

Children forgotten in hot cars: a mental models approach for improving public health messaging

Castle A Williams, Andrew J Grundstein

Department of Geography,
University of Georgia, Athens,
Georgia, USA

Correspondence to

Castle A Williams, Department
of Geography, 210 Field Street,
Room 204 Athens, GA 30602,
USA; castleaw@uga.edu

Received 26 October 2016

Revised 29 May 2017

Accepted 13 June 2017

ABSTRACT

Introduction On average, in the USA, 37 young children die every year due to vehicular heatstroke. Additionally, over half of these incidents occur when a parent/caregiver forgets a 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.

Methods This study will employ a 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 in order to construct and explore these mental models.

Results A comparative analysis was conducted, and three key differences were observed between these mental models. Unlike the experts, the parents/caregivers in the study emphasised perceived lifestyle factors (eg, low-income parent) as important elements in increasing an individual's likelihood of forgetting a child in a car. Importantly, the parents/caregivers primarily obtained information from news reports, while experts believed public health campaigns would reach more parents/caregivers. Lastly, while experts stressed that this tragedy could happen to anyone, most parents/caregivers failed to acknowledge that they could forget their own child in a car.

Conclusions To confront this denial, future public health messaging must strive to engage and reach all parents/caregivers. This can be accomplished using a multifaceted messaging strategy that includes personalising core messaging, providing additional resources to media outlets and building rapport between key partners.

INTRODUCTION

In the USA alone, on average, 37 young children die every year due to vehicular heatstroke.¹ Further, these completely preventable incidents involve a parent or caregiver forgetting a child in a car (54% of incidents),¹ children trapped in a car/trunk (ie, self-entrapment; 29%) or children intentionally left in a vehicle (17%).¹ Although this has been a

prevalent health issue in the news media over the past years, the current paediatric vehicular heatstroke statistics may underestimate the number of children affected annually. To further complicate matters, a large portion of the current research literature focuses on questions driven by the physical sciences when in reality this issue lies at the intersection of public health, injury prevention and the atmospheric sciences. For example, the major topics of discussion surrounding this issue include understanding the microclimate conditions in a vehicle^{2–11} and examining the characteristics of past incidents.^{12–15}

The next step in the process of understanding these tragic incidents, then, is to connect this scientific information to improve and promote more effective public health messaging. Guard and Gallagher¹² 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 various governmental and child safety advocacy groups have worked to raise awareness about these tragedies, rigorous studies have yet to be completed evaluating the effectiveness of the current messaging and/or the knowledge of parents/caregivers on this issue.

This study seeks to address this gap in the literature by examining the components that both parents/caregivers and experts deem important surrounding the topic of children *forgotten* in hot cars. These incidents represent over 50% of vehicular heatstroke reports, and they provide the unique opportunity to further explore the vast psychological characteristics associated with this issue. 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 used.¹⁶ Mental model studies are useful in determining the type of knowledge and understanding that currently exists among a group of individuals (eg, 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. For example, if the experts are using specific terminology (eg, greenhouse effect) or focusing on a portion of the risk that the lay public does not consider important (eg, how quickly a car heats up), then these mental model studies can be used to adjust their public health messaging to fit their audience.

¹These incidents occur when a child is forgotten and left unattended by a parent/caregiver. Additionally, the parked car's interior temperature rises causing the child to suffer from heatstroke. For the remainder of the manuscript, this will be denoted using the phrasing: 'children forgotten in hot cars'



CrossMark

To cite: Williams CA, Grundstein AJ. *Inj Prev* Published Online First: *please include Day Month Year*. doi:10.1136/injuryprev-2016-042261

