SHOULD I STAY OR SHOULD I GO: ONLINE EXPERIMENTS ON SELF-PROTECTION UNDER THREATENING SITUATIONS

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ABSTRACT

This study explores the impact that external/internal factors may have on self-protective behaviour under threatening situations. Six online experiments (18 trials) were designed using the PsyToolkit platform and the 3D visualization of Pathfinder. The experiments combined threats (Fire Alarm, Explosion and Shootings), physical context (Open area and Enclosure) and social influence (Individual, Group Go and Group Stay). In total 1807 participants took part in the study. Participants first were exposed to three different situations (trials) and decided the self-protective actions (stay vs go) and then they filled out a post-experiment questionnaire. The proportion of people who decided to stay was higher (67%) than the option to go. Participants were more likely to stay when they were in an Enclosure room. Furthermore, they increased their decision to leave when they were with people leaving the environment. We also found that the decision to stay was associated with males and higher ages (with participants over 45 years old). Results also shown that individuals had tendency to spend more time deciding in Fire Alarm and Enclosure contexts.

INTRODUCTION

Terrorism is increasingly recognised as a serious, worldwide public security concern. Around 753 terrorist attacks occurred in the Europe between 2011 and 2019 (START, 2021) causing 642 fatalities and 4547 injuries. The threat of terrorism is not new in Europe (Bernardini, G. et al., 2021) and still worries citizens. The EU Fundamental Rights Agency 2020 (FRA, 2020) reported that 47% of Europeans are worried about becoming victims of terrorism in the coming year consequently counterterrorism is one of the main challenges for governments (EU Directive, 2017; COM, 2020) and new policies have recently been introduced to stop financing, regulate weapons and improve cybersecurity (Blahova, M., 2019; Gruszczak, A., 2022; MacDonald, E. et al, 2007; Sardi, I. et al, 2019). Research on terrorism can be classified into three main approaches. The first approach focuses on terrorist acts (Bąk, T., 2017; Bennett, B. T., 2018; Torres-Soriano, M. R., 2019) and the methods/strategies to minimize their impact (Ezell, B.C., et al, 2010; Feng, Q. et al, 2019; Grant, M. et al, 2015). The second approach involves studies on the behaviour of attackers (Canter, D. et al., 2014; Gallagher, M. J., 2022) and often employs game theory principles and methods (Levine, E. S., 2012; Megahed, A., 2019; Reniers, G. et al, 2016; Rios, J. et al, 2016). The third approach focuses on the behaviour and performances of the victims/survivors through interviews (Adam, C., 2017; Fahy, R. F., 2011; Grimm, A. et al, 2014; Kuligowski, E. D., 2011; McConnell, N. C. et al, 2010) thus providing comprehensive and useful qualitative information. However, quantitative data on people reactions to threatening situations is scarce. One research identifies people's behaviours that increase risk during evacuations and communication strategies to reduce risk (van der Wal, C. N. et al, 2021). Another study provides a dataset on pedestrian behaviours in terrorist attacks (focusing on the built environment) and their frequency, as well as pedestrian dynamics using fundamental diagrams (Quagliarini, E. et al, 2021).

However, we often fail to realise why we make (or do not make) certain choices or actions. Therefore, one of the main gaps in this field of research is the need to understand people's motivation and behaviours during threats. A better understanding of our self-protective behaviours will improve our day-to-day security and increase the probability of survival in the face of a threat. To make progress in addressing this gap, we want to assess the question "Should I stay or should I go?" with the aim of defining the relationships between external/internal factors and the self-protective behaviours of people during threats. For that, we used online survey experiments involving 1807 individuals facing fire alarm, explosion and shooting scenarios. We statistically analyse self-protective behaviours in relation to physical context, social influence and sociodemographic characteristics.

METHOD

To date various experimental methods have been developed and introduced to measure people behaviour in emergencies. In most recent studies, VR has been applied (Arias, S., 2021; Becerik-Gerber, B. et al, 2022; Kinateder, M., 2016; Ruggiero, L. et al, 2022). Here we used online experiments combining 3D visualization of Pathfinder (Pathfinder, 2022) and Psytoolkit (Stoet, G., 2010; Stoet, G., 2017), a well-known experimental platform. This approach was chosen because it has several attractive features: 1) easy access to diverse participant population, including individuals from unique and previously inaccessible target populations; 2) bringing the experiment to the participant instead of the opposite; 3) high statistical power by enabling access to large samples and 4) virtual environment can emulate complex threats/stimulus without danger to participants.

