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RESEARCH

Initial Bystander Response to a Simulated Out-of-Hospital Cardiac Arrest

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ABSTRACT

Objective: The main aim was to investigate laypersons' automatic reactions when confronted with an unexpected, real-life simulated out-of-hospital cardiac arrest (OHCA).

Methods: 16 participants with no prior knowledge of cardiopulmonary resuscitation (CPR) were individually confronted with a simulated OHCA, while observing art in a museum, as a deceptive task. Participants wore an eye-tracker and were continuously videotaped to collect their responses. Following the simulated OHCA, participants were interviewed to collect reflections on their reaction and then debriefed by a psychologist. One month later, appearance of posttraumatic stress disorder was requested by mail.

Results: The primary outcome was the timing and helping behavior of the layperson. Five of 16 participants noticed the casualty within 40 seconds after collapse and initiated immediate help. Two participants provided no help, although they had noticed the collapsed person. The second outcome was the participants' reflection on their response to the simulated emergency. The main reasons for delayed helping behavior were a lack of cardiac arrest recognition, misinterpretation of the emergency, bystander effect, and distraction by the deceptive task.

Conclusion: Results show the need for public awareness regarding the recognition of cardiac arrest and correct interpretation of an emergency.

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ABSTRACT

Doel: Het belangrijkste doel was om de spontane reacties van omstanders te onderzoeken wanneer ze worden geconfronteerd met een onverwachte, gesimuleerde hartstilstand buiten het ziekenhuis (OHCA).

Methodologie: 16 deelnemers zonder voorkennis van reanimatie (CPR) werden individueel geconfronteerd met een gesimuleerde OHCA, terwijl ze, als misleidende taak, kunst in een museum observeerden. Deelnemers droegen een eye-tracker en werden voortdurend gefilmd om hun reacties te registreren. Na de simulatie werden de deelnemers geïnterviewd om reflecties op hun reactie te verzamelen en volgde een nabespreking met een psycholoog. Een maand later werd het al dan niet voorkomen van een posttraumatische stressstoornis bevraagd per post.

Resultaten: Het primaire resultaat was de timing en het hulpgedrag van de omstander. Vijf van de zestien deelnemers merkten het slachtoffer binnen 40 seconden na de gesimuleerde hartstilstand op en schakelden onmiddellijk hulp in. Twee deelnemers boden geen hulp, hoewel ze de bewusteloze persoon wel hadden opgemerkt. Het tweede resultaat was de reflectie van de deelnemers op hun reactie op de gesimuleerde noodsituatie. De belangrijkste redenen voor uitgesteld hulpgedrag waren een gebrek aan herkenning van een hartstilstand, een verkeerde interpretatie van de noodsituatie, het omstandereffect en afleiding door de misleidende taak.

Conclusie: De resultaten tonen aan dat er behoefte is aan publieke bewustwording met betrekking tot het herkennen van hartfalen en de juiste interpretatie van een noodsituatie.

抽象的

目标：主要目的是研究普通人当要面对突如其来的模拟院外心脏骤停情况（OHCA）时的自然反应。

方法：安排16名没有心肺复苏（CPR）知识及经验的参与者在进行一个虚构的艺术博物馆参观活动时，让他们个别经历一次模拟的院外心脏骤停（OHCA）情境。所有参与者都佩戴了眼动仪，并连续进行录影以收集他们的反应。在模拟心脏骤停情境结束后，与参与者进行面谈以收集他们对自己反应的反思，随后由心理学家进行总结反馈。一个月后，通过邮件询问参与者有否出现创伤后应激障碍。

结果：第一个结果是关于路人的反应时间和帮助行为。在16名参与者中，有5人在伤者倒地后40秒内能注意到伤者并立即提供了帮助。有2名参与者虽然注意到了倒地的人，但未有提供任何帮助。第二个结果是有关参与者反思他们在模拟紧急情况下的反应。对于延迟施行帮助的原因主要包括缺乏识别心脏骤停情况的知识、对紧急情况的误解、旁观者效应以及被虚构的任务分散了注意力。

