



## RESEARCH ARTICLE

# Are Parents Willing to Use Technology to Prevent the Tragedy of Forgetting Children Inside Cars?

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### Abstract:

### Background:

Forgetting children inside cars is a tragedy that can happen to anyone, anywhere. Especially on hot summer days, when the temperature inside the car rises quickly, it may lead to a tragic result: vehicular heatstroke. In the U.S. on average, 37 children die this way every year.

### Objective:

This paper aims to provide further insights and a deeper understanding of the variables that may affect parents' willingness to adopt a technology (various systems or smartphone apps) to remind them not to forget a child inside a vehicle.

### Methods:

Ninety-two participants, all parents of children under the age of 10 and car owners, participated in an internet survey. The participants completed an internet-based questionnaire, which included socio-economic and personality questions, as well as items pertaining to perceptions, attitudes and behavioral intentions toward using this type of technology. The framework was designed based on the Technology Acceptance Model (TAM).

### Results:

The results indicate that the perceived usefulness of such technology is significantly and positively correlated with usage attitudes. Women showed a significantly more positive usage attitude and stronger behavioral intentions compared to men. It was also found that a higher level of stated anxiety implies a more positive usage attitude, and stronger behavioral intentions to use this type of technology.

### Conclusion:

More effort should be made to understand how such tragedies can be avoided and what the role of technology is in this regard. The most important challenge is to encourage those parents, who are less reluctant, to try out this technology, in an attempt to prevent the tragedy of forgetting children inside cars.

**Keywords:** Heatstroke, Vehicle, Technology, Children, Parents, Forgetting.

Article History

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## 1. INTRODUCTION

A forgotten baby or young child in a locked car (often referred to as "*Forgotten children syndrome*") is a devastating incident, which can happen anywhere, to anyone - even the most loving caregivers. On hot summer days, when the temperature inside cars rises quickly, leaving a child in a car may lead to a tragic result: vehicular heatstroke. The interior of a parked, enclosed vehicle can reach life-threatening tempera-

tures within 15-20 minutes. Within an hour, under an ambient temperature of 30°C, interior car temperatures can rise to around 60°C. On average, temperatures increase 1.7°-1.9°C per 5 minutes. Within 30 minutes, 80% of the temperature increase is accounted for and within 60 minutes vehicles have reached peak temperatures. Although overheating is more prevalent in warm weather conditions, it can also occur in temperate climates [1 - 5].

Young children are especially vulnerable to vehicular heatstroke. They are also more prone to hyperthermia than adults because they have a greater surface area-to-body mass ratio, a less effective thermoregulatory system, and are unable

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or unaware of the need to act (*e.g.*, remove excess clothing or exit the vehicle) [1, 3, 4, 6 - 8]. Hence, their body temperature rises about four times faster than that of an adult [2].

Grundstein *et al.*, 2011 [9] used the term “intentionally left behind” to describe cases in which a caregiver may consciously have left a child unattended in the car, but not necessarily with the intent to harm him or her and “simply forgot” the child. According to Null, 2018 [10], 772 children have died, due to pediatric vehicular heatstroke, since 1998 in the US. This means that, on average, 37 children die this way on an annual basis. These children range in age from 5 days to 14 years. More than half of the deaths were children under two years of age. The US is well documented regarding this phenomenon, while very little research has been conducted in other countries [11]. In Israel, the focus of the current study, between 2008 and 2018, the media reported 647 cases of forgotten children, who were left alone in a car or trapped inside a vehicle, and this syndrome appears to be on the rise. A total of 27 of these cases resulted in the child’s death. In the remaining cases, the children were left with systemic injuries at various levels. The parents, no doubt, remain traumatized for life.