Experimental design

Six experiments were designed combining three factors. The first factor is the threat, which includes Fire Alarm, Explosion and Shootings scenarios. The second factor establishes the physical context where the participant is at the time the threat is triggered. The options are an Open area (like a diaphanous hall) and an Enclosure environment (like a room). The third factor comprises the social influence, which differs in the confederates (virtual people) the participant sees when the threat is produced. Individual or Group scenarios are the social situations analysed. The Individual situation is without confederates, the participant is alone when sees the threat. The group scenario is divided into Group Go (participant sees virtual people leaving the scene) and Group Stay (virtual people remain in the enclosure). Table 1 shows the combination of factors for each of the six experiments. Each experiment consists of three trials (18 trials were designed and coded). This experiment matrix gives us the possibility to undertake the analysis between factors and self-protective behaviours in many ways. This is due to the keys of the design: participants were randomly assigned to one of the experiments; each participant performs only one experiment; all participants face the threats in the same order; all participants experience the three social influences; each threat is shown in all physical and social combinations; half of participants were in an enclosure and the other half in an open area.

Table 1: Factors analysed in each experiment.

EXPERIMENT 1			Trial Code	EXPERIMENT 2			Trial Code
Fire Alarm	Open area	Individual	Fi.Op.In	Fire Alarm	Enclosure	Individual	Fi.En.In
Explosion	Open area	Group Stay	Ex.Op.GS	Explosion	Enclosure	Group Stay	Ex.En.GS
Shootings	Open area	Group Go	Sh.Op.GG	Shootings	Enclosure	Group Go	Sh.En.GG
EXPERIMENT 3			Trial Code	EXPERIMENT 4			Trial Code
Fire Alarm	Open area	Group Go	Fi.Op.GG	Fire Alarm	Enclosure	Group Go	Fi.En.GG
Explosion	Open area	Individual	Ex.Op.In	Explosion	Enclosure	Individual	Ex.En.In
Shootings	Open area	Group Stay	Sh.Op.GS	Shootings	Enclosure	Group Stay	Sh.En.GS
EXPERIMENT 5			Trial Code	EXPERIMENT 6			Trial Code
Fire Alarm	Open area	Group Stay	Fi.Op.GS	Fire Alarm	Enclosure	Group Stay	Fi.En.GS
Explosion	Open area	Group Go	Ex.Op.GG	Explosion	Enclosure	Group Go	Ex.En.GG
Shootings	Open area	Individual	Sh.Op.In	Shootings	Enclosure	Individual	Sh.En.In

To avoid learning behaviour Enclosure and Open area locations varied within threats (i.e. a participant in Experiment 1 sees three different Open area with their corresponding social influence and a participant in Experiment 3 sees the same Open area in Experiment 1 but with different social influence). The number of confederates implemented in group trials were five virtual individuals. The purpose was to give a clear visualization of their actions to the participant, which would not be possible if the environment was highly densely. A key challenge was reproducing realistic environments to participants. We used the 3D visualization capabilities of Pathfinder. A simulation was conducted with the corresponding inputs of physical and social environment for the 18 trials. A video of each simulation was recorded using the capabilities of the model. The fire and smoke visual cues were simulated using the Fire Dynamic Simulation software [FDS] (McGrattan, K. et al, 2013) and then imported into the 3D visualization of Pathfinder. The videos were joined with auditory (alarm, explosion, shoots) and visual (fire, smoke, shootings) stimuli with a video editor to represent each threat factor faithfully. Figure 1 shows examples of Experiment 1 as Open area and Experiment 2 as Enclosure. Note that physical context refers to the locations where the participant is located when the threat is triggered.

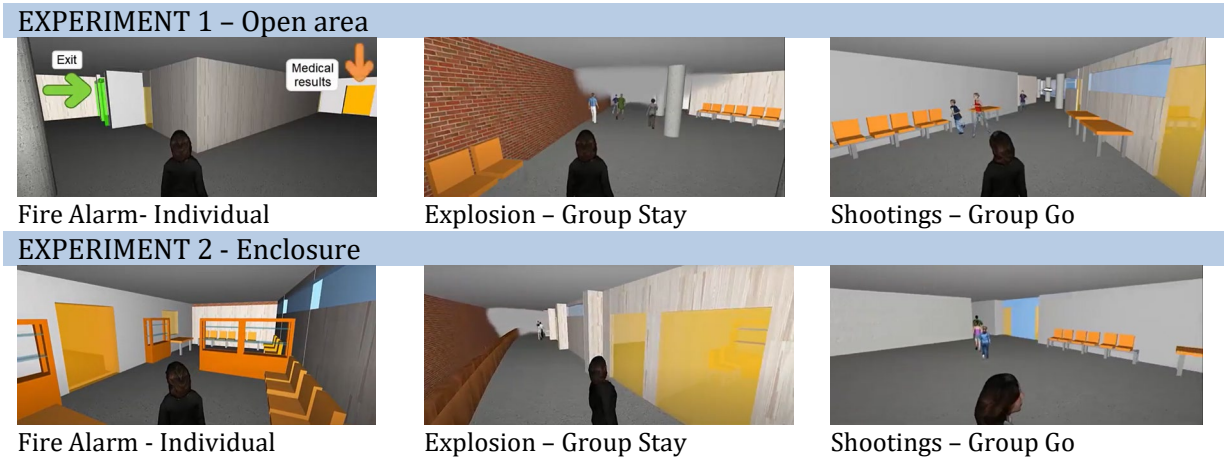


Figure 1: Snapshots of the online experiments using Pathfinder.

