AutoMate

An empathic first-aid communication system to reduce the bystander effect in car accidents

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This paper focuses on breaking the bystander effect in the context of a car accident, and how a first-aid communication system (AutoMate) can improve the empathy from the bystanders towards the victim. Conducting a user study on a car simulator, we found positive reactions from eight users towards AutoMate, leading to a more empathic approach from them to the victim. We investigated how AutoMate can help to reduce the bystander effect in car accidents. We found AutoMate to be a useful tool as an integrated add-on in existing car systems. The results show that AutoMate's guidance displayed high levels of clarity and easy to use interaction that lead to a more reassured driver, having a more positive impact on their empathy levels.

Additional Key Words and Phrases: HCI, empathy, bystander effect, vehicle, interaction design, first-aid, emergency situation, User-Centered Design, voice assistance

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1 INTRODUCTION

Empathy is being able to understand and sympathize with other people's emotions. It's cognitive, moral, behavioral and emotional levels [23] that distinguishes humans, as social cues are one of the most important aspects in social interaction. To have a more emotional engagement, and thus a deeper empathy, it is necessary to use these four levels together, as only the emotional part of the empathy would not suffice without a cognitive statement, and vice versa [23]. Human empathy has been fogged by apathy of the bystander effect, and we see that the reasons for this could be a lack of feeling responsible and a lack of emotional attachment towards the victim, as well as fears and insecurities about helping from the bystander's side. It can be concluded that they feel overwhelmed and afraid that they might do something wrong or worsen possible injuries. This can lead to situations, especially in a car accident, where bystanders would ignore victims. Car accidents are a common occurrence, and often people tend to pass through an accident without much thought. Using mobile apps such as Waze [7] or Google maps, the user navigates away from an accident to avoid these types of encounters. This leads not only to an apathetic approach of an accident, as victims can be considered as a nuisance rather than someone that needs help, but victims would be completely by themselves in these situations, and that is judgmental for the situation, as every lost minute could be crucial for someone's life. Our approach for this project was based on this research question:
RQ: How can extended first-aid knowledge available in a voice assistance system help bystanders empathize with

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victims of car accidents?
Sub-RQ: How does sharing information about a nearby accident affect another person's behavior/emotions?
Sub-RQ: How can the communication system provide knowledge to reduce bystander cognitive dissonance?
In our research, we discovered that actively asking for a bystander to come and help would create a more effective impact on them, as they would be put in the spotlight and would break the routine of ignoring the victim. We created a communication system in the first person that talks to the driver as if it was the victim asking for help. We developed an initial version of a first-aid communication system (AutoMate), where the system informs the drivers - bystanders - that an accident occurred and how far it was. The purpose was to do a user test with experienced drivers and learn, based on their own perspective, how they would feel and react towards this system. The system must provide guidance to the bystander as well as reassure the victim that help would come. The importance of our system lies in overcoming the bystander effect in order to help people who are suffering from injuries. Using digital interfaces integrated in users' daily routines as a means to enhance empathy and helpfulness between people is an important contribution to HCI.