Research provides a medical explanation for this syndrome how it happens that parents “simply forget” the child, that is: walk away from the locked car without realizing they have left their child inside. The motor part of our brain, which enables us to carry out routine activities “without thinking” (*e.g.*, driving our regular morning route from the home to the workplace) competes or overlaps (*i.e.*, “takes over”) the cognitive part of the brain, which enables us to make clear, immediate and upcoming decisions (*e.g.*, stop to do some shopping on the way to work). Consequently, even though we might plan to stop, this plan may be forgotten, especially when distracted or involved in another task (*e.g.*, talking on the phone while driving) [12]. Forgotten children syndrome is the result of a sort of “competition” - between the brain’s “habitual memory” system and its “prospective memory” system - in which the habitual memory prevails [13]. This syndrome often ensues when a change in the parent’s routine occurs, accompanied by stressful or distracting experiences before or during the drive [7, 13, 14].

Various countermeasures have been suggested in an attempt to cope with forgotten children’s syndrome. These include massive campaigns about desirable routines such as “look before you leave”, and legislation which aggravates the punishment for leaving a child in a car. In this regard, technology (either systems which are directly integrated into the vehicle or dedicated smartphone apps) may play an important role in “reminding” people, right on time, before it is too late, what needs to be done.

Pertaining to systems, Arbogast *et al.*, 2012 [6] provide a review of various types of technological devices that exist in the market. In addition, the efficacy of several heatstroke prevention technologies has been evaluated. These technologies sense the presence of a child in a car seat and alert caregivers if they walk away from the car without removing the child. It was found that these devices require considerable effort from the parent/caregiver to ensure the smooth operation; this operation was also found to be inconsistent. A new

generation of safety devices, which can sense and monitor the environment, was proposed in Aiello *et al.*, 2014 [15]. Rudd *et al.*, 2015 [8] reviewed various aftermarket products, and indicated that these products may comprise a part of the overall solution to the problem of child deaths, due to heatstroke in vehicles. Pertaining to smartphone apps, their greatest advantage as countermeasures is their low cost and wide availability; therefore, they can be tailored to specific purposes and used to influence patterns and behavior [16]. For example, a smartphone app that provides notifications or alerts [8], a smartphone app that is linked to an occupied car seat or a child reminder system [7, 13].

Clearly, technology is evolving rapidly. A technological solution in which a sensor alerts a caregiver that a child has been left in a car could be a plausible intervention strategy [6 - 8]. Williams and Grundstein, 2018 [17] reported that parents/caregivers acknowledged they would be more incentivized to purchase stand-alone technological devices if they were easy to use or could be obtained at a reduced cost. Nevertheless, it is worrisome that most laypeople refuse to take any precautionary measures because they believe this forgotten child syndrome could never happen to them - a potentially fatal misconception [7, 13, 17]. Furthermore, even with a meaningful cost incentive, these parents say they would not purchase such a system [7].

This study’s goal is to provide further insights and a deeper understanding of the variables that may affect parents’ willingness to adopt such a technology to prevent them from forgetting their child inside a car. This may enable to narrow the gap in the area of research by dealing with the role of technology and its acceptance as a tool for mitigating the forgotten child syndrome. The paper is organized as follows: in the next section, we describe the Methodology. Then, we present the results, followed by the Discussion. The paper ends with a Conclusion section.

## 2. METHODOLOGY

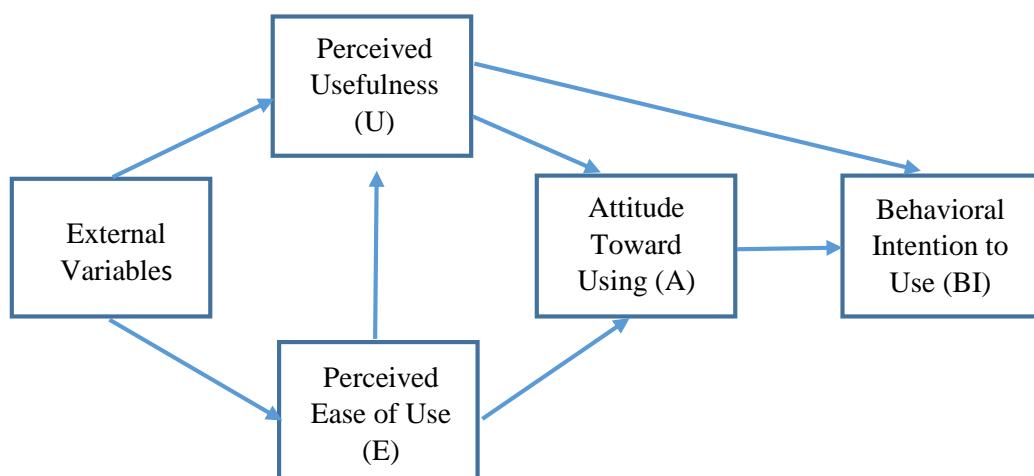
Ninety-two participants, 59 females and 33 males, all parents of children under the age of 10 and car owners, participated in a survey conducted in Israel in 2017. The participants completed an internet-based questionnaire, which included socio-economic and personality questions as well as items pertaining to perceptions, attitudes and behavioral intentions toward using technology (systems or smartphones apps) that “reminds” them not to forget a child inside a car.