The post-questionnaire was designed to obtain the sociodemographic characteristics and impressions of participants. We asked about gender, age, education and incomes to collect personal information. Furthermore, terrorism perception involved questions about terrorism concern, probability of suffer or being injured in an attack and the self-capacity of response. Previous experiences in drills and training were also collected. Once the design of trials and post-questionnaires were completed, we combined them using the PsyToolkit platform. This online platform is typically used to conduct psychological experiments and fits perfectly with our requirements (e.g. videos visualization, choose different options, time and answer record). The experiment was conducted into two phases. *Phase 1.-* A pilot was carried out involving 41 participants that performed 2 out of 6 experiments. This phase allowed us the possibility to know whether the experiment worked correctly and whether its design fulfilled the purpose of the study. A link provided by PsyToolkit was sent to the participants through email and social networks. The results of the pilot gave us a preliminary overview of the impact the explored factors may have on self-protective behaviours. However, the Group scenario of the social influence was analysed together (Group Go + Group Stay); the participant saw half of confederates leaving and the other half staying in the same trial. This reduced the possibility to clearly know whether the decision made by the participant was influenced by one or the other action of the confederates. Therefore, the purpose of the study was not being fulfilled faithfully. Changes were made in the experimental design, dividing the Group scenario in Group Go and Group Stay independently. *Phase 2.-* The final design with all experiments was conducted by 1807 participants.

Experimental procedure

Participants were informed about the purpose of the experiment, the estimated time to complete it and the fulfilment of the post-questionnaire. They were also advised to use headphones to perform the experiment in the best possible way. Then they confirmed their participation and gave their consent for data collection by researchers (being advised that no personal data that could identify them would be recorded). As an indispensable requirement, participants had to confirm that they were of legal age. The experiment had the ethical approval of the Ethical Committee of the University of Cantabria. The survey company had their own requirements for the fulfilment of the experiment. Considering that an online experiment is conducted by the participant alone and that researchers cannot resolve doubts, it was necessary that the dynamics of the trials were perfectly clear. An informative screen with the explanation of the experiment was shown to participants who confirmed that they have read it. At this part, the trials started. Before starting the first trial (fire alarm), participants were indicated that they were in a health care center to get some medical results. Then, they watch the video of the presented threatening situation and choose a decision (Fire Alarm: *leave/wait*; Explosion: *leave/help*; Shootings: *leave/hide*). Decisions had to be made within a time limit of 10s to record the first intuition of the participants. However, responses after that time limit were recorded as well. Finally, participants filled out the post-questionnaire.

Participants

Phase 1.- The 41 participants involved in the pilot of the experiments were 24 female and 17 males with a mean age of 41.9 years (standard deviation = 11.3 years).
Phase 2.- The 1807 individuals recruited by a survey company were representative of the Spanish population (for gender and age, but not for education) with a gender proportion of 51% females/49% males. The ages ranged from 18 to 76 years (mean=47.88, standard deviation=16.13). Minors were considered more susceptible at-risk and not included in the study. Demographic characteristics are shown in Figure 2. At least 300 individuals participated in each Experiment. The participation in evacuation drills and the safety training prior to the experiment were collected. Results showed a medium participation in drills (47.78%) and a lacked training (31.82%). Furthermore, participants rated their self-perception of terrorism on a 10-point scale (0 = very low, 10 = very high). Results are reported in Table 2. Participants are frightened by terrorism with a mean score of 7.23 but believe that their probability of suffering an attack or being injured in one is low (mean score of 3.26 and 3.88 points). In addition, participants reported low confidence in know what to do in the event of a threat (mean of 4.18).