2 RELATED WORK

To frame the necessity of our system, we conducted a broad research about the need of bystander action, the causes of the bystander effect and already existing systems to further safety and help in car accidents. Bystander action usually has an impact on the outcome of an accident, especially with respect to bridging the time between an accident and the arrival of the ambulance. In case of an emergency the appropriate conveying of first-aid steps can be of great significance.[21] Recent first-aid training has a massive impact on bystanders' willingness to stop and help [14] [22]. As Hall et al. point out, the motivations for bystanders to not help can be rooted in numerous factors [13], such as: the number of other bystanders at the scene [9] [19] [18], the severity of an accident [10], the demographics and appearance of the victim [17] [10], the relationship to the victim [16][10], insufficient first-aid knowledge[17], fear of liability [14] [1] or simply the fear of doing something wrong [14] [17] [1] [24]. Differences between the challenges of face-to-face and non-face-to-face situations have been analyzed [25] [20]. Current solutions mainly focus on facilitating the automatic sending out of emergency calls and the victim's data to the ambulance. The most popular example might be the eCall system which is mandatory for all newly registered cars within the European Union since 2018 [6]. In case of an accident (e.g. when the airbag is activated) the eCall system automatically calls the ambulance [3]. Besides that it can also be activated manually through a button [15] [4]. Since eCall can not be deactivated by the driver, there has also been some discussion about privacy and ethics, as users are afraid that their information would be shared not only with ambulances, but other people, or that their data would be hacked [11]. Apart from that there have been similar approaches from several car companies [8]. Smartphone applications tackling this functionality exist as well such as iOnRoad Augmented Driving or Porsche Car Connect [2]. Systems that go beyond informing the ambulance and instead network with other cars in a certain radius did not seem to be of big interest yet. The usage of an emotionally-laden or anxious voice may be counterproductive [5] and interfaces in such a context should avoid high color contrast and flickering animations [5]. Using an appropriate combination of visuals and voice within a car interface has been proven to work well in guiding and reducing stress for witnesses of traffic accidents. [5] Zepf et al. mentioned that an empathic interface [26] on vehicles can prevent emotional distress from drivers and dangers such as car accidents. They claimed that the driver's emotional state can affect their ability to drive, and thus focused on studying what external real life triggers could influence the user's emotion [26]. Gröber et al [12] mentioned that with the automatization of cars, they are becoming more complex and with that, increasing new possible forms of accidents. They pointed out that having proper communication inside the car could help drivers understand the car's behavior, build trust in the technology and

resolve possible problems [12]. This study showed that a form of communication between car and driver can be helpful to prevent possible accidents, and so, a first-aid communication system would also be beneficial for both bystander and victim.

3 AUTOMATE

To frame the functionality of our system we conducted interviews with possible users as well as one interview with a paramedic from the red cross for expert knowledge. The user interviews had the main purpose of finding out about people's driving habits and how they usually react in case of an accident. We asked some early questions about our concept, such as their opinions about sharing health information.

The expert interview had the purpose of gathering important insights about first-aid. Before developing AutoMate, the first-aid content needed to be suitable for bystanders who do not have detailed expert knowledge. With this insight, we were able to keep a balance between providing necessary first-aid knowledge and not overwhelming the driver. The paramedic stated five basic first-aid steps, and three steps considered optional. Paramedics do not expect nor encourage in-depth first-aid knowledge from bystanders. Moreover, he noted that people might have reasons to not stop by, especially when the accident is fatal and the bystander has emotional barriers.
Another reason for conducting the expert interview was to find out which types of victim's health data could be helpful for a bystander. He stated that most of the health data we had in mind (allergies, medication, etc.) are not helpful at all for laymen but rather for the ambulance. So, during the interview we came to the conclusion that AutoMate should only portray basic information about the user's wellbeing as well as the fatality of the accident.

The final concept. We created a concept which fulfills the following functionality: Before starting the car the user logs in with their personal profile on the car interface in the middle console. In the personal profile the user's basic data (first name and age) is stored. Optionally, they can also provide an avatar and additional data such as children being on board. When an accident occurs in a certain radius, the user receives a notification on the interface of their car. There will be a visual cue as well as a short sound to attract the users attention without distracting them. In a real setting, the user would have the possibility to accept or decline to stop by and help. As mentioned before, the decline option is important to have since there might be serious reasons for not being able to help. After accepting, the system provides information about the accident. The data will not only be visually displayed on the screen but also read out loud by a voice assistant. The information will be told in a first person perspective to create a feeling of an actual person talking to the driver. In the next step the voice assistant asks the user to follow the route to the accident. In the meantime, there will be a map portrayed on the screen, similar to a usual navigation system. When arriving at the accident location the system will start providing the five first-aid steps we determined in the previous section. These steps may vary depending on the type of accident, but in our work we focus on one specific scenario where the following five first-aid steps are needed: *1. Park safely. 2. Turn on the warning lights and place the triangle somewhere visible. 3. Take your first-aid kit. 4. Approach the victim from the front and check if they have any injuries. 5. Kneel down next to the victim and calm them down.* On the screen, the steps will be portrayed in short sentences and a pictogram. The user will be able to click through, skip or repeat a step anytime they want. The selected step will be read out loud by the voice assistant.