A system was referred to as a device installed in the vehicle and detects, by means of sensors, whether a child is forgotten in the vehicle. An app was referred to as an app installed on the mobile device and alerts / reminds to check that a child is not forgotten in the vehicle, *e.g.*, when disconnecting the mobile phone from the car Bluetooth.

Six respondents who answered the pilot survey, as well as four respondents who did not complete all the questions in the survey, were excluded from further analysis. This convenience sample comprised of 92 participants was recruited from various e-mailing lists and social media (*e.g.*, Facebook) of the authors, and the data collection procedure lasted for one month.

**Table 1.** The questionnaire framework.

Variable	Total No. of Items	Description	Cronbach's Alpha
Socio-economic Level	6	Gender, age, education, no. of children, age of children, working status	-
Anxiety	1	The level of anxiety for one's own children compared to other parents	-
Perceived Usefulness (U)	5	The extent to which a person believes that a particular system will help him	0.698
Perceived Ease of Use (E)	3	The extent to which a person believes that using a particular system will be easy	0.606
Attitude toward Using (A)	3	The extent to which a person's attitude toward a particular system is positive	0.674
Behavioral Intention to Use (BI)	5	The extent to which a person intends to use a particular system	0.674

**Fig. (1).** Framework of the TAM model (adapted from Venkatesh and Davis, 1996 [19]).

The questionnaire framework was based on the Technology Acceptance Model (TAM), proposed by Davis, 1989, Venkatesh and Davis, 1996 and Venkatesh *et al.*, 2003 [18 - 20]. The TAM models the factors that affect users' decisions while considering to accept and use new technology. The final version of the questionnaire, which captures the TAM factors included 23 items; its division into variables, factor analysis and the Cronbach's alpha values for the TAM variables, are shown in Table 1. It should be noted that this questionnaire framework was reached after several items were removed to improve the factors' reliability.

As can be seen in Table 1, Cronbach's alpha values indicate that all of the items of a specific variable, as presented in the questionnaire, are reliable for measuring this specific variable. The questions were designed to fit the concept of the variable. For example, a Perceived Usefulness item was: "I believe that using an app to remind me that there are children in the car will prevent me from forgetting my children in the car"; a Perceived Ease of Use item was "Using such an app can be complex for me"; an Attitude toward Using item was "I rely that using such an app may improve children safety"; a Behavioral Intention to Use variable was "I will activate such a system on a regular basis". The six socio-economic items included gender, age, education, number of children, age of children, and occupation status.

The answers scale for all of the items (apart from socio-economic items) ranged from 1 to 4 where "4" indicating

"agree to a large extent" and "1" indicating "defiantly disagree to a large extent". Some of the items were reversed, due to the opposite wording of the question in a way that would suit the other questions.

Fig. (1) presents the framework of the suggested TAM model. The external variables include anxiety and socio-economic items. Behavioral intention to use might be affected by the other variables and, according to the TAM approach, serves as the best predictor of actual use.