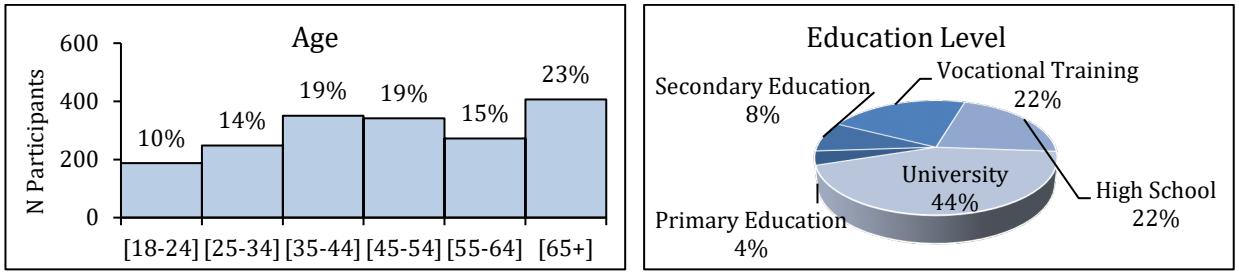


Figure 2: Age and Education of participants whose conduct the final experiment.

Table 2: Numeric summary of participants' terrorism perception.

Terrorism Perception							
	Mean	SD	Median	Quartile 1	Quartile 3	SE	95th percentile
Fear	7.23	2.62	8	5	9	0.06	10
Suffer an attack	3.26	2.25	3	1	5	0.05	7
Being injured	3.88	2.42	4	2	5	0.05	8
Preparedness	4.18	2.57	5	2	6	0.06	8

Measures/Statistical analysis

The main dependent variables were the decision and the decision time. The decision was the self-protective behaviour of participants after seeing each threat. The decision time was defined as the time participants spent to choose the decision. The answers to the questionnaire were also recorded. External factors (threats, physical and social context) and internal factors (sociodemographic characteristics) were the independent variables for the analysis. The results were registered in an Excel spreadsheet. Due to the type of data, dichotomous decisions and external and internal factors (dichotomous or polytomous), contingency tables with chi-square tests of independence were used to rate their relations. Shapiro-Wilk tests (to test if a sample comes from a population normally distributed) exposed that none of the decision time samples were normally distributed (p<.001). Thus, we used non-parametric tests to compare factors and decision time. Kruskall-Wallis test (to test if samples originate from the same distribution) was used for threat factor (three independent groups) and Wilcoxon rank-sum test (to compare whether the medians of the samples differed between them) for the analysis of physical and social factors (two independent groups). All statistical analysis was performed using the JASP software (Goss-Sampson, M. A., 2022).

RESULTS

Simple statistical analyses were used to analyse the relationship between the manipulated factors and the self-protection decisions. The first set of analyses examined the impact of external factors and the second one the impact of internal factors.

External Factors

Threat factor (Figure 3): A chi-square test of independence was performed to examine the relation between the threatening situations and the decisions adopted by participants. The relation between these variables was significant, χ^2 (2, N = 5421) =254.39, p < .001. Interestingly, higher proportions of participants decided to stay (wait/help/hide) in all conditions: Fire Alarm (21/79), Explosion (33/67) and Shootings (46/54). Decision times were significantly affected by threat factor H(2) = 205.8, p<.001. Pairwise comparisons using Dunn's post hoc showed that both Explosion (Mdn = 6.79) and Shootings (Mdn = 6.93) significantly reduces decision times (p<.001) compared to Fire Alarm (Mdn = 7.97). There was also significant difference between Explosion and Shootings (p=.035). Finally, we analysed the percentage of participants that decided when the time limit of 10s finished off, with 566 individuals divided into 50% in Fire Alarm, 23% in Explosion and 26% in Shootings.

