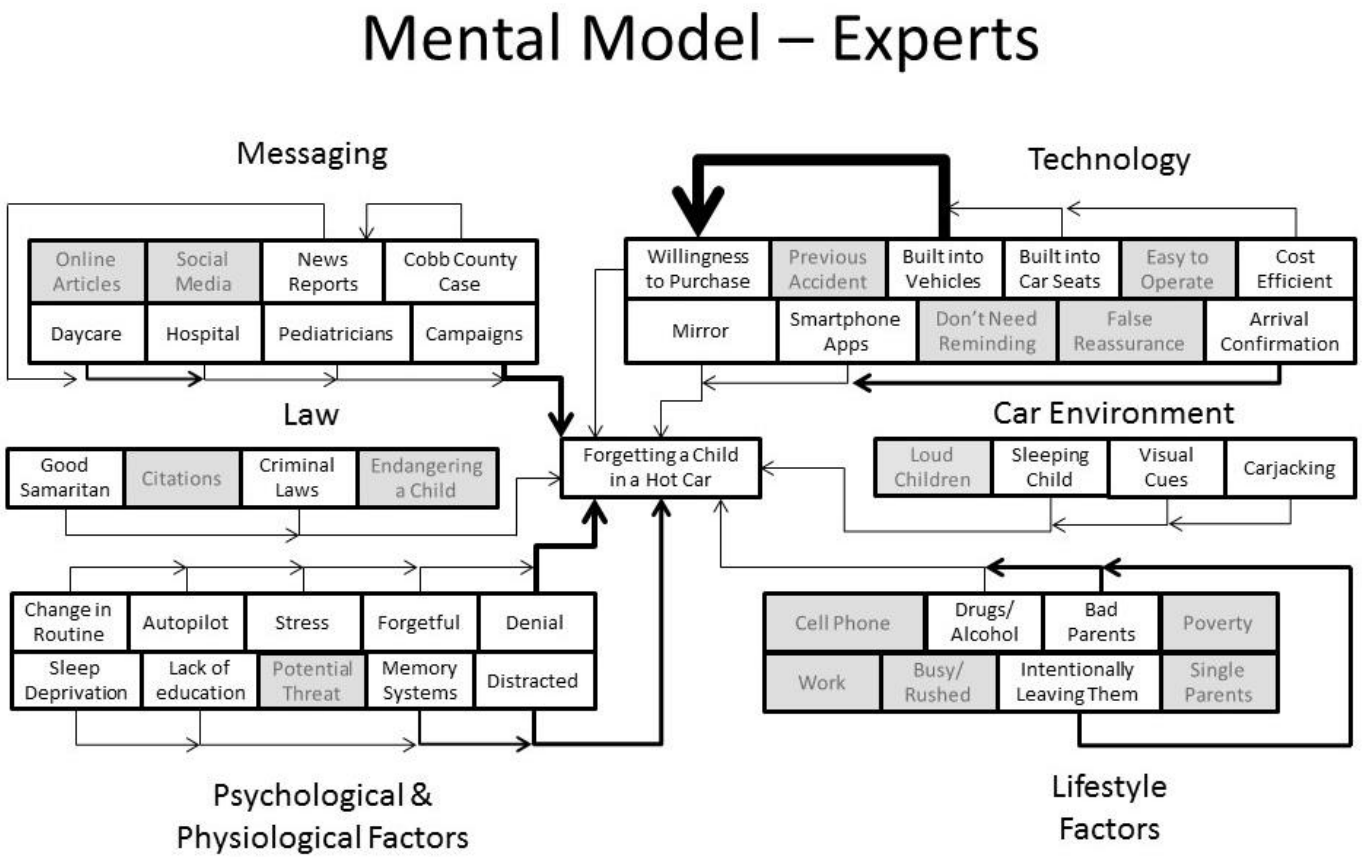


Figure 2.2. The expert mental model. The greater the line's weight, the more frequent that topic was discussed during the interview. The gray boxes represent topics that were not brought up during the expert interviews.