Mental Model – Experts

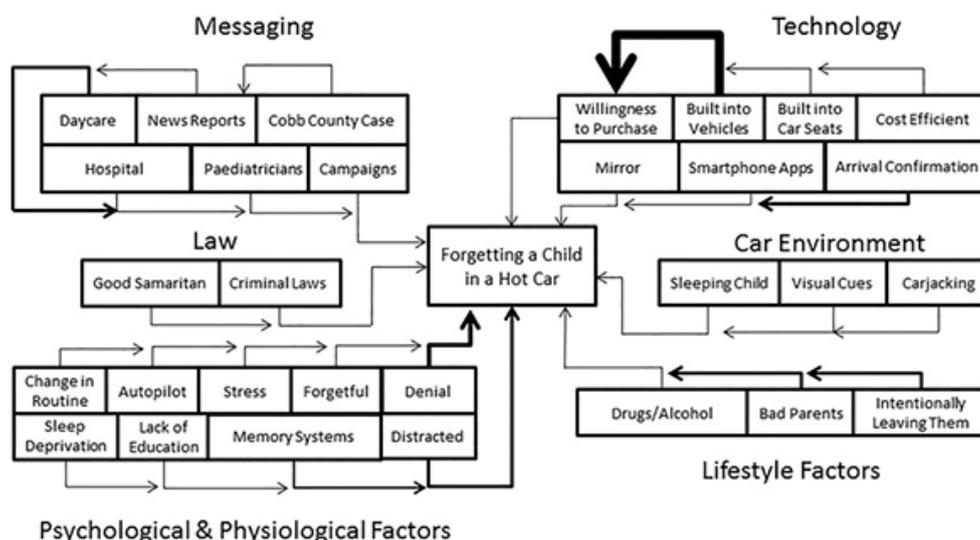


Figure 1 The expert mental model. Greater line weight indicates that a topic was more frequently discussed during the expert interviews. The lifestyle factors category, in this model, represents experts' beliefs of lifestyle misperceptions often made by parents/caregivers.

While this is an unconventional approach for addressing the act of forgetting, as the mental models approach usually targets decision-making, the injury prevention behaviours associated with forgetting a child in a hot car all require a decision prior to implementation. Therefore, this study aims to examine the decision-making and/or willingness of parents/caregivers to *avoid* forgetting their child. This is a novel method for the field of heatstroke prevention, but this framework has been used to obtain a better perspective on the lay public's understanding of various environmental^{17–20} and health-related risks.^{21 22}

In the sections that follow, the interview methodology and content analysis techniques will be discussed. 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 and (2) the implications of this study on future public health messaging and injury prevention behaviours.

METHODS

Expert analysis of children forgotten in hot cars

To better understand the various concepts and variables associated with children being forgotten in vehicles, a mental model was developed in collaboration with several 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 and/or real-world experience creating and distributing messaging used to prevent paediatric vehicular heatstroke. 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. 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 the expert's goals and priorities in preventing children from being forgotten in hot cars, and slowly narrowed down to discussing messaging, policies/laws, involvement of

paediatricians/childcare providers, technology and other topics they deemed important. Following the interviews, the audio recordings were transcribed verbatim and the expert's responses were graphically depicted to identify variables, concepts and relationships associated with this health topic (figure 1). Following the development of this mental model, a pilot study was conducted with three parents from different socioeconomic and educational backgrounds. Using the results from both this preliminary study and the expert testimonials, the interview protocol was further refined to improve clarity and remove irrelevant items prior to interviewing parents/caregivers.ⁱⁱ

Interview procedure

To gain access to parents/caregivers with children younger than the age of 5, six childcare and health facilities across Athens-Clarke County, Georgia, were used to recruit participants for the mental model interviews.ⁱⁱⁱ 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 years, (2) had a child/grandchild 5 years of age or younger and (3) owned and regularly drove a vehicle. For demographic information associated with the participants, please see table 1. The parent/caregiver interviews

ⁱⁱFor a list of items associated with the semistructured interviews, please contact the authors.

ⁱⁱⁱPrior 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.⁴³ 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-income and high-income groups. The selected facilities then agreed to advertise the study to parents and caregivers by placing flyers in their designated area for childcare pick-up and/or through the use of social media.

Table 1 Parent and caregiver demographic information

Variable	n	%
Gender		
Female	20	80
Male	5	20
Parent/caregiver		
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 US\$10 000	3	12
US\$10 000 to US\$19 999	3	12
US\$20 000 to US\$29 999	2	8
US\$30 000 to US\$39 999	3	12
US\$40 000 to US\$49 999	1	4
US\$50 000 to US\$59 999	0	0
US\$60 000 to US\$69 999	3	12
US\$70 000 to US\$79 999	1	4
US\$80 000 to US\$89 999	3	12
US\$90 000 to US\$99 999	1	4
US\$100 000 to US\$149 999	2	8
US\$150 000+	3	12

began with a general question to initiate a conversation regarding their knowledge and opinions surrounding children being forgotten in hot cars (ie, What are your thoughts on children being forgotten in hot cars during warm summer months?), with the interviewer continuing to prompt parents/caregivers until the discussion began to dissipate. Following this open-ended conversation, parents/caregivers were prompted with semistructured questions associated with the themes observed during the expert interviews (eg, do you know about children left unattended in vehicle laws and/or policies?). The length of the interviews ranged from 16 to 45 min (mean 28:45 min, SD 7:28 min), with the transcripts ranging from 1087 words to 5115 words (mean 2545.8 words, SD 1109.35 words).^{iv}

At the end of the interview, participants were given a US\$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. This time period was selected (1) to ensure that extreme heat was a relevant risk to the parents/caregivers and (2) to avoid the late summer months where extreme temperatures and/or other hot car deaths may have influenced their responses. Previous ethnographic research and other mental model 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'.^{23 24}