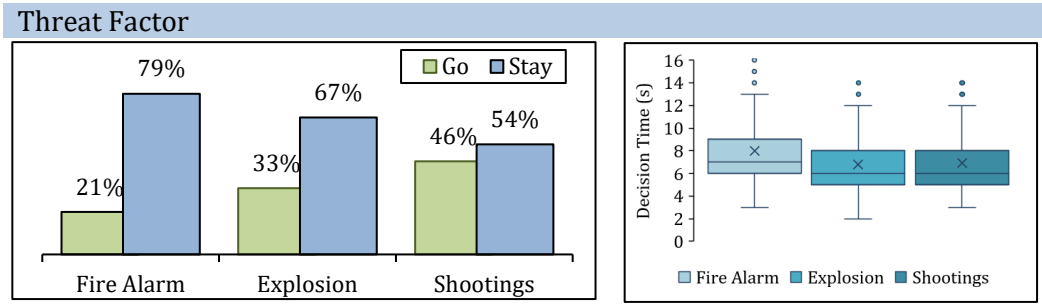
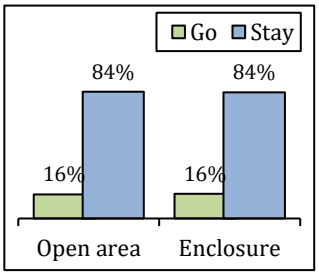
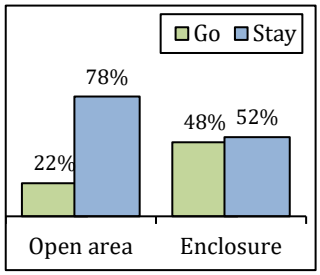
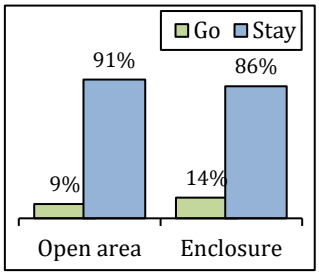
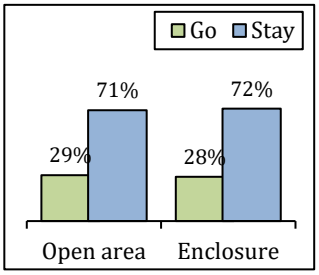
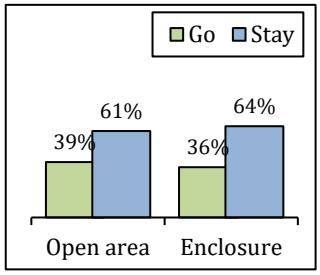
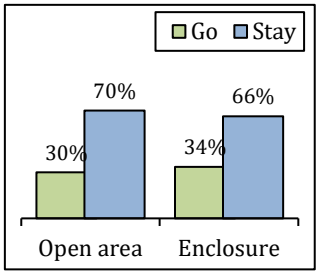
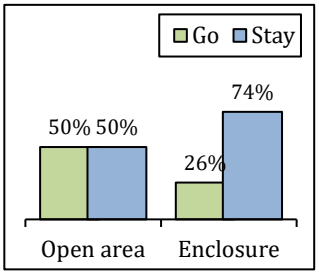
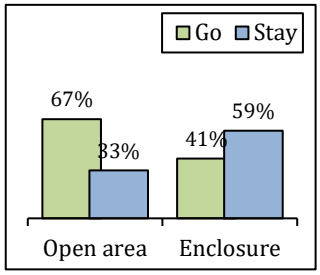
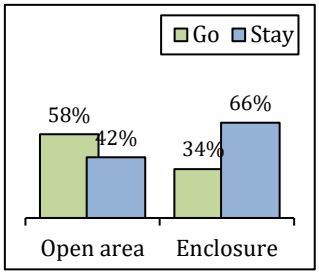


Figure 3: Graphical results of the impact of threat factor.

Physical factor: this analysis compared the decision making of individuals according to their starting locations (Open space vs Enclosure) in all conditions. Taken together, these results indicate that there is an association between the physical context and the self-protection under Shootings attacks (e.g. participants were more likely to stay and hide when they were in an Enclosure room) as shown in Table 3. For Fire Alarm, there was a significant difference between the physical locations in one condition (when confederates leave the area) where individuals decided to stay in open area.