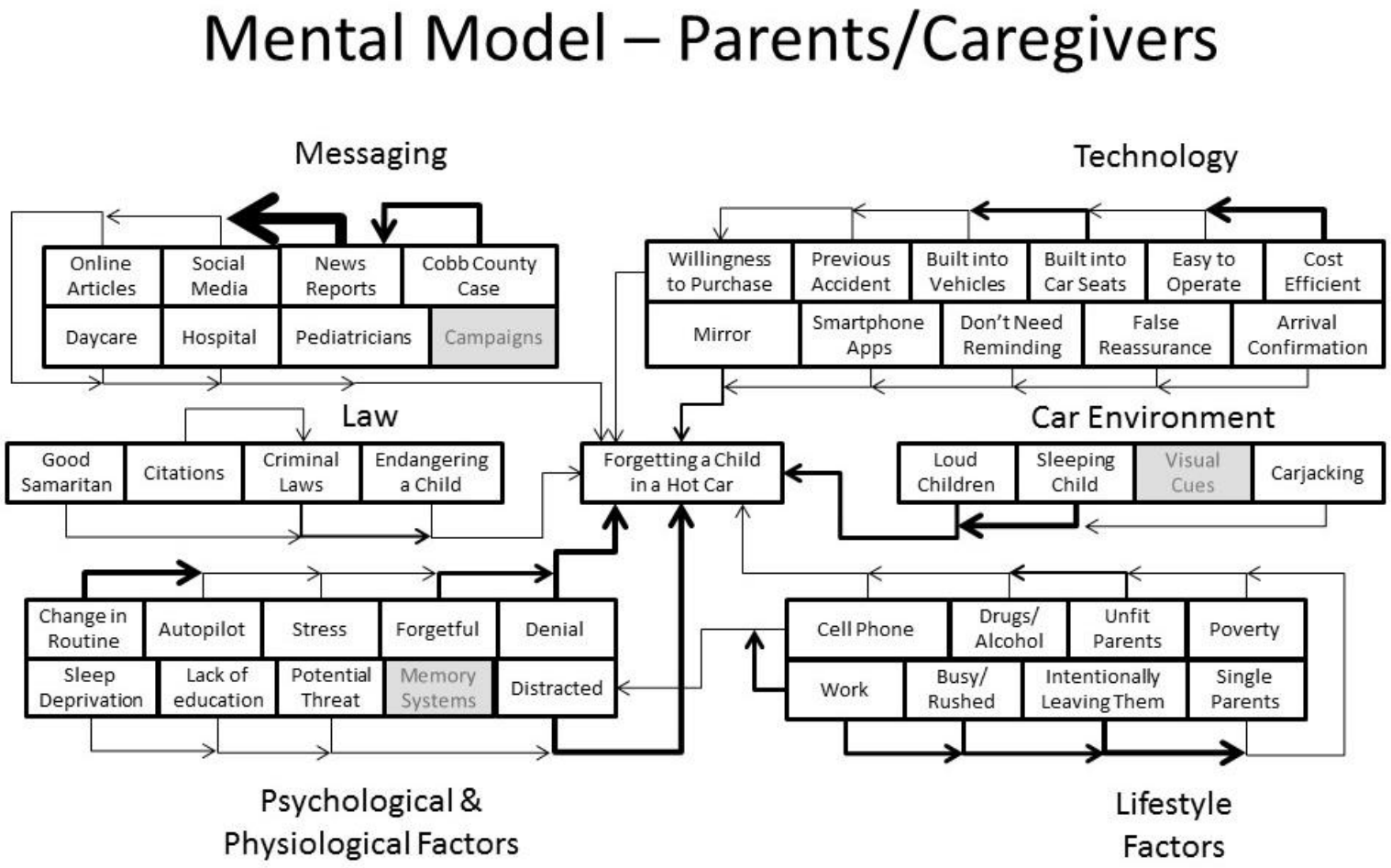


Figure 2.3. The parent and caregiver mental model. The greater the line's weight, the more frequent the topic was discussed during the interview. The gray boxes represent topics that were not discussed during the parent/caregiver interviews.