Qualitative content analyses

After the interviews were transcribed verbatim, the open-ended questions were explored via a content coding analysis.²⁵ 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 codes was determined after several iterations of collapsing the thematic categories. The responses were then reanalysed and assigned a content code from the final set of thematic categories. However, due to the intricacies of the in-depth interview data, several responses were assigned multiple codes when a participant mentioned different thematic categories during their discussion. To assess the reliability of this coding process, a second rater was trained using the final set of content codes. A random sample of the parent/caregiver responses was then assessed by the second rater due to the complexity and depth of the interviews. Previous intercoder reliability studies^{26 27} were used to select the appropriate subsample; therefore, a random sample of 15% of the total responses (106 interview questions, 395 lines of text) was assessed by the second rater. The consistency between coders was evaluated using Cohen's Kappa (κ) statistic.²⁸ This statistic evaluates the consistency between two raters with a numerical result that can vary from 0 to 1, with higher values indicating more consistency among the rater's analysis of the participants' responses. The Cohen's Kappa statistic for this random subsample of the parent/caregiver responses was 0.816, which is an acceptable reliability statistic for content analyses.²⁹

Next, a summative content analysis²⁵ 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 called Text Fixer³⁰ was used to determine the frequency of specific words and phrases discovered during the content coding analysis (eg, 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 re-examined, 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 that allowed the most frequent phrases from each group to be compared with one another.

RESULTS

Expert mental model

The first portion of this analysis seeks to understand the expert mental model (figure 1) and the knowledge they believe parents/caregivers associate with children being forgotten in hot cars. This diagram acts as a visualisation 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.

On further examination of these themes, we are able to identify their likely influence (ie, increasing and/or decreasing) on a parent's/caregiver's risk of forgetting a child in a hot car. For example, the messaging and law categories both act to raise

^{iv}Only 23 parents/caregivers agreed to be recorded.

awareness among parents/caregivers about the issue. Therefore, these two categories work towards decreasing the likelihood that an individual would forget a child. Alternatively, sleep deprivation and forgetfulness were associated with the psychological and physiological category. This theme, in addition to the expert's beliefs of lifestyle misperceptions frequently mentioned by parents/caregivers (ie, 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 back seat; however, these devices may also provide false reassurance to parents/caregivers. 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 and physiological factors), parents'/caregivers' focus on incidents involving children intentionally left in vehicles (lifestyle factors) and the role that policy plays in the overall risk of forgetting a child (law). This analysis will conclude with an examination of the media channels and key messages used by experts to promote vehicular heatstroke prevention (messaging).

During the interviews, several experts emphasised the potential for technological interventions to reduce the number of children affected annually; 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 incidents 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 experts' 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 experts' 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. Even though these incidents are often close calls, their news stories provide 'positive messaging' and 'raise awareness without the death of a child'.

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 paediatrician 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 experts were asked to provide three key messages that they would hope parents and caregivers would take away from their materials. Out of the six experts who provided key messages, only three messages were consistent among the experts. Although often ranked last among the experts (table 2), the key message 'this can happen to anyone' was mentioned by four different individuals. However, a variety of communication priorities were also observed among the experts that mentioned these particular messages. With each expert striving to prevent a different type of vehicular heatstroke (eg, forgetting a child, trunk/car entrapment or intentionally leaving a child), their different priorities and messages may unintentionally distract from the broader key messages that experts generally agree are important to convey to parents and caregivers.

Table 2 Key messages provided by the expert panel during the mental model interviews

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 realise.
 B. Hot car deaths have occurred with temperatures in the upper 60s°F (~20°C).
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.

A bolded key message means that it was most frequently discussed among the experts.

Mental Model – Parents/Caregivers

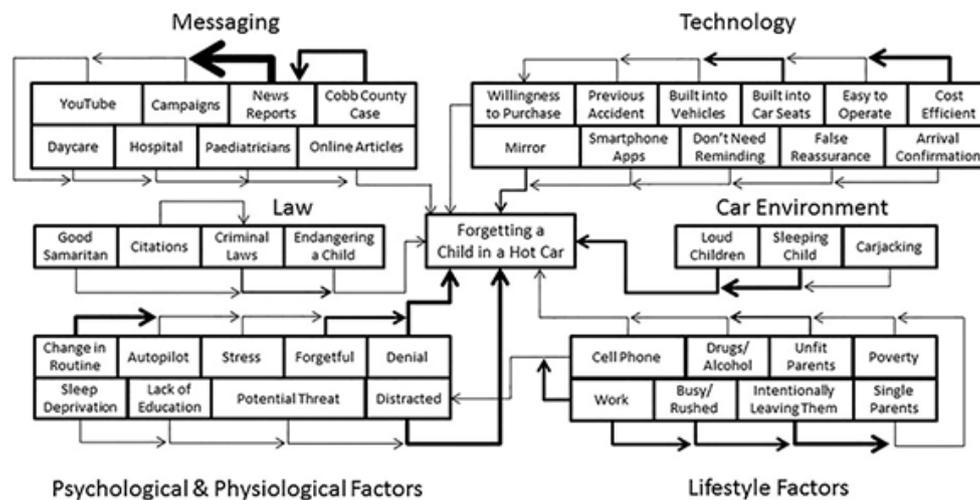


Figure 2 The parent/caregiver mental model. Greater line weight indicates that a topic was more frequently discussed during the parent/caregiver interviews.