结论：结果显示需要提高公众对心脏骤停的识别能力以及对紧急情况的正确理解。

抽象的

目標：主要目的是研究普通人當要面對突如其來的模擬院外心臟驟停情況（OHCA）時的自然反應。

方法：安排16名沒有心肺復蘇（CPR）知識及經驗的參與者在進行一個虛構的藝術博物館參觀活動時，讓他們個別經歷一次模擬的院外心臟驟停（OHCA）情境。所有參與者都佩戴了眼動儀，並連續進行錄影以收集他們的反應。在模擬心臟驟停情境結束後，與參與者進行面談以收集他們對自己反應的反思，隨後由心理學家進行總結回饋。一個月後，通過郵件詢問參與者有否出現創傷後壓力症候群。

結果：第一個結果是關於路人的反應時間和幫助行爲。在16名參與者中，有5人在傷者倒地後40秒內能注意到傷者並立即提供了幫助。有2名參與者雖然注意到了倒地的人，但未有提供任何幫助。第二個結果是有關參與者反思他們在模擬緊急情況下的反應。對於延遲施行幫助的原因主要包括缺乏識

別心臟驟停情況的知識、對緊急情況的誤解、旁觀者效應以及被虛構的任務分散了注意力。

結論：結果顯示需要提高公眾對心臟驟停的識別能力以及對緊急情況的正確理解。

Keywords: first aid; basic life support; recognition; lay person; bystander effect; out of hospital cardiac arrest

INTRODUCTION

In the European Region (EU), cardiovascular diseases (CVD) account for more than 1.7 million deaths or 32.7% of all deaths (Eurostat, 2020). Defibrillating the heart within 3 to 5 minutes after collapse increases survival rates up to 50–70% (Perkins et al., 2015). Given the narrow time span for emergency medical services (EMS) to reach the exact location of an out-of-hospital cardiac arrest (OHCA) victim, survival relies on the actions of bystanders to perform CPR. Early recognition, willingness to perform bystander CPR and prompt actions of bystanders are crucial for survival from OHCA and emphasize the importance of the first link in the chain of survival (Perkins et al., 2021; Viereck et al., 2017).

While most studies which focus on the first chain of survival investigated the timespan between collapse and calling EMS, only a few studies explored early recognition and laypeople's possible reactions when faced with a real-life sudden OHCA. Most of these studies focus on the willingness to resuscitate, more specifically compressing the chest with or without giving ventilations. Reactions are explored by means of questionnaires with hypothetical emergency scenarios on paper (Cho et al., 2010; Savastano & Vanni, 2011). A major disadvantage of questionnaires is the social desirability response bias, leading to socially desirable answers. Other studies used a retrospective interview to identify barriers to provide CPR in an OHCA, but included (i) trained lay rescuers (Riegel et al., 2006) or (ii) explored barriers to bystander CPR initiation and continuation (such as physical inability to perform CPR, communication failure, etc.) once the emergency call was performed (Aldridge et al., 2024).

This paper focuses on the early recognition stage of a witnessed OHCA, before an emergency call. The aim of this study was to investigate for the first time the actual initial response of untrained laypeople when encountering an OHCA (simulation is blinded for the participant). Innovative in this study is the use of an eye-tracking device which allowed capturing exactly when the participant noticed the collapse or collapsed victim and where the participant looked following the collapse. By deceiving the participants about the research goal and design, they were unaware of the simulated emergency that was about to occur. The primary outcome was the timing and helping behavior of a layperson. The second outcome was the participants' reflection on their action in the simulated OHCA.