4 STUDY DESIGN

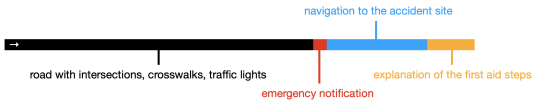

Fig. 1. Graphical depiction of driving scenario including emergency point

The study was set-up in a driving simulator environment. The driving scenario was implemented with SCANeR™ software by AVSimulation. The ride starts right before an intersection, which is crossed by some pedestrians. In the route there are a couple of intersections with traffic lights. In general, there is low traffic density in the area.
Driving the predefined route took about five to ten minutes. At the intersection before the bridge (see Figure 1), AutoMate alerts to an accident in the immediate vicinity of the participant. During this process, a voice assistant describes the situation and asks the driver for support and guidance.
After the participant perceives the emergency situation and confirms to help, the location of the injured person appears as a map. The participant follows the map and arrives at the accident site after about two minutes of driving. As soon as the driver confirms their arrival at the accident location, the five first-aid steps appear. At the same time, the voice assistant asks the driver to go through and follow the steps before leaving the car. Since the victim might be in a critical situation, this step takes only about one minute. Once the first-aid steps have been gone through, the driver gets out of the car with the intention of helping the injured person. Since this is in the context of a simulator lab study, the study ends at this point. The emergency situation including alerting, playing the voice assistant script, and controlling the first-aid steps of the AutoMate interface were manually controlled by a human assistant who observed the interaction. Figure 2 shows the participant interacting with AutoMate in the emergency siuation.

Fig. 2. On the left: Emergency detection; on the right: First-aid Steps

5 METHODS AND PROCEDURE

In order to assess the interface, we used a mix of qualitative and quantitative methods. To first generate an estimate of participants' empathy level, we used the standardized Toronto Empathy Questionnaire (TEQ), which represents empathy as a primarily emotional process. The TEQ consists of 16 questions, each rated on a five point scale from 'never' to 'often'. Furthermore, we used the User Experience Questionnaire+ (UEQ+) with the subscales attractiveness, efficiency, perspicuity, novelty, trust, usefulness, value, visual aesthetics, intuitive use, trustworthiness, quality of content, clarity and response quality as a quantitative assessment of usability and user experience. Semi-structured

post-interviews were utilized to gain qualitative insights on empathy during the emergency situation, appropriateness, awareness, and understanding of the AutoMate interface and interaction. Questions asked included: *How do you feel about the situation you have just experienced? How was it to empathize with the victim, even though she is a stranger? How much the information shared about the accident helped your decision? How hard was it to understand and interact with the AutoMate? What do you feel about the information shared? Would you be comfortable sharing your location with other people?*

In addition, demographic data (age, gender) was collected. Open-ended and questions scored on a 7-point Likert scale were defined for general assessment of driving experience, assessment of behavior in an accident (self or bystander), and initial assessment of first-aid skills. We recorded via an observation protocol the driving behavior of the participants in general, their reaction to the emergency situation and their interaction with the AutoMate System. The study proceeded in five phases: In phase one, participants were introduced to the study goals and agenda, gave their informed consent, and filled in the pre-questionnaire which includes the experience questions and the TEQ. In phase two, participants could familiarize themselves with the simulator by driving one or several laps across a different track. In phase three, participants drove across the track with the emergency situation. In phase four, participants responded to the interview questions about empathy, the AutoMate interface, interaction with AutoMate and the setup in general. Finally, in phase 5, the participant was asked to fill in the post-questionnaire that consisted of the UEQ+ with the subscales mentioned above. On average, the studies lasted about 30 to 40 minutes.

6 RESULTS

Sample Description. Overall, eight participants took part in the study. Individuals who were related to the University were used for recruitment due to time limitations. Most participants were undergraduates or individuals related to the authors, but none of them were familiar with the study. The lowest degree of the participants was a bachelor's degree. 37,5 % considered themselves as female (N=3) and 62,5% as male (N=5). The youngest participant was 23 years old, the oldest 29. With a mean and median age of 26 years, the sample was rather young (SD=2,05). No participant indicated to suffer from a perception disorder or epileptic seizures, which would have been reason for exclusion from the study. All participants had a valid driving license and 50% (N=4) indicated that they are driving weekly, 25% (N=2) monthly and 25% (N=2) less often. 25% of respondents indicated that they tended to be inexperienced drivers (N=2), another 25% indicated that they tended to be experienced, one participant considered themselves to be an experienced driver, whereas 37.5% (N=3) indicated that they were very experienced drivers.