Parent and caregiver mental model

The second portion of this analysis examined the parent/caregiver mental model (figure 2) 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 (eg, changing their routine) or decrease (eg, 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 and 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 denied being able to forget their own child. 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'. In an attempt to further probe the participants about their opinions on the topic, they were asked: 'What happens that leads to children being forgotten in hot cars?' A majority of parents/caregivers were not sure (n=6, 24%) or believed that parents were overwhelmed/distracted (n=6, 24%). Other responses included 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,^v sleeping children and forgetful parents.

With a majority of participants (1) denying that they could forget their own child in a hot car and (2) acknowledging the perception that unfit parents and/or lifestyle factors may increase a parent's/caregiver's risk of forgetting a child, perceived personal risk factors were investigated. These perceived risk factors were assessed by asking participants: 'Is there a type of parent or 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 a 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%). For example, this expansion of the original question produced parent and caregiver responses that included: 'I feel bad for saying this, but a working parent [would be more at risk.]' and 'a parent that doesn't care, or a parent who is low-income [would be more at risk.]'

With many parents/caregivers exhibiting stereotypical perceptions surrounding the risk of forgetting children in hot cars, we wanted to examine their media exposure by asking: 'Have you seen any ads, public service announcements, or materials involving kids being forgotten in hot cars during the 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 learnt about the issue through news and incident reports (n=24, 58.6%). Additionally, 16 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%),

^vIn 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.

Table 3 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

Respondents could indicate multiple preferred media channels.

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 them could provide any specific details about the materials. With the limited exposure to materials associated with paediatric 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. 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 3](#).

DISCUSSION

A comparative analysis between the experts' and parents'/caregivers' 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](#)), the experts ([figure 1](#)) focused on campaigns and public service announcements as the optimal framework for raising awareness. However, according to 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 mental models, both parents/caregivers and experts agreed that paediatricians and childcare facilities were a potential source of information on this topic. According to the results, some experts discussed the current use of posters, pamphlets and other passive messaging currently in various healthcare facilities.

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. 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

Mental Model

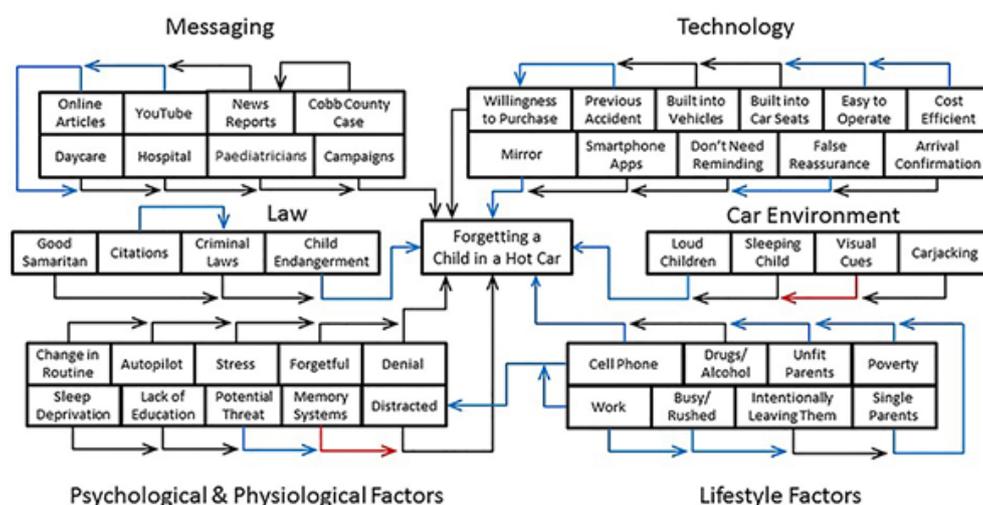


Figure 3 A mental model combining the knowledge of both experts and parents/caregivers. The black arrows represent agreement between experts and parents/caregivers, the blue arrows represent concepts only discussed by parents/caregivers and the red arrows represent ideas only discussed by experts. The black lines, in the lifestyle factors category, affirm the misperceptions initially mentioned in the expert mental model.