METHODS

Participants

Members of the general public (n = 17) volunteered for an experiment involving an art exhibition. Participants were recruited via an 'Invitation to participate' flier distributed in public areas (public transport station, city hall, etc.) and via social media. Adults aged over 18 and under 65 years old were included. Participants were excluded if they had impaired vision, received basic life support (BLS)-training in the last 5 years, were pregnant or had serious physical or mental health problems. After registration, a short questionnaire was administered to check for these inclusion and exclusion criteria and to request the necessary demographic data including age, gender, ethnicity, and socioeconomic group. These data resulted in a purposively selected sample of participants achieving diversity in these demographics.

Setting

The study was conducted in a museum that was exceptionally closed to the public during the experiment. Six adjacent rooms were used for the different phases of

the experiment: briefing (1), installation and calibration of the eye-tracker (2), experiment with simulation (3–4), interview (5) and debriefing by the psychologist (6). The fifth room was also used for live view observation. Ethical approval was obtained from the Social and Societal Ethics Committee of KU Leuven (G-201608599).

Study design and protocol

A mobile eye-tracker worn by the participant and video cameras set up in the simulation room were used to observe the distribution of visual attention and reactions of the participant when individually confronted with an unexpected victim of OHCA. A post-simulation interview allowed for reflection on these observed responses.

Upon arrival, the participant received standardized and deceiving introductory information, signed a written informed consent form and deposited all personal items, including smartphones. After mounting and calibrating the eye-tracking glasses, the participant was taken to the first simulation room, where they were instructed to look closely at the art objects. An indicated route on the floor guided the participant to the adjacent room. There, the OHCA was simulated by a trained BLS trainer (male, 56 years old), specialized in simulating cardiac arrest for more than 10 years. He acted as a workman and received timing instructions to start and stop simulating a cardiac arrest by means of a discrete earphone. Instructions were given from another adjacent room by use of a live view camera. To discreetly draw the participant's attention to his presence, the workman was instructed to pass participants in the first room while carrying his toolbox. In addition to the casualty, an actor was present in the room in the role of an approachable bystander. She acted as a cleaning lady pretending to listen to music by wearing on-ear headphones. She was instructed to avoid eye contact with both participant and casualty, and to freeze (i.e. not providing help) as soon as she was approached by the participant and informed of the collapse. Freezing is, in addition to fighting and fleeing, one of the natural reactions in a life-threatening situation. The simulation ended when the participant (i) left the simulation room in search of help, (ii) did not initiate any helping behavior and left the room, (3) had the intention to perform bystander CPR or (4) showed signs of panic. When signaled to end the simulation, the casualty woke up at a slow pace not to frighten the participant.

Once the simulation was completed, one of the researchers conducted a semi-structured interview and obtained a second informed consent from the participant. Subsequently, the participant received confidential psychological support from a clinical psychologist. This debriefing facilitated participants to cope with their potentially overwhelming emotions caused by this unexpected confrontation with an emergency. Four weeks later, each participant filled in the Impact of Event Scale (Horowitz, Wilner & Alvarez, 1979) to investigate whether traumatic reactions occurred after the OHCA experience.

Data collection and analysis

To measure the timing and type of helping behavior, the participant's eye- and body movements were captured by means of the Pupil Pro Binocular mobile eye-tracker (scene camera: 1920x1080@30fps; eye camera: 640x480@120fps) and three cameras that captured (1) the overview of the simulation room (live view cam), (2) the participant's facial reaction when noticing the collapsed casualty and (3) the participant's reaction when providing help (hidden camera close to the victim).

Annotation of the video recordings was performed manually and independently by two researchers using the video annotation tool ELAN 6.1. From the perspective of the participant (by means of the eye-tracking recordings), two areas of interest were annotated: the casualty and the bystander. The behavior of the participant (type of initial helping behavior and performed helping actions) and timing (moment of collapse (baseline), collapse notification and initiation of helping behavior) was annotated. The time interval between (i)collapse and notification of the collapsed casualty and (ii) collapse and help initiation was calculated.

By means of the interview and Impact of Event Scale, demographics (age, gender, education), awareness of deception, self-reflection on performed helping behavior

(reasons, excuses) and emotional impact of the study one month later (posttraumatic stress disorder (PTSD)) was collected.