Questionnaires. 37,5% had witnessed a car accident, and were shocked and scared to react. The others never had witnessed, but they believed that they would try and help, but they were honest that in the situation they might be too stressed to react properly without guidance. One of the more interesting data was that around 66% of females don't believe they have the proper knowledge of first-aid, whereas 60% of males do believe they have the proper knowledge. 66% of females and 60% of males would not feel comfortable performing first-aid.

TEQ: 75% of the participants (N=6) scored slightly above average in empathy on the TEQ. The average score was 45. One participant scored above the average score with 52 points, whereas another participant scored below with 35 points. This shows that in our case the participants have a similar empathy level. However, it should be noted that we only had 8 participants in our study. Therefore, it would be interesting to see to what extent this result changes with a broad number of participants.

UEQ: The UEQ+ resulted in medium to high ratings (all scores in the positive range of the scale) on all scales, with only Novelty, Visual Aesthetics, and Efficiency rated lower overall. Usefulness was rated highest, followed by

Clarity, Quality of Content and Response Quality. The overall acceptance of AutoMate is relatively high. To simplify the presentation of the results, the reduced scale -2 to +2 (instead of -3 to +3) were used for the figure below.

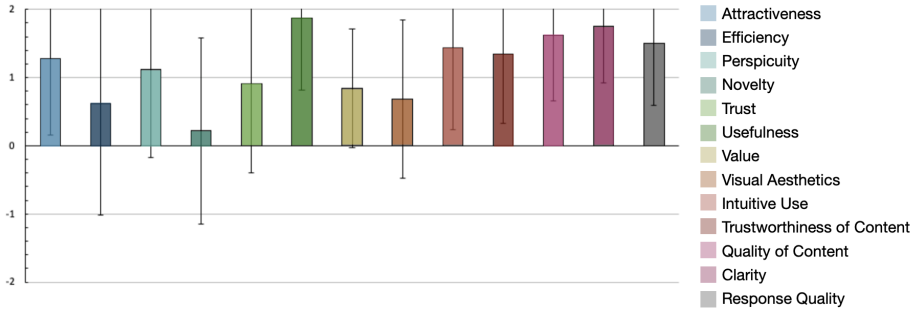

Fig. 3. UEQ+ Means and Standard Deviation per Scale

Post Interview. After the study's main part in the car simulator we conducted a 15 minute interview to gather the participants' impressions. The overall feedback was positive. In the following, we summarize the results from the post-interaction interviews clustered by interface, background experiences, empathy, privacy and possible changes.

Interface. Participants mentioned some confusion they had when driving to and arriving at the accident location. Five participants criticized the map, as it was not dynamic and therefore not intuitive to use. As a direct criticism about the system itself, half of the participants mentioned a feeling of impatience when listening to the first-aid steps after parking the car. They had a need to directly leave the car and help the victim, but at the same time needed to finish listening to the first-aid steps. We also noted that in most cases participants did not notice that they were able to skip the steps by clicking on the interface. One participant described how they once experienced an accident and forgot all the first-aid steps out of nervousness, so during the simulation they were glad to have all steps directly at hand. The system's design was overall rated positive. Most participants described it as clear, straightforward and easy to understand.

Background experiences. In general there seemed to be a discrepancy between the levels of first-aid skills of the different participants. Most of the participants stated that the first-aid steps provided by AutoMate were easy to follow and did not stress them too much. One participant even seemed to be underwhelmed as the mentioned steps were self-explaining and nothing new. One insight describes the simplicity of the steps as a negative connotation, whereas another insight describes that these steps helped the participant to be more calm. While the underwhelmed participant had a first-aid class while doing their driver's license, the latter one never had such a class. This shows us that different backgrounds and levels of comfort with first-aid is something that needs to be considered by the system in the future. For users with advanced first-aid skills it might be helpful to include the three additional steps we gathered during the expert interview (see chapter AutoMate).