Table 4 Current vehicular heatstroke slogans and rhymes in use throughout the USA

Organisation	Slogan or rhyme
National Highway Traffic Safety Administration ³¹	'Where's baby? Check for baby'
U.S. Department of Health and Human Services ³²	'Where's baby? Look before you lock'
National Weather Service ³³	'Beat the heat, check the backseat' 'Look before you lock'
Safe Kids Worldwide ³⁴	Avoid leaving your child alone in a car, not even for a minute Create reminders Take Action
Kids and Cars ³⁵	'Look before you lock'
Department of Early Care and Learning of Georgia ³⁶	'Look again'

a car seat and (2) their willingness to pay more money for this product. Additionally, the parents/caregivers acknowledged that they would be more incentivised to purchase stand-alone technological devices if they were easy to use 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 emphasised that various lifestyle factors (eg, single parent, low-income parent etc) increase the likelihood of forgetting a child in a hot car. However, both experts and parents/caregivers acknowledged that incidents associated with intentionally leaving a child may lead to a lower perceived risk of *forgetting* a child among parents/caregivers. For example, one caregiver explained that 'I think they leave their kids in the car intentionally. I don't see how you would forget your kids in a car'. Therefore, these intentional incidents dominate the mindset of some parents/caregivers, and as a result, some believe that this tragedy only happens when parents/caregivers 'leave their kids in the car intentionally'. Even with several participants (n=13, 52%) denying they could forget their own child/grandchild in a hot car, like the caregiver in the previous example, the two mental models agreed that denial, distracted individuals and/or a change in routine are common psychological and physiological explanations for forgetting a child in a car.

By comparing these mental models, we were able to construct a consolidated figure (figure 3) using the expertise of all participants in this study. The combined model helps to illustrate areas of overlap as well as differentiate parent/caregiver and expert thinking on the subject. This additional figure provides a big-picture approach of the current understanding surrounding the topic of children forgotten in hot cars and acts as a first step towards tailoring public health messaging to better represent the needs of parents/caregivers. Therefore, these mental models and the knowledge of their discontinuities can offer an evidence-based approach to improve future public health messaging.

Implications for future public health messaging and injury prevention

These mental model interviews, which examined the topic of children forgotten in hot cars, provide invaluable insight for improving the reach and significance of future public health

messaging. We found that the differing messaging priorities among the experts (table 2) and the inability for parents/caregivers to recall any public service announcements clearly demonstrate the need for improvement in both reaching parents and making the message stick. 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 organisations³¹⁻³⁶ across the country that pertain to vehicular heatstroke (table 4). 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'. To overcome these challenges, the heatstroke prevention community should come together to craft a set of core consistent messages for each hazard (ie, forgetting a child, intentionally leaving a child and self-entrapment). Following a rigorous evaluation and pretesting among parents/caregivers, those messages can then be shared through materials, social media posts and key partners (eg, public health practitioners, health journalists etc).

After the completion of the mental model interviews, it was also evident that the creation of a more relevant and engaging message should be a priority. Based on our results, the current heatstroke prevention messaging may struggle to (1) overcome the stereotypical assumptions that certain lifestyle factors increase a parent/caregivers' risk of forgetting a child and (2) emphasise that all parents/caregivers are at risk. To address parents'/caregivers' assumptions about certain lifestyle factors, perhaps the heatstroke prevention community could incorporate narrative communication into future heatstroke prevention materials.³⁷ While personal testimonials are currently used to raise awareness, do parents/caregivers identify and/or perceive themselves to be similar to these individuals? To address the lifestyle misperceptions observed during the parent/caregiver interviews, new materials could include a close call narrative describing a pillar of the community (eg, doctor, police officer, pastor etc) forgetting a child in a hot car. Additionally, the heatstroke prevention community should also consider further personalising the vulnerability of parents/caregivers in future risk communication materials (eg, it can happen to *you* vs it can happen to *anyone*). Future studies should evaluate these recommendations in order to determine their ability to increase parents'/caregivers' perceived threat and/or to promote behavioural change.

Another suggestion for improving future health messaging involves accounting for *how* most parents/caregivers obtain information about this health topic. As previously mentioned, our participants overwhelmingly described learning about this health issue through news and incident reports (n=24, 58.6%). While many health journalists and media outlets may not consider themselves health educators, the results of this study suggest that news reports have the ability to impact the risk perceptions of parents/caregivers surrounding this health issue. Thus, the heatstroke prevention community should consider providing additional resources to media partners and encouraging rapport development between public health officials and media outlets. While previous studies have mentioned that health journalists consider their relationship with local public health officials as 'lacking', health journalists also believe that having a stronger relationship with their local public health

practitioners will only 'improve the current state of health journalism'.³⁸ To strengthen these relationships and provide additional resources to media outlets, public health practitioners should consider prepackaging injury prevention and health information related to hot car deaths.³⁹ Providing this information ahead of time will ensure that (1) media outlets receive injury prevention information in a timely manner and (2) that the core messages designated by the heatstroke prevention community are communicated to the many publics.³⁹ While providing *frequent* injury prevention information is not commonplace in health journalism and often requires an incident to occur before a news report is shared with our target audience, there are additional strategies that can be implemented in conjunction with the creation and distribution of media kits to more effectively warn of the impending threat.