The interview consisted of nine questions. The Dutch version of the Impact of Event Scale was used to collect information about the emotional state of the participants one month after participation. It provides information about two PTSD characteristics: (1) reliving the situation and (2) avoiding memories and feelings associated with the occurred situation (Horowitz, Wilner & Alvarez, 1979). All interviews were audio recorded and transcribed verbatim.

RESULTS

A total of 17 participants met the inclusion criteria and participated. One participant was excluded from the analysis due to incorrectly following the route. The remaining 16 (females = 7, males = 9) participants were between 20 and 61 years old (mean age 28.6).

Participants' helping behavior

* Notification of the collapse

The perception of collapse was analyzed by means of the eye-tracking recordings in combination with the video recordings. Three participants (Table 1, no. 1, 2, 9) noticed the collapse either because they looked accidentally in the direction of the workman just before the collapse or heard the noise of the collapse and responded by looking towards the victim. The eye-tracking data showed that the other 13 participants did not see the collapse and spotted the collapsed victim when he was already lying motionless on the floor for at least 20 seconds. These observations were confirmed during the interview.

Participant no.	Time of notifying the collapsed victim	Time interval between notification and initiating help	Time interval between collapse and initiating help
1	00:02	4 sec	6 sec
2	00:00	4 sec	4 sec
7	00:39	3 sec	42 sec
9	00:01	1 sec	2 sec
15	00:25	4 sec	29 sec
5	04:16	22 sec	4 min 38 sec
8	05:22	37 sec	5 min 59 sec
10	02:31	18 sec	2 min 49 sec
11	01:26	43 sec	2 min 10 sec
17	01:45	32 sec	2 min 17 sec
4	00:23	2 min 41 sec	3 min 04 sec
6	00:39	5 min 2 sec	5 min 41 sec
13	00:35	3 min 38 sec	4 min 13 sec
16	00:28	2 min 4 sec	2 min 32 sec
12	05:21	/	/
14	03:15	/	/
3	excluded	excluded	excluded

Table 1: Representation of the timing of helping behavior in order of response time as described in the results section. Time of collapse (00:00) is used as the baseline.

* Timing of helping behavior after notification

Five participants (Table 1, no. 1, 2, 7, 9, 15) initiated help within 5 seconds after noticing the collapse. According to the eye-tracking data, three of them noticed the collapse, while the other two spotted the collapsed casualty 25 and 39 seconds after collapse. None of them hesitated to walk towards the casualty to initiate help. They all verbally checked consciousness. Three of them checked consciousness by gently touching the casualty's shoulder or knee. Two participants checked the casualty's pulse. One participant tried to move the casualty into the recovery position. All five participants looked at the bystander while walking towards the casualty or after checking consciousness. Four of them walked towards her to ask for her help. One participant showed mild signs of panic, shouting twice "I don't know what I need to do…". One participant asked the bystander to search for other help while moving the casualty into the recovery position. Only two participants responded to the freeze of the bystander by walking towards an exit searching for other help.

Five participants (Table 1, no. 5, 8, 10, 11, 17) noticed the casualty more than 60 seconds after collapse. They did not initiate help immediately and observed the casualty more than once before acting. Four participants also checked the presence of the bystander during this time of hesitation. They initiated help 18 to 43 seconds after noticing by checking the casualty's consciousness either verbally (no. 8, 17), physically by touching the casualty (no. 10) or both (no. 5, 11). All five participants asked for help from the bystander and requested the bystander to call someone. In addition, only one of these five participants went searching for other help.

Four participants (Table 1, no. 4, 6, 13, 16) noticed the collapsed casualty within 40 seconds after collapse, but initiated help more than two minutes later. Following notification of the collapse, all participants looked towards both the casualty and bystander several times while continuing the observation of art. The initial helping behavior was performed with hesitation and consisted of checking consciousness either verbally, verbally and physically or walking towards the bystander without checking the casualty's consciousness first. All four participants approached the bystander requesting her to call someone. Only one participant responded to the freeze of the bystander by searching for other help.