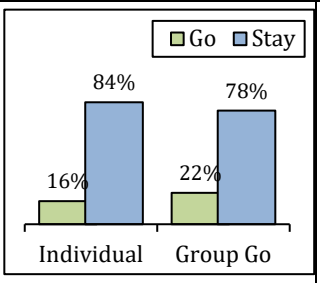
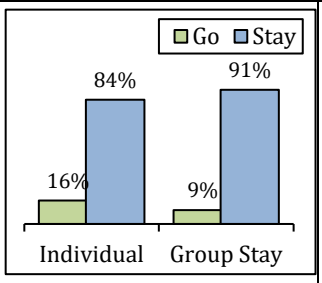
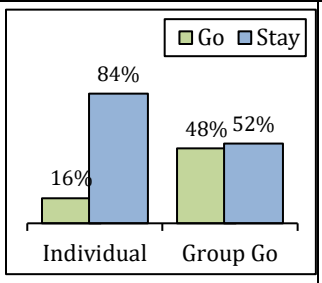
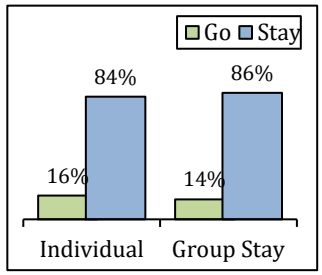
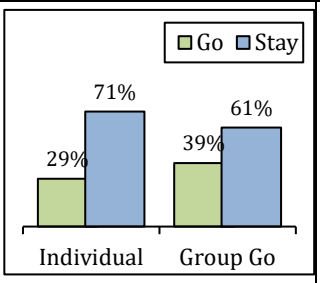
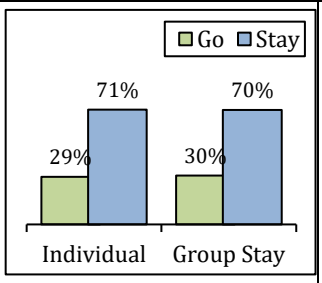
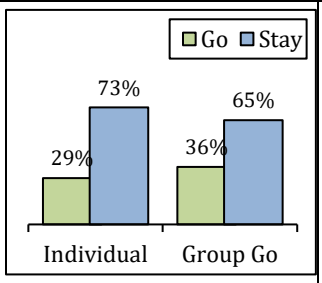
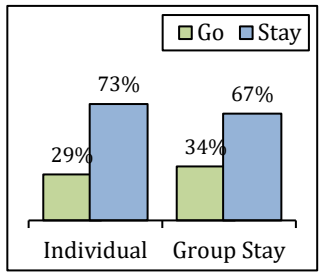
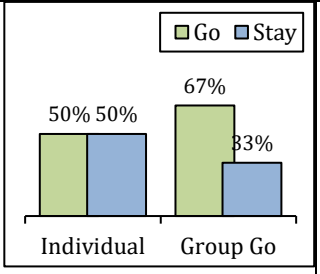
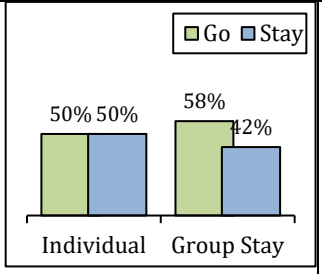
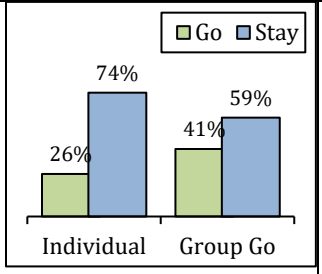
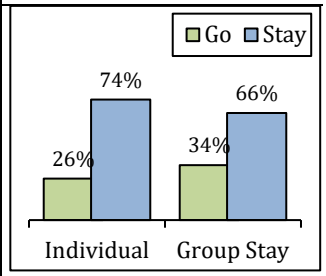
Nevertheless, a chi-square test did not show any significant differences for explosions. Interestingly, there were also some differences in the decision times (e.g. all conditions of Fire Alarm) where the Wilcoxon rank-sum tests indicated that the median Enclosure ranks were statistically significantly higher than the Open area ranks.

Table 3: Results of the impact of physical factor (see Table 1 for trials code).

Physical Factor [Open area – Enclosure]		
Fire Alarm		
Fi.Op.In vs Fi.En.In	Fi.Op.GG vs Fi.En.GG	Fi.Op.GS vs Fi.En.GS
		
χ^2 (1, N=602)=0.012, p=.912	**χ^2 (1, N=604)=47.21, p<.001***	χ^2 (1, N=601)=2.72, p=.099
Explosion		
Ex.Op.In vs Ex.En.In	Ex.Op.GG vs Ex.En.GG	Ex.Op.GS vs Ex.En.GS
		
χ^2 (1, N=604)=0.08, p=.777	χ^2 (1, N=602)=0.766, p=.382	χ^2 (1, N=602)=0.928, p=.335
Shootings		
Sh.Op.In vs Sh.En.In	Sh.Op.GG vs Sh.En.GG	Sh.Op.GS vs Sh.En.GS
		
χ^2 (1, N=604)=38.12, p<.001*	**χ^2 (1, N=604)=43.87, p<.001***	**χ^2 (1, N=604)=35.37, p<.001***
*** Significant result**		

Social factor analysis compared the participants' decisions with the social influence (Individual (established as the base) vs Group Go and Group Stay) in all cases. The results obtained are presented in Table 4. Strong evidence of social influence was found for Shootings trials where participants increased their decision to leave despite the confederates' actions. For Explosion analysis, there was only association in first case (e.g. participants were more likely to go when confederates go). Finally, there were also differences in the ratios of Fire alarm results both when confederates go and stay. The analysis of decision time revealed that participants, when accompanied, took less time to decide in an open area, in contrast to those in an enclosure space who took longer.

Table 4: Results of the impact of social factor (see Table 1 for trials code).

Social Factor [Individual – Group Go – Group Stay]			
Fire Alarm			
Fi.Op.In vs Fi.Op.GG	Fi.Op.In vs Fi.Op.GS	Fi.En.In vs Fi.En.GG	Fi.En.In vs Fi.En.GS
			
χ^2 (1, N=601)=3.22, p=.073	**χ^2 (1, N=601)=5.95, p=.015***	**χ^2 (1, N=605)=71, p<.001***	χ^2 (1, N=602)=0.84, p=.361
Explosion			
Ex.Op.In vs Ex.Op.GG	Ex.Op.In vs Ex.Op.GS	Ex.En.In vs Ex.En.GG	Ex.En.In vs Ex.En.GS
			