### 3. RESULTS

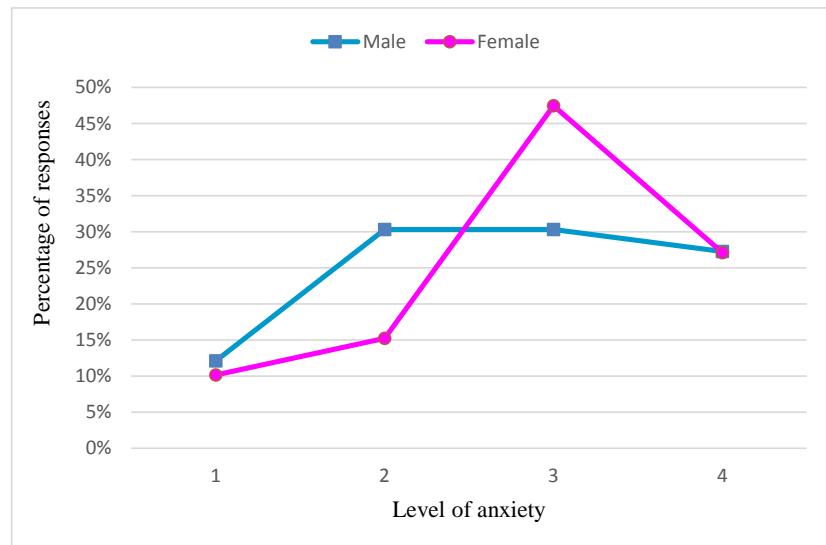
#### 3.1. Statistics of the External Variables

Pertaining to socio-economic characteristics of the sample - 43% had one child, 23% had two children, 24% had three children, and 6% had four children. A total of 28% held an MA degree, 45% held a BA degree, 24% had a high school education, and 3% had an elementary school education. The average age of participants was 36 years old ( $SD=6.5$ ). A total of 96% of the sample said they were full-time employees. Interestingly, 85% of the sample stated they did not use any app or system to remind them not to forget a child inside a car. A total of 12% of the sample indicated they usually use an app to remind them; 3% stated that their car is equipped with a specific system and that, in addition, they also use an app to remind them not to forget their children in the car. Due to the relatively low numbers, for further consideration, the results of those who currently use technology (either technology or a

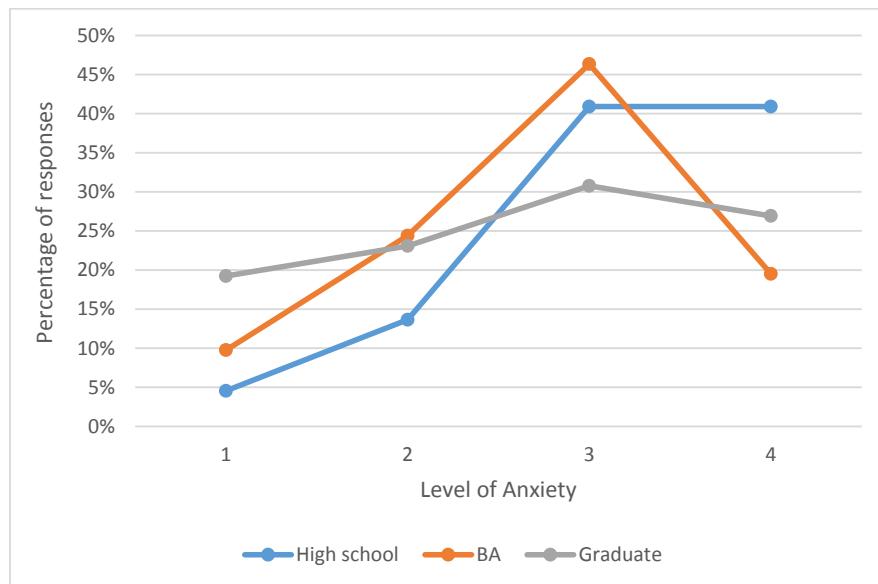
smartphone app) were combined. It should be noted that no significant differences in the socio-economic variables were found between the sub-sample participants, who use technology to remind them not to forget a child in a car and the sub-sample participants, who do not.