Two participants (Table 1, no. 12, 14) did not initiate any kind of helping behavior after noticing the casualty. Both participants noticed the collapsed casualty for the first time more than 3 minutes after collapse. They looked several times towards the casualty and the bystander and passed the casualty while performing the deceptive task. One of them showed notable signs of doubt in how to act by walking towards and away from the casualty, but decided to continue looking at the art.

Self-reflection on the presence or absence of the helping behavior

The deceptive intent in this study design was successful with at least 10 of the 16 participants. They all claimed not to have questioned the authenticity of the situation and therefore were naive about the real purpose of the study. By asking explicitly during the interview, five participants (no. 1, 2, 4, 5, 14) reported having doubts about the deception. However, the reaction of these participants during the deception did not diverge from that of the other ten participants. On the contrary, four of them initiated helping behavior. Only one participant (no. 10) felt that he was being deceived during the simulation and expressed his suspicion towards the bystander during the deception.

* Reasons for not initiating helping behavior

One of the two non-responsive participants was convinced the person was asleep. As he acknowledged there was no danger for the casualty, he did not act. The other non-responder gave several contradicting explanations about why he suspected the situation to be false: "I thought, if that is art… I saw the man coming down the stairs…, but I did not notice it was the same person… I actually thought it was a doll… I thought he was in a kind of sleep…".

* Reasons for (slowly) initiating helping behavior

Although 14 participants initiated help, nine participants did not think of an OHCA initially. They indicated that they first thought the casualty was doing something on

the ground (for instance listening to something), was asleep or may be an object of art. None of the participants mentioned a clear recognition of cardiac arrest.

Different reasons were given for delayed initiation of help. Initial thoughts of not knowing what to do and fear of doing something wrong were replaced by initiating help because they noticed that nobody else came to help or that the casualty did not respond after multiple shouts.

* Emotional impact of participation during and one month after participation

None of the participants reported any experience of stress during the simulation. Video recordings showed the presence of a mild panic reaction in only one person. The questionnaire, sent out one month after the simulation, revealed no clinical signs of PTSD. With the exception of one mild reaction (13), all participants showed a subclinical result (0–7) after completing the Impact of Event Scale.

DISCUSSION

The primary objective of this study was to get an insight into the timing and helping behavior of laypersons when confronted with a simulated, though blinded for the participant, OHCA. Our results show a wide range in how and how quickly lay people respond in an OHCA. Five out of 16 participants initiated potential lifesaving helping behavior within 5 seconds after noticing a possible victim of cardiac arrest. Three of them noticed the actual collapse and acted immediately within 6 seconds after collapse. However, delayed (N = 9) or no (N = 2) helping behavior in case of an OHCA occurred more frequently. Previous studies showed that the high mortality rate of OHCA is associated with a delayed initiation to start CPR after collapse. This can be due to fear of infection, being incapable, legal implications and causing damage to the victim (Savastano & Vanni, 2011). Over time the survival rate is quite stable in the first 4 minutes following collapse (with an estimated survival rate of 44%) and then declines steeply (Gold et al., 2010). However, the time from collapse to EMS arrival often exceeds 5 minutes (Takei et al., 2010), emphasizing the need for prompt bystander action (Perkins et al., 2015).

In cases of delayed response from participants, crucial seconds were lost. We observed considerable hesitation in approaching the victim. Consciousness was checked several times. Asking for help was performed at a slow pace. Additionally, some participants checked the pulse, and one tried to move the victim into recovery position, implying the presence of false or old information in the memory of laypeople. Also, none of the 16 participants checked for normal breathing or opened the airway. Most participants asked for help from the bystander. Two did this as initial helping behavior without checking the casualty's consciousness first. Only four participants searched for other and more suitable assistance than the bystander who froze. The other participants seemed not to know how to react themselves. From these observations, we recommend BLS-trainers to take these differences into account and inform participants about fight-flight-or-freeze reactions.