χ^2 (1, N=600)=6.23, p=.013*	χ^2 (1, N=601)=0.02, p=.879	χ^2 (1, N=605)=3.67, p=.055	χ^2 (1, N=604)=1.96, p=.161
Shootings			
Sh.Op.In vs Sh.Op.GG	Sh.Op.In vs Sh.Op.GS	Sh.En.In vs Sh.En.GG	Sh.En.In vs Sh.En.GS
			
χ^2 (1, N=601)=18.8, p<.001*	**χ^2 (1, N=600)=3.87, p=.049***	**χ^2 (1, N=602)=15.2, p<.001***	**χ^2 (1, N=605)=4.99, p=.026***
*** Significant result**			

Internal Factors

The results obtained from the preliminary analysis of how participants' sociodemographic influence the decisions and the decision time across threats are shown in Table 5.

Gender: greater evidence of association was found between gender and the decision to stay in Explosion threat (74% males facing the 61% of females). Less impact was observed for Fire Alarm where the 81% of males decided to stay compared with the 77% of females. No significant differences were found for Shootings. Data also shown that females were more likely to leave than males in the three threating situations. Decision time was significantly higher for males in Fire Alarm and Shootings threats, but not for Explosion.

Age: a correlation was found between age and the decision of stay in all three threats (in particular, participants over 45 years old had a greater tendency to stay), with the highest percentage in Fire Alarm and progressively decreasing in Explosion and Shootings. There was also a significant association with decision time (e.g. the higher mean values of time, the higher ages of participants).

Education level: significant association was observed between the level of education and the decision for Fire Alarm and Shootings (the lower the level of education completed, the greater the tendency to decide to stay). For the decision time, participants took on average longer to decide the lower their educational level.
Previous Drill: the participation (or not) in a drill before reducing the mean values to decide.
There was no significant association between monthly income or prior training and the decision or decision time.

Table 5: Statistical results of the impact between internal factors and dependent variables.

Internal Factors	Decision	Decision Time
Gender	Fire Alarm: χ^2 **(1, *N*=1807)=4.18, *p*=.041***	Fire Alarm: ***W*=448168, *p*<.001***
	Explosion: χ^2 **(1, *N*=1807)=32.98, *p*<.001***	Explosion: W=415561, p=0.479
	Shootings: χ^2 (1, *N*=1807)=2.52, *p*=.113	Shootings: ***W*=445109, *p*<.001***
Age	Fire Alarm: χ^2 **(5, *N*=1807)=60.49, *p*<.001***	Fire Alarm: ***H*(5) = 85,95, *p*<.001***
	Explosion: χ^2 **(5, *N*=1807)=36.39, *p*<.001***	Explosion: ***H*(5) = 53,13, *p*<.001***
	Shootings: χ^2 **(5, *N*=1807)=16.69, *p*=.005***	Shootings: ***H*(5) = 41,08, *p*<.001***
Education	Fire Alarm: χ^2 **(4, *N*=1807)=16.18, *p*=.003***	Fire Alarm: ***H*(4) = 12,22, *p*=0.016***
	Explosion: χ^2 (4, *N*=1807)=19.39, *p*=.052	Explosion: H(4) = 0.61, p=0.952
	Shootings: χ^2 **(4, *N*=1807)=15.08, *p*=.005***	Shootings: ***H*(4) = 12,91, *p*=0.012***
Previous Drill	Fire Alarm: χ^2 **(1, *N*=1807)=17.89, *p*<.001***	Fire Alarm: ***W*=372340, *p*=0.002***
	Explosion: χ^2 (1, *N*=1807)=0.94, *p*=.331	Explosion: ***W*=373541, *p*=0.002***
	Shootings: χ^2 (1, *N*=1807)=0.017, *p*=.897	Shootings: ***W*=371875, *p*=0.001***

*** Significant result**

CONCLUSIONS

Should I stay or should I go? There is no right answer, as it depends on the characteristics of the situation, and no one is the same as any other. Proving that there is a relationship among cues, environment, social and sociodemographic factors with the actions we take, will improve security. Here we conduct online experiments to analyse the impact that external factors (threat, physical and social) and internal factors (sociodemographic characteristics) have on the self-protective actions and the time to decide it. We designed 18 trials combining three features as threat factor (Fire Alarm, Explosion and Shootings), physical factor (Open area or Enclosure) and social factor (Individual, Group Go and Group Stay). 1807 participants took part in the experiment. The analysis showed is more comparative that predictive; but results revealed that external and internal factors influenced participants' self-protective decisions.