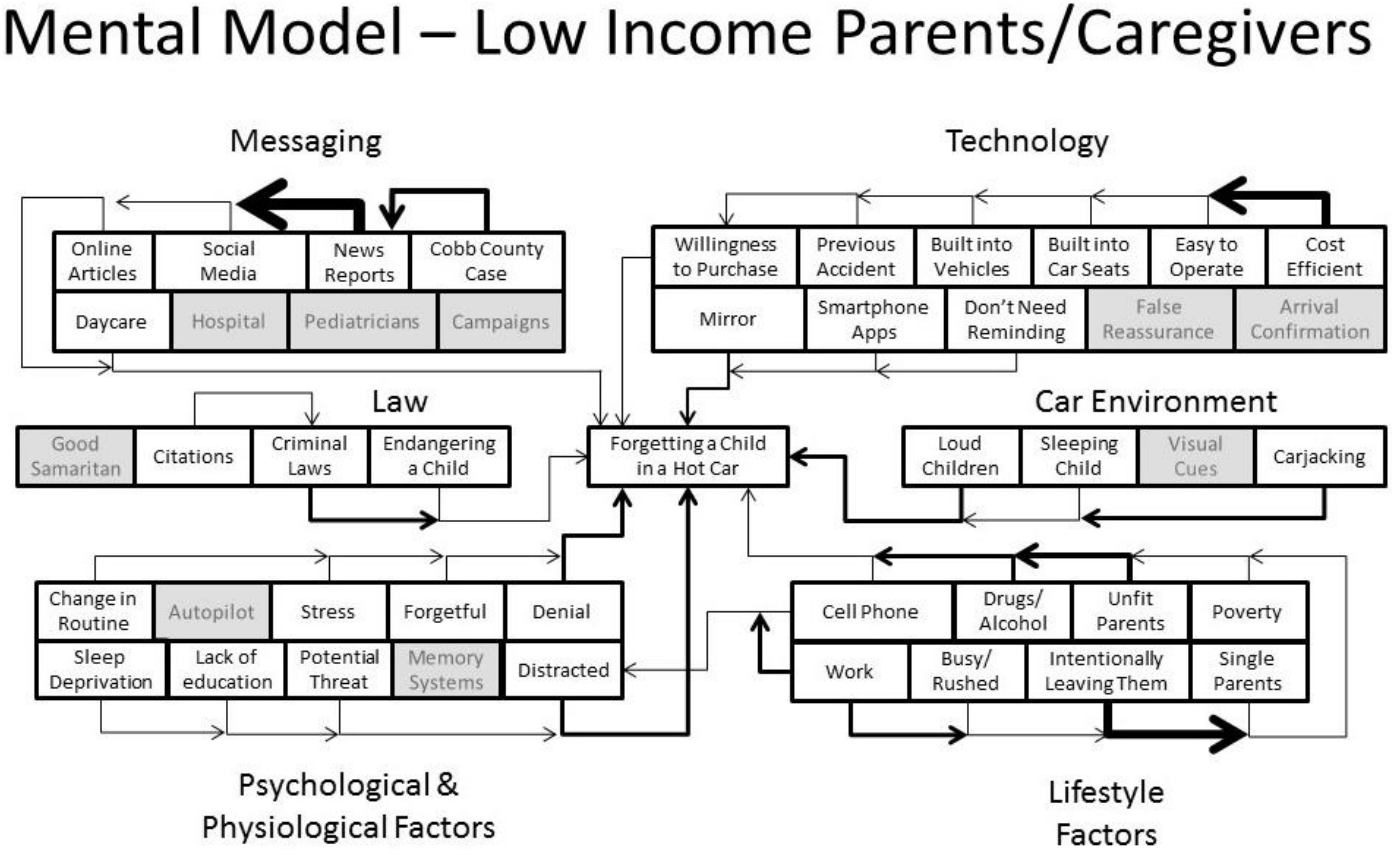


Figure 2.4. The low income parent and caregiver mental model. The greater the line's weight, the more frequent the topic was discussed during the interview. The gray boxes represent topics that were not discussed during the parent/caregiver interviews.