According to the parents/caregivers in our study and as shown in [table 3](#), their most preferred medium for receiving future safety information involved various social media platforms (Facebook, Twitter, YouTube etc). Perhaps future messaging strategies could take advantage of this preference and work towards integrating more preventative messaging into these platforms. For example, the use of just-in-time messaging via social media could be used when extreme temperatures are in the forecast. By providing reminders, core messages and specific injury prevention behaviours prior to the arrival of extreme temperatures, parents/caregivers should be more salient of this issue and, as a result, implement injury prevention behaviours inside their vehicle.⁴⁰ In conclusion, the future of heatstroke prevention involves the effective use and continued research into different media outlets, messaging strategies and evaluating the risk perceptions of parents/caregivers.

Limitations

While these mental models provide suggestions and areas of improvement for 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 of a few individuals to identify key frameworks associated with a particular issue; therefore, we cannot (1) accurately generalise these results across all parents and caregivers and/or (2) identify specific actions to promote behavioural change among these individuals. However, this exploratory research is needed to both inform future risk communication materials and surveys on the topic. Future work, associated with the next step in the mental models approach, should strive to overcome these limitations by distributing a structured survey to a larger, more diverse (eg, more fathers and caregivers) sample. Further, these survey studies should attempt to quantify the risk perceptions of parents/caregivers and further assess specific knowledge surrounding children being forgotten in hot cars. Are parents/caregivers knowledgeable about laws, specific technological advances and/or other injury prevention strategies? Can we better quantify perceived susceptibility among parents/caregivers? Is public health messaging even a viable prevention strategy when targeting a forgetting behaviour? Future research should attempt to answer these questions to better understand what impact, if any, their personal susceptibility has on their ability to adopt injury prevention techniques.

Finally, two local vehicular heatstroke incidents occurred during the interview process (5 May 2015 and 11 May 2015) that may have influenced the parents'/caregivers' level of awareness, willingness to participate and/or opinion of the

issue. Both incidents were non-fatal; however, both received considerable media attention due to their unusual circumstances (ie, a veteran getting arrested for busting a car window to save an animal⁴¹ and a daycare refusing to admit that they forgot a child in a van for hours⁴²). Further, the continued coverage of the Cobb County incident and trial through the study period may have also impacted the parents'/caregivers' opinions of the topic.

CONCLUSION

Through the development of these mental models, we have determined that differences (eg, 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 had previous knowledge of this health issue, 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 (eg, single parent, low-income parent or a working parent) increase a parent's/caregiver's risk for forgetting a child. It is certainly possible that the use of news and incident reports, which are a primary source of information for our sample of parents/caregivers, may serve to exacerbate such stereotypes. Therefore, understanding and acknowledging these *differences* can assist in creating more effective public health messaging. In particular, future health messaging must strive to engage and reach all parents/caregivers. This can be accomplished using a multi-faceted messaging strategy that includes, but is not limited to, personalising core messaging, providing additional resources to news media, rapport development between public health officials and health journalists, and just-in-time messaging. In conclusion, we hope this study will act as a vital component in the refinement of current vehicular heatstroke messaging, raise awareness about this health topic and reduce the number of children forgotten in hot cars annually.

What is already known on the subject

- ▶ The circumstances, characteristics of victims and geography of paediatric vehicle-related hyperthermia has been widely explored.
- ▶ The microclimate environment in vehicles creates dangerous conditions for children left unattended.

What this study adds

- ▶ This is the first study to investigate the knowledge and risk perceptions of parents/caregivers in relation to vehicular heatstroke.
- ▶ Results from this study will help inform public health communication and outreach, in addition to improving injury prevention measures.

Acknowledgements The authors thank the three anonymous parents for their comments during the pilot test that further refined the interview questions. The authors thank Broad Acres Daycare, Childcare Network, The Preschool Academy, Champions for Children, the McPhaul Center and Mercy Health Center (all in Athens-Clarke County) for their help distributing flyers and promoting the study. The authors thank the experts who provided great insight into their personal perceptions about

this issue and how they believe parents understand this health topic. The authors thank Dr Alan Stewart, Dr Jenn Rice and Dr Glen Nowak for their constructive feedback in the development of this manuscript. The authors thank the four anonymous reviewers for their constructive feedback, which greatly improved the manuscript. Finally, the first author (CAW) would like to acknowledge the support of the American Meteorological Society 21st Century Campaign Graduate Fellowship and a National Science Foundation Graduate Research Fellowship in the completion of this work (grant number DGE-1443117).