Empathy. One part of our assumption was that addressing the participant directly and through a first person perspective has an impact on the willingness to help. Three participants stated to be surprised when the notification came in and suddenly the emergency sound appeared. After the surprise, all of our participants appreciated the guidance provided by the voice assistant. The voice assistance as an additional layer of information was valued, as it made the participant aware that there is a real person seeking for help. Most participants found it easy to empathize with the victim, even though she was a stranger. Gertrude, the persona, was an old lady, and most participants felt responsible

to help her, as she was elderly and they believed she would be more likely to have serious injuries even from a mild accident. Interestingly, two participants stated that it does not make any difference if the victim was a friend or a stranger as they would help anyways while at the same time two other participants said they could not empathize much with the victim because they did not see her or were too busy driving. One participant mentioned that empathy might be increased if the victim had a profile picture that showed her in person. We can conclude that, by addressing the driver directly from a first person point of view, empathy is increased in a way that drivers have a clear image of the person seeking help. Therefore they show an increased willingness to help. The information shared about the victim contributes to this as well.

Privacy. At the same time personal data seemed to be a very controversial issue for most of our participants. While most of the participants saw no problem in sharing accident-related data (such as the severity, the location and if the ambulance is on their way) data that relates directly to the victim sparked some discussion. Several participants seemed to be torn. On the one side they admitted that personal data helps in empathizing with the victim. In our scenario, the participants had a clear image of the victim in their heads due to the victim's age and name shared. As one participant describes it: *"When you know there is an older person maybe you approach them differently"*. On the other hand, half of the participants said that they would feel uncomfortable with sharing personal data, even if it increases their chances of receiving help in case of an accident. Revealing the victim's real name seemed to be an issue of discussion as well. Several participants liked knowing a victim's name and being able to address them directly. It could also be reassuring and calming for the victim if someone talks to them directly. Three participants saw a risk of discrimination when disclosing a victim's real name. Especially the earlier mentioned 'having a clear image of the victim in your head' seemed to be seen as a disadvantage when it comes to bias and discrimination. Interestingly, one participant also mentioned how they do not *"(...) like the idea of designing a technology for racists (...)"*, which means that the system should not be changed just because of someone's bad stance. It was interesting to see how some participants really seemed to weigh up the arguments for and against sharing data in their head. One participant admitted how they contradicted themselves at several points in the interview. This shows us how challenging and sensitive this topic is. We concluded that the sharing of personal data is something the user should be able to set individually in the settings of their personal profile.

Possible changes. When asked if they would use AutoMate in their cars, a majority confirmed that the system would make them feel more reassured. It adds comfort and safety to already existing systems. Although AutoMate was rated overall positive, there was also some criticism and room for improvement mentioned. When receiving the accident notification, one participant stated that they missed information about how long the ambulance will take. Moreover, they think it could be helpful if their location was also shared with the victim. Two participants referred to the voice assistant being too slow. Another participant added that the assistant's pronunciation was weird and robot-like. When arriving at the destination three participants said they missed an indicator to confirm that they reached the right location. As mentioned earlier the timing of the first-aid steps was highly criticized. That is why one participant voiced the idea of having AutoMate connected to their smartphone, so that they could listen to the first steps after leaving the car. Another participant stated that they would prefer having all five steps directly on one screen, so they can quickly skim through them.

7 DISCUSSION AND LIMITATIONS

With respect to RQ1, we found that the proposed AutoMate interface with extended first-aid knowledge available in a voice assistance system helps bystanders empathize with victims of car accidents. The AutoMate system is to be built