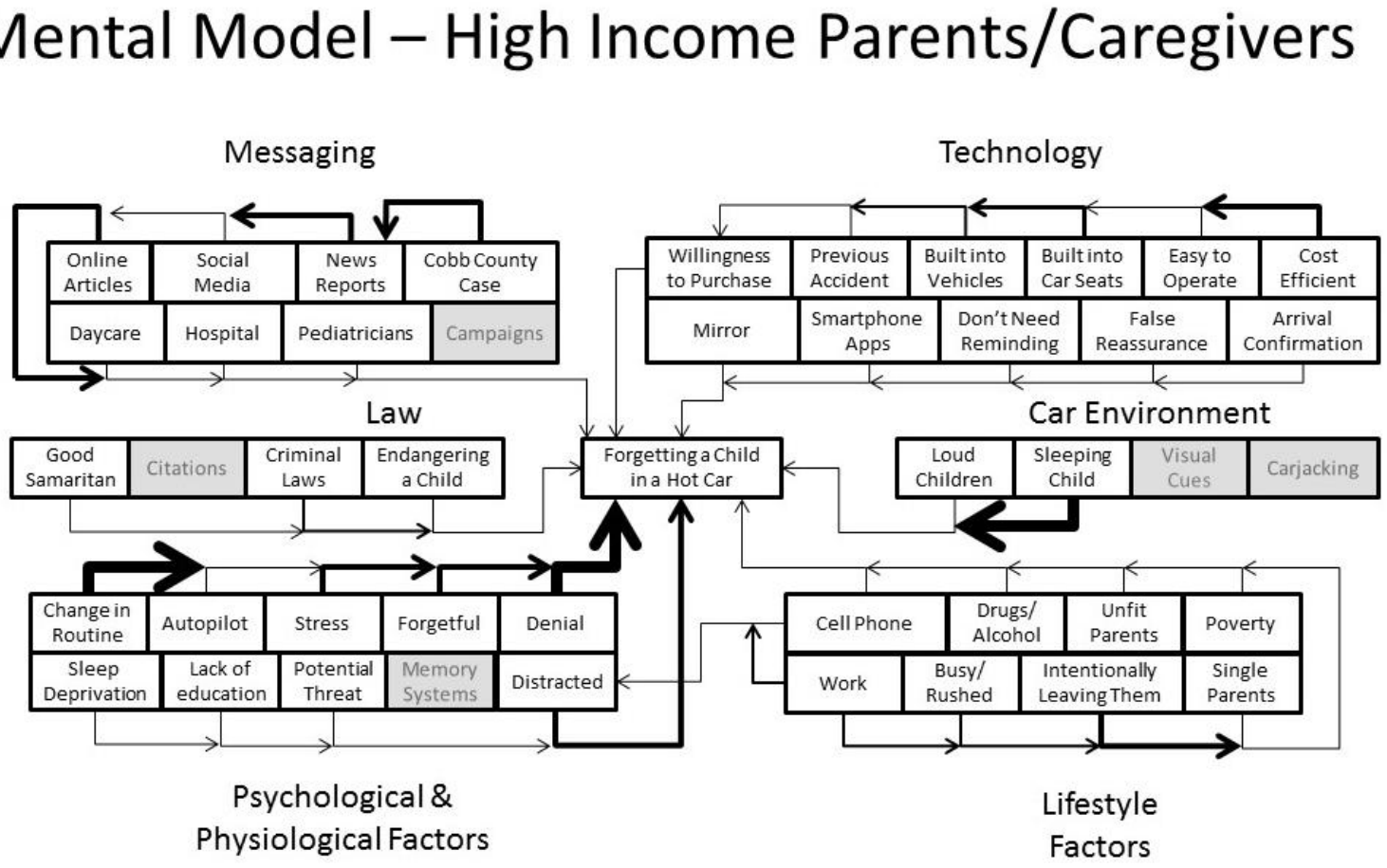
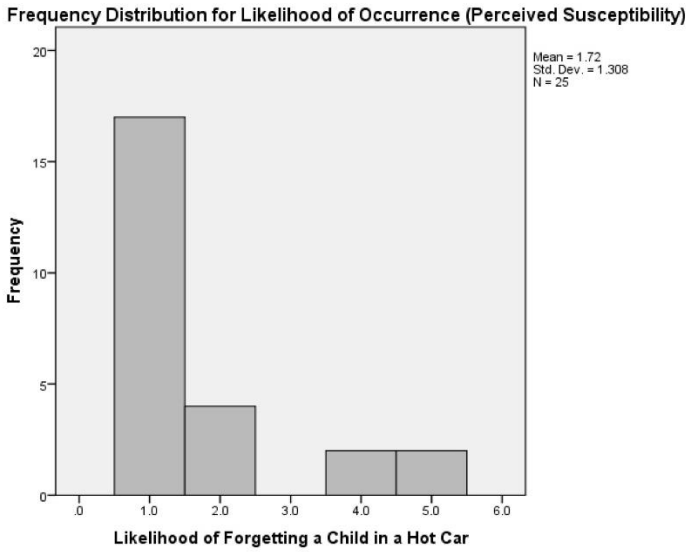