Our second objective was to get access to the participants' reflection on their actions in the simulated OHCA. Participants reported several reasons for delayed initiation of help. The most common reason is a lack of laypeople's recognition of cardiac arrest. None of the participants stated to have clearly recognized a possible cardiac arrest in the collapsed victim. Instead of not recognizing OHCA, many participants assumed the victim was asleep, was listening/doing something on the floor or was an object of art being part of the deceptive task. While recent actions are undertaken to improve bystander CPR through smartphone applications and text-message initiatives, our results highlight the need to educate the broader public about OHCA recognition.

A second reason is associated with the presence of a bystander. Most participants showed clear signals of doubts in how to interpret the situation of the collapsed victim. The eye-tracker registered many eye movements back and forth between the casualty and the only bystander in the room before help was initiated. The fact that the bystander acted as non-responsive could have reassured doubting participants that nothing serious was going on, which resulted in a delayed initiation of helping behavior. Furthermore, some participants copied the freeze reaction of the bystander

when asking for help. This implies the replacement of an individual for a shared responsibility, also referred to as the bystander effect (Darley & Latané, 1968; Fischer et al., 2011). While many participants hesitated to provide help and froze, none of the participants reported experiencing stress following the notification of the collapsed person. This is in line with the results of a study with 1243 laypersons responding to an emergency during the Public Access Defibrillation Trial, which revealed only low levels of stress caused by the situation (Riegel et al., 2006).

A third potential explanation for delayed help is distraction. Most participants reported to be focused on the deceptive task of observing the art. As a result, they claimed not to see nor hear the actual collapse of the casualty. They spotted the collapsed person for the first time when they actually passed the casualty on the guided route. However, this profound focus cannot clarify why participants did not immediately initiate help after noticing the casualty on the ground. It can only explain why some participants did not immediately notice the collapsing casualty, as also stated by some participants. It is worth mentioning that the deceptive task might simulate the many distractors, such as the extended use of smartphones, in our daily lives.

A limitation of our observational study is the sample size limit the generalizability of the results. Nevertheless, the nature, extent and innovative aspect of this study (e.g. use of deception and a mobile eye-tracking device) made it both ethically and practically difficult to extend our sample. To overcome the issue of sample size, we constituted the trial group as diverse as possible in age, gender and education to make it more representative for the general population. Future studies can build on our study by including larger and therefore more diverse participant samples to increase generalizability. Adding physiological measurements such as heart rate and stress levels, might offer additional objective information on a participant's emotional response to the simulation. Secondly, exploring the long-term effects of training and repeated exposure to simulated emergency situations can provide insight into how these experiences influence future bystander behavior. Lastly, comparing responses in different types of emergency situations (cases, environments, etc.) or between individuals with different levels of BLS training could provide a deeper understanding of how different factors influence bystander actions.

CONCLUSION

In summary, this study is the first to provide an indication of the natural and unbiased initial reactions of witnesses of an OHCA. Our results emphasize the need for public awareness regarding recognition of cardiac arrest, correct interpretation of an emergency situation and importance of prompt actions even when untrained in BLS. Furthermore, training programs should address the barriers identified in our study, such as misinterpretation of an emergency situation and the bystander effect, to enhance the first link in the chain of survival. Lastly, eye-tracking technology could be adapted and integrated into BLS and first aid courses to provide feedback and support learning experiences for both laypeople and trained responders.

DATA ACCESSIBILITY STATEMENT

The data used in this study is available upon request from the corresponding author.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

FW and NC were involved in the initial concept of the work, the data collection, analysis and interpretation, and the main drafting of the manuscript.

TB was involved in the data collection and analysis, and the initial drafting of the manuscript.

PI supported the original concept of the work and the drafting of the manuscript.

SDB, GB and TG were responsible for the data collection by means of the eye-tracking: initial design, acquisition, analysis, and interpretation of the data. They supported the drafting of the manuscript.

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