Funding American Meteorological Society 21st Century Campaign Graduate Fellowship and National Science Foundation Graduate Research Fellowship (DGE-1443117).

Disclaimer Any opinions, findings, conclusions or recommendations expressed in this manuscript are those of the authors and do not necessarily reflect the views of the American Meteorological Society, National Science Foundation or the childcare facilities.

Competing interests None declared.

Ethics approval This study received IRB approval from the University of Georgia on 3 April 2015 (IRB ID: STUDY00002006).

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement Information provided in the article is available to be quoted and used in future publications; however, the transcripts from the original research are not available.

© Article author(s) (or their employer(s) unless otherwise stated in the text of the article) 2017. All rights reserved. No commercial use is permitted unless otherwise expressly granted.

REFERENCES

- 1 Null J. Heatstroke deaths of children in vehicles. <http://www.noheatstroke.org/> (accessed 7 Oct 2016).
- 2 Roberts KB, Roberts EC. The automobile and heat stress. *Pediatrics* 1976;58:101–4.
- 3 Zumwalt R, Petty C. Temperature in closed automobiles in hot weather. *Forensic Sci Gaz* 1976;7:7–8.
- 4 King K, Negus K, Vance JC. Heat stress in motor vehicles: a problem in infancy. *Pediatrics* 1981;68:579–82.
- 5 Surpure JS. Heat-related illness and the automobile. *Ann Emerg Med* 1982;11:263–5.
- 6 Gibbs LI, Lawrence DW, Kohn MA. Heat exposure in an enclosed automobile. *J La State Med Soc* 1995;147:545–6.
- 7 McLaren C, Null J, Quinn J. Heat stress from enclosed vehicles: moderate ambient temperatures cause significant temperature rise in enclosed vehicles. *Pediatrics* 2005;116:e109–12.
- 8 Grundstein A, Meentemeyer V, Dowd J. Maximum vehicle cabin temperatures under different meteorological conditions. *Int J Biometeorol* 2009;53:255–61.
- 9 Grundstein A, Dowd J, Meentemeyer V. Quantifying the heat-related hazard for children in motor vehicles. *Bull Am Meteorol Soc* 2010;91:1183–91.
- 10 Duzinski SV, Barczyk AN, Wheeler TC, et al. Threat of paediatric hyperthermia in an enclosed vehicle: a year-round study. *Inj Prev* 2014;20:220–5.
- 11 Grundstein AJ, Duzinski SV, Dolinak D, et al. Evaluating infant core temperature response in a hot car using a heat balance model. *Forensic Sci Med Pathol* 2015;11:13–19.
- 12 Guard A, Gallagher SS. Heat related deaths to young children in parked cars: an analysis of 171 fatalities in the United States, 1995–2002. *Inj Prev* 2005;11:33–7.
- 13 Booth JN, Davis GG, Waterbor J, et al. Hyperthermia deaths among children in parked vehicles: an analysis of 231 fatalities in the United States, 1999–2007. *Forensic Sci Med Pathol* 2010;6:99–105.
- 14 Grundstein A, Null J, Meentemeyer V. Weather, geography, and vehicle-related hyperthermia in children. *Geogr Rev* 2011;101:353–70.
- 15 Ferrara P, Vena F, Caporale O, et al. Children left unattended in parked vehicles: a focus on recent Italian cases and a review of literature. *Ital J Pediatr* 2013;39:71–4.
- 16 Morgan M, Fischhoff G, Bostrom A, et al. Risk communication: a mental models approach. *Cambridge University Press* 2002.
- 17 Wagner K. Mental models of flash floods and landslides. *Risk Anal* 2007;27:671–82.
- 18 Bostrom A, Morgan M, Fischhoff B, et al. What do people know about climate change? 1. Mental models. *Risk Analysis* 1994;14:959–70.
- 19 Lowe TD, Lorenzoni I. Danger is all around: eliciting expert perceptions for managing climate change through a mental models approach. *Global Environmental Change* 2007;17:131–46.
- 20 Bostrom A, Morss RE, Lazo JK, et al. A mental models study of hurricane forecast and warning production, communication, and decision-making*. *Weather Clim Soc* 2016;8:111–29.
- 21 Downs JS, de Bruin WB, Fischhoff B. Parents' vaccination comprehension and decisions. *Vaccine* 2008;26:1595–607.
- 22 Downs JS, Murray PJ, Bruine de Bruin W, et al. Interactive video behavioral intervention to reduce adolescent females' STD risk: a randomized controlled trial. *Soc Sci Med* 2004;59:1561–72.