Figure 2.5. The high income parent and caregiver mental model. The greater the line's weight, the more frequent the topic was discussed during the interview. The gray boxes represent topics that were not discussed during the parent/caregiver interviews.

A



B

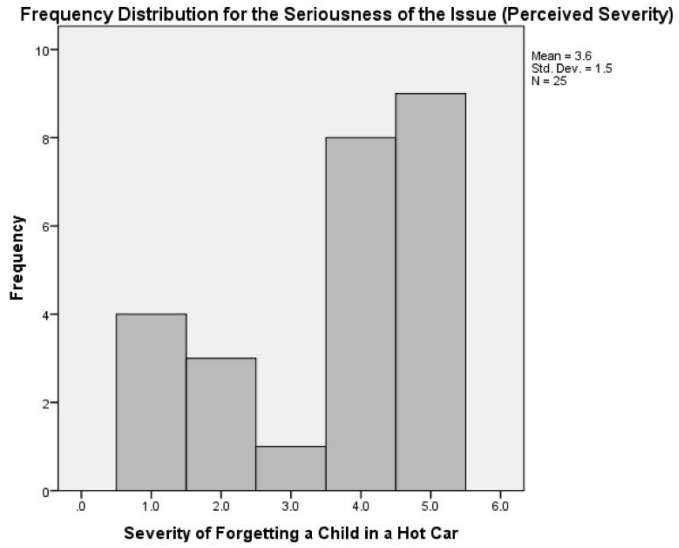


Figure 2.6. A frequency distribution for A) an individual's likelihood of forgetting a child in a hot car (perceived susceptibility) and B) the severity of forgetting a child in a hot car (perceived severity). Likelihood is measure on a Likert scale (Likert, 1932) from 1 (extremely unlikely) to 5 (extremely likely). Severity is measured on a similar Likert scale from 1 (not serious at all) to 5 (extremely serious)