Level of anxiety concerning gender - the extent to which participants stated they were concerned about their children compared to other parents - is presented in Fig. (2). As can be seen, women seem to be more anxious, compared to men: a total of 74% of the women stated they experience high levels of anxiety (3 or 4 on the anxiety scale) compared to 58% of the men. However, this difference was not found to be significant. The level of anxiety was not found to be correlated with a number of children.

Level of anxiety concerning education - the extent to which participants stated they were concerned about their children compared to other parents - is presented in Fig. (3). As can be seen, parents with a higher level of education seem to experience lower levels of anxiety. However, the differences were not found to be significant. The level of anxiety was not found to be correlated with the other socio-economic variables: age, number of children, and age of children. It should be noted that although the sub-sample participants, who use technology reported higher levels of anxiety (mean=3.07, SD=0.99) compared to the sub-sample participants, who do not use technology (mean=2.80, SD=0.94), the difference was not found to be significant.



**Fig. (2).** Level of anxiety in relation to gender.



**Fig. (3).** Level of anxiety in relation to education.

**Table 2.** General statistics of the TAM variables.

Variable	Average	SD	Median
Perceived Usefulness (U)	3.11	0.55	3.25
Perceived Ease of Use (E)	2.84	0.77	3.00
Attitude toward Using (A)	2.71	0.69	2.50
Behavioral Intention to Use (BI)	2.37	0.79	2.33

**Table 3.** TAM variables in relation to gender (\* =  $p < 0.05$ ).

-	Males (N=33)	Females (N=59)	-
Variable	Average	SD	T
Perceived Usefulness (U)	3.18	0.53	3.06
Perceived Ease of Use (E)	2.90	0.86	2.81
Attitude toward Using (A)	2.51	0.63	2.82
Behavioral Intention to Use (BI)	2.11	0.73	2.52

### 3.2. The Role of the TAM Variables

Table 2 presents the statistics of the four TAM variables: Perceived Usefulness, Perceived Ease of Use, Attitude toward Using, and Behavioral Intention to Use. As can be seen, the important variable of Behavioral Intention to Use, which, according to the TAM model serves as the best predictor of actual use, has the lowest value compared to the other variables. That is high values of perceived usefulness, perceived ease of use, and attitude toward using do not necessarily imply a high value of behavioral intention to use the indicated technology. The Behavioral Intention to Use of the sub-sample participants, who currently use technology was found to be higher than that of the sub-sample participants, who currently do not use any technology, but this difference was not significant.

All of the relationships among the variables, as presented in Fig. (1), were tested. However, the only relationship found to be significant was the relationship between U and A ( $r = 0.25$ ,  $pvalue < 0.01$ ); That is, higher perceived usefulness implies a more positive attitude towards actual use.

In addition, other relationships were examined. It was found that the relationship between anxiety and A is significant ( $r = 0.24$ ,  $pvalue < 0.05$ ), meaning, a higher degree of stated anxiety implies a more positive attitude toward using. In addition, it was found that the relationship between anxiety and BI is significant ( $r = 0.18$ ,  $pvalue < 0.05$ ). That is, a higher degree of stated anxiety implies a higher intention to use technology to remind a parent/caregiver not to forget a child inside a vehicle.

Upon examining gender differences, a few insights were obtained, as presented in Table 3. Women have a significantly more positive attitude toward using such technology and show significantly stronger behavioral intention to use the technology.

### 4. DISCUSSION

This paper attempts to provide further insights and a deeper understanding of the variables that may affect parents' willingness to adopt technology to remind them not to forget a

child inside a car. Such technology may serve as the main countermeasure to cope with forgotten children's syndrome, a tragic phenomenon, which can happen anywhere, to anyone. In Israel, the focus of this study, between 2008 and 2018, the media reported 647 cases of forgotten children, who were left alone in a car or trapped inside a vehicle. Unfortunately, this syndrome is on the rise. A total of 27 of these cases resulted in the child's death. The others remain traumatized for life., it seems that most people refuse to take any precautionary measures because they believe this could never happen to them personally - a potentially fatal mistake.