- 23 Guest G, Bunce A, Johnson L. How many interviews are Enough?: an experiment with data saturation and variability. *Field Methods* 2006;18:59–82.
- 24 Austin LC, Fischhoff B. Injury prevention and risk communication: a mental models approach. *Inj Prev* 2012;18:124–9.
- 25 Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. *Qual Health Res* 2005;15:1277–88.
- 26 Lombard M, Snyder-Duch J, Bracken CC. Content analysis in mass communication: assessment and reporting of intercoder reliability. *Hum Commun Res* 2002;28:587–604.
- 27 Uysal S, Madenoglu C. A content analysis of scientific research studies on technology leadership in Turkey. *Procedia Soc Behav Sci* 2015;191:37–43.
- 28 Cohen J. A coefficient of agreement for nominal scales. *Educ Psychol Meas* 1960;20:37–46.
- 29 Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33:159–74.
- 30 Text Fixer. Word analysis tool. <http://www.textfixer.com/tools/online-word-counter.php> (accessed 7 Oct 2016).
- 31 National Highway Traffic and Safety Administration. NHTSA unveils campaign to prevent child heatstroke deaths in cars. <http://www.nhtsa.gov/About+NHTSA/Press+Releases/2012/NHTSA+Unveils+Campaign+to+Prevent+Child+Heatstroke+Deaths+in+Cars> (accessed 7 Oct 2016).
- 32 U.S. Department of Health and Human Services. Where's baby? Look before you lock <http://www.acf.hhs.gov/ecd/interagency-projects/look-before-you-lock> (accessed 7 Oct 2016).
- 33 National Weather Service. Beat the heat, check the backseat!. https://www.weather.gov/arx/heat_backseat (accessed 7 Oct 2016).
- 34 Safe Kids Worldwide. Preventing heatstroke. <http://www.safekids.org/preventing-heatstroke> (accessed 7 Oct 2016).
- 35 Kids and Cars. Safety tips from KidsAndCars.org <http://www.kidsandcars.org/files/2015/06/Heat-Stroke-Safety-Tips.pdf> (accessed 7 Oct 2016).
- 36 Department of Early Care and Learning of Georgia. Look again: Governor and Mrs. Deal and state agencies warn of the dangers of leaving children unattended in vehicles. <http://dec.al.ga.gov/documents/attachments/lookagainrelease2016.pdf> (accessed 7 Oct. 2016).
- 37 Ricketts M, Shanteau J, McSpadden B, et al. Using stories to battle unintentional injuries: narratives in safety and health communication. *Soc Sci Med* 2010;70:1441–9.
- 38 Friedman DB, Tanner A, Rose ID. Health journalists' perceptions of their communities and implications for the delivery of health information in the news. *J Community Health* 2014;39:378–85.
- 39 Parmer J, Baur C, Eroglu D, et al. Crisis and emergency risk messaging in mass media news stories: is the public getting the information they need to protect their health? *Health Commun* 2016;31:1215–22.
- 40 Intille SS. Ubiquitous computing technology for just-in-time motivation of behavior change. *Stud Health Technol Inform* 2004;107:1434–7.
- 41 Mosbergen D. Army veteran breaks window to save dog from car, gets arrested. http://www.huffingtonpost.com/2015/05/13/man-saves-dog-arrested-michael-hammons_n_7271370.html (accessed 4 Jan 2017).
- 42 Stevens A. *Daycare owner lied about 2-year-old being left in van for hours*: Atlanta Journal Constitution. <http://www.ajc.com/news/cops-daycare-owner-lied-about-year-old-being-left-van-for-hours/nUpmzCceTjmK7ildawWPTN/> (accessed 4 Jan 2017).
- 43 All GA Kids. Search for childcare providers. <http://allgakids.org/search/> (accessed 15 Feb 2015).



Children forgotten in hot cars: a mental models approach for improving public health messaging

Castle A Williams and Andrew J Grundstein

Inj Prev published online August 9, 2017

Updated information and services can be found at:
<http://injuryprevention.bmj.com/content/early/2017/08/09/injuryprev-2016-042261>

References

These include:

This article cites 31 articles, 6 of which you can access for free at:
<http://injuryprevention.bmj.com/content/early/2017/08/09/injuryprev-2016-042261#BIBL>

Email alerting service

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Notes

To request permissions go to:
<http://group.bmj.com/group/rights-licensing/permissions>

To order reprints go to:
<http://journals.bmj.com/cgi/reprintform>

To subscribe to BMJ go to:
<http://group.bmj.com/subscribe/>