CHAPTER 3

SUMMARY AND CONCLUSIONS

3.1 Summary

With previous vehicular heatstroke literature predominantly focused on the physical sciences, this thesis has taken an interdisciplinary approach to better understand how to communicate the risks associated with forgetting a child in a hot car to parents and caregivers. This was accomplished by employing a hybrid mental models approach to risk communication, in order to determine the current knowledge and risk perceptions of parents and caregivers on this health topic. Moreover, elements of the Health Belief Model were integrated into this hybrid mental models approach to obtain information on parents'/caregivers' perceived threat and willingness to adopt new health behaviors. Using this methodology, this thesis has addressed the following questions. First, what current knowledge, beliefs, attitudes, and risk perceptions do parents/caregivers possess in regards to forgetting a child in a hot car? Second, does the expert mental model differ from the mental model of parents/caregivers? Finally, how can we use the elements of the Health Belief Model to inform future public health messaging? In the sections that follow the inconsistencies of the mental models will be summarized, the limitations of the study will be discussed, and suggestions for improving future public health messaging will be provided.

3.2 Conclusions

Through the development of two mental models, we have determined that differences (e.g. primary source of information and increased risk attributed to lifestyle factors) exist between the experts developing the vehicular heatstroke prevention messaging and the parents/caregivers receiving that information. Although the participants in the study acknowledged the seriousness of this issue to themselves and others, a majority refused to believe they could forget their own child in a hot car. Further distancing themselves from the possibility of occurrence, many parents and caregivers explained that they believe this is either an intentional act or that particular lifestyle factors (e.g., single parent, low-income parent, or a working parent) increase a parent's/caregiver's risk for forgetting a child. Additionally, the use of news and incident reports as their main source of information may be further exacerbating the stereotypes associated with hot car deaths. Evidence of this potential positive relationship between news/incident reports and lifestyle factors was observed when the parent/caregiver mental model was isolated by annual household income. Until these *differences* are recognized and addressed in future public health messaging, the perceived susceptibility of parents and caregivers will remain in its current insignificant state.

While these mental models provide suggestions and areas of improvement for the current public health messaging, there are several limitations associated with the methodology that should be addressed. The mental models approach is designed to examine the knowledge and risk perceptions of a few individuals to identify key frameworks associated with a particular issue; therefore, we cannot accurately generalize these results across all parents and caregivers. However, this exploratory research is

needed to both inform future risk communication materials and surveys on the topic. Secondly, the participants more than likely held an opinion about the issue that prompted them to volunteer for the interview process. Additionally, the sample contained few fathers, and lacked representation from a few ethnic/racial demographics and a diverse set of caregivers (e.g., relatives, daycare providers, etc.). Future research, associated with the next step in the mental models approach, should involve the distribution of a structured survey to a larger sample of parents and caregivers. This survey will provide a more diverse sample of caregivers and fathers, as well as determine if their lack of perceived susceptibility extends broadly to extreme temperatures. Finally, two local vehicular heatstroke cases occurred during the interview process that may have influenced the level of awareness among our sample; however, some of these individuals still exhibited low perceived susceptibility toward forgetting a child in a vehicle.

To increase behavior change and the adoption of injury prevention techniques, the Health Belief Model posits that public health messaging must strive to balance both perceived susceptibility and severity. This can be accomplished by prioritizing a perceived susceptibility message within the heatstroke prevention community that aims to personalize the vulnerability of this devastating tragedy (e.g. it can happen to you vs. it can happen to anyone). Further, we hope this research will highlight the need to explore alternative messaging strategies and to not solely rely on the use of public health campaigns to inform parents about the risks associated with vehicular heatstroke. Different approaches could include the use of passive techniques (i.e., stickers, keychains, steering wheel covers, etc.) and just-in-time messaging, in order to remind a parent/caregiver without any additional effort or a major change in their everyday

behavior. In conclusion, we hope this study will act as a vital component in the refinement of current messaging to promote awareness of vehicular heatstroke prevention, inform parents and caregivers about their vulnerability, and encourage the adoption of injury prevention techniques in order to reduce the number of children forgotten in hot cars annually.

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