into existing systems as an integrated feature. It will be activated only when needed. We further found that bystanders feel more responsible to help by sharing information about a nearby accident, as they are directly approached by the victim (sub-RQ1). Addressing the bystander directly, as a victim with name and age, and asking for help is enough for them to feel empathy towards the victims. However, it is important to underline these findings with a larger number of participants, because even if in our case the participants in the TEQ had a similar empathy level, this might not reflect on the general public. Based on our findings, the cognitive dissonance of bystanders can be reduced by the guidance of the voice assistant and the offering of basic first-aid steps. This gives users the feeling that they are being supported in providing help (sub-RQ2). As Klieger et al. and Fischer et al. make clear, a recent first-aid training has a massive impact on bystanders' willingness to stop and help. Therefore, we could imagine offering workshops or informative videos at regular intervals in the AutoMate system to keep first-aid knowledge up-to-date. Unlike the functions of the eCall system [6], AutoMate additionally serves as a first-aid communication system that alerts the closest bystander and asks for help, however, similar to the eCall system we found privacy issues [11] in AutoMate. It's empirical to acknowledge that a lot of our participants voiced their concerns over these issues. In order to prevent this, the user themselves can choose which information they want to share. The only necessary information is the location. As Zepf et al. mentioned, an empathic interface [26] on vehicles can prevent emotional distress from drivers and dangers such as car accidents, and as an empathic system, AutoMate makes drivers feel more calm and at the same time more responsible to help victims. Lastly, Gröber et al [12] mentioned that a form of communication between car and driver can be helpful to prevent possible accidents. Therefore a communication between those two parties can help prevent worsen conditions from victims as well as building a trust between drivers and cars. Since this is a laboratory study, it is not possible to perform it 100% realistically. In our simulator setup, the non-panoramic view (frontal projection only) and the lack of integrated vehicle interfaces such as turn signal and clutch resulted in a rather artificial environment. A higher number of participants might have led to more meaningful results, but due to the time constraints of the study semester, only study colleagues and friends of the authors could participate. Due to the non-representative participants, the study results might be biased. Future studies in an improved setup and version of AutoMate might reveal further possibilities. In addition, it is beneficial to strive for a between subject design approach to measure the impact of empathy in two versions, namely the differences between the first- and third person perspective and also a human-like or robot voice.

8 CONCLUSION

In this paper, we provide a report on a study in which we investigated an interface to reduce the bystander effect in car accidents. We found that the direct approach or contact of the bystander can lead to positive effects. The map interface, which was used to navigate to the accident scene, was not effective and the interface of the last first-aid steps was not intuitive. The accident in this scenario was very mild, therefore the first-aid steps provided by AutoMate were kept minimal. As a result, it did not evoke strong emotions such as anxiety and fear in the participants. Nevertheless, the availability of navigation in combination with voice assistance is very helpful. Although, using voice assistance for the first-aid steps in AutoMate had a more superfluous impact, the direct approach of the injured person was perceived very positively. Despite the fact that the drivers could not see/knew the injured person, they could feel empathy towards the injured person. The participants felt responsible to help the victim. We therefore conclude that AutoMate is suitable as an empathic system to reduce the bystander effect in car accidents. Future work should focus on improving functionality, especially with regards to the user experience of navigation and first-aid steps on the spot. A possible outcome is a collaboration with car manufacturers to integrate AutoMate in existing car interfaces.

9 APPENDICES

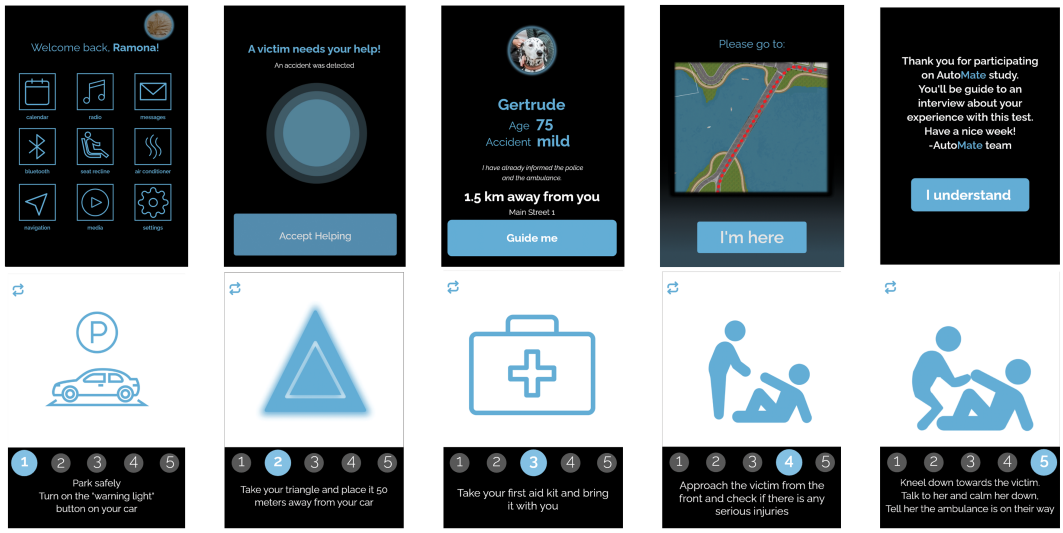

Fig. 4. AutoMate screens

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