A convenience sample of ninety-two participants, 59 females and 33 males, all parents of children under the age of 10 and car owners, participated in the survey. The participants completed an internet-based questionnaire, which was designed in line with the Technology Acceptance Model (TAM), to evaluate participants' willingness to use technology (systems or smartphone apps) to remind them not to forget a child inside a car. The questionnaire includes socio-economic and anxiety characteristics, as well as items about perceived usefulness, perceived ease of use, attitudes toward using such technology, and behavioral intention, as presented in the TAM.

The results show that perceived usefulness of this type of technology, which reminds people not to forget a child inside a vehicle, is significantly and positively correlated with usage attitudes. Women show a significantly more positive attitude toward using this technology, and express stronger behavioral intention. About the role of anxiety, it was found that a higher level of stated anxiety significantly implies a more positive attitude toward using such technology, and stronger behavioral intention. Women seem to be more anxious than men; however, the difference was not found to be significant. The level of anxiety in relation to education may suggest that parents with higher levels of education experience lower anxiety levels; yet, the differences were not found to be significant.

While considering the study results, its limitations should also be acknowledged. Firstly - the sample. Due to being a convenience sample, it is not generally representative of the target population, parents of young children. Also, only 92

respondents participated in this study, and a larger sample size is recommended. Parents of young children worldwide may have different characteristics and consequently, the reproducibility of this study, in other countries and contexts, is highly suggested. Secondly, it seems that the character of anxiety, which was captured by a single item in this survey, may play an important role, and should, therefore, be further scrutinized. Thirdly, a more comprehensive analysis, including other models and additional variables that may more clearly explain parents'/caregivers' intention to use technology to remind them not to forget a child inside a vehicle, should be tested.

Undoubtedly, more effort should be invested to understand better how such tragedies can be avoided and the role of technology in this regard. In Israel, the focus of this study the forgotten child syndrome may remain timely as it should be noted that according to the Israeli Central Bureau of Statistics [21], children under the age of 10 consists 20% of the population, and the level of motorization, 390 passenger cars per 1,000 residents is increasing dramatically in recent years.

Technology is evolving rapidly. Technology may certainly play an important role; however, because of the various types of technology available (e.g., systems, devices, apps) - which differ in many aspects, including cost, the complexity of use, and the manner in which they are integrated into vehicles - more comprehensive analyses should be conducted. Other social countermeasures may further contribute to this effort. For example, Williams and Grundstein, 2018 [17], suggested a multifaceted messaging strategy, which includes personalizing core messaging, providing additional resources to media outlets, and building up a rapport among key partners. Based on our results, it might be more beneficial to favor women when addressing such technologies, as they show a significantly more positive attitude toward using and stronger behavioral intention compared to men. The most pressing challenge is to encourage those parents/caregivers, who are less reluctant, to try out the technology, in an attempt to prevent the tragic phenomenon of forgetting children inside their cars.

## CONCLUSION

This paper presents an analysis of parents' willingness to utilize various technologies systems/smartphone apps) to prevent the tragedy of forgetting children inside cars. Specifically, we strive to provide insights and a better understanding of the variables that play a role in adopting such technology. To investigate this research question, we used a survey methodology reflecting the Technology Acceptance Model (TAM). As the results indicate, the perceived usefulness of such technologies is significantly and positively correlated with attitudes toward using. Women show a significantly more positive attitude toward using this technology and stronger behavioral intention regarding usage compared to men. It was also found that a higher level of stated anxiety implies a more positive attitude toward using, and stronger behavioral intention.

Technology is evolving rapidly. An ever-expanding market for these technological tools will be available and relevant to reducing the extent of the tragedy of forgetting children inside cars.

Technology-based solutions may provide fair and effective countermeasures; however, as this paper shows, barriers still exist, and the willingness to use this type of technology remains questionable.

## CONSENT OF PUBLICATION

Not applicable.

## AVAILABILITY OF DATA AND MATERIAL

Not applicable.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Declared none.

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