Surprisingly more people decided to stay than go in all **Threat factor** situations, this could be for the lack of the threat perceived due to the online format of the experiments. Nevertheless, the proportion of individuals deciding to leave increases as a function of the threat (lowest for Fire Alarm 21%, followed by Explosion 33% and highest in Shootings 64%). This may be associated with the dangerousness of the scenarios. **Physical factor** comparison involving the decision made while in open area or enclosure space provided differences for Fire Alarm and Shootings. Open area was related to the decision of leave in case of shoots and Enclosure in case of alarm. 61.5% of individuals believe that being already in an Enclosure room, the option most likely to survive is to stay in it. In accordance with previous studies (Cuesta, A. et al, 2021; Haghani, M., 2017; Kinateder, M., 2016), the analysis of **Social factor** have demonstrated that confederates can influence over decisions. When participants were with confederates deciding to leave, the evacuation rate increased. Contrary to some cases with confederates deciding to stay, where the proportion of participants who decided the same was not increased in all conditions. A further study with more focus on this condition is therefore suggested to explore whether the participants' decision is caused by the two trials carried out before.

The investigation of participants' characteristics and its impact on decisions has shown some interesting findings. The results of **gender** analysis show that females were more likely to evacuate than males. Nevertheless, the self-protective action most decided by both genders was to stay. Another important finding was that **Age**, **education** and the **previous participation in a drill** also had association with the decision made in some trials. Related to the analysis of decision time, participants spent more time in Fire Alarm trials and Enclosure environment as we expected. Another important finding was that being alone or with people around had impact on decision times. Finally, this experiment detected that higher ages imply higher times to decide and that males used more time than females.

The present results support the advantages listed in the introduction about online experiments and highlight the desirability of conducting them to collect data from evacuation studies and human behaviour. Only 47% of the participants had participated in an evacuation drill before and 68% had not received safety training. This experiment format would be a great opportunity to improve these ratios and give people more confidence to be prepared during a threat. It is to be expected that this confidence training will be widely accepted due to certain findings such as the combination of a high degree of fear of terrorism and a sense of unpreparedness in the event of an emergency. However, the findings in this study are subject to some limitations. Although the environment matched reality very well, there are features that will never be 100% the same (e.g. textures, interaction with objects or people, the threats themselves). In addition, the fact that the researchers did not monitor the participation of individuals in person may have led to some unresolved doubt. Finally, although the combination of factors resulted in the design of the experiments conducted, perhaps the participants who did not perform the individual trial in the first place acquired some learned behaviour from the trials with confederates.

These outcomes extend our knowledge of self-protection with a main conclusion: external and internal characteristics are interconnected components to decide the self-protective actions. However, more research on this topic needs to be undertaken as: 1) analyse the impact of sociodemographic characteristics within physical and social context, 2) rank the impact level of each factor (i.e., calculate which factor is the most influential and under what conditions) and 3) employ the results produced to develop a model which will predict the survival probability in different conditions.

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REFERENCES

Adam, C. and Gaudou, B. (2017), "Modelling Human Behaviours in Disasters from Interviews: Application to Melbourne Bushfires", *Journal of Artificial Societies and Social Simulation*, **20**, DOI: 10.18564/jasss.3395

Arias, S. (2021), "Application of Virtual Reality in the study of Human Behavior in Fire – Pursuing realistic behavior in evacuation experiments", Dissertation, Lund University.

Bąk, T., (2017), "Manners of Performing Terrorist Attacks", *International conference Knowledge-based Organization*, **23**, *25-31*, DOI: 10.1515/kbo-2017-0004

Becerik-Gerber, B. et al. (2022), "The impact of security countermeasures on human behavior during active shooter incidents", *Nature*, **12**, DOI: https://doi.org/10.1038/s41598-022-04922-8

Bennett, B. T. (2018), "Understanding, Assessing, and Responding to Terrorism: Protecting Critical Infrastructure and Personnel", *Chapter 3: Types of Terrorist Attacks,* 2nd Edition, 99-136, ISBN: 978-1-119-23781-5

Bernardini, G. and Quagliarini, E. (2021), "Terrorists acts and pedestrians' behaviours: First insights on European contexts for evacuation modelling", *Safety Science*, **143**, 105405.

Blahova, M. (2019), "Security forecasts of terrorist attack", *MATEC Web of Conferences*, **292**, 01035, DOI: https://doi.org/10.1051/matecconf/2019

Canter. D., Sarangi, S. and Youngs, D. (2014), "Terrorists' personal constructs and their roles: A comparison of the three Islamic terrorists", *Legal and Criminological Psychology*, **19**, 160-178, DOI:10.1111/j.2044-8333.2012.02067.x

Cuesta, A. et al. (2021), "Alone or with others: Experiments on evacuation decision making", *Fire Safety Journal*, **120**, 103018, DOI: https://doi.org/10.1016/j.firesaf.2020.103018

Directive (EU) 2017/541 of the European Parliament and of the Council of 15 March 2017 on combating terrorism.

MacDonald, E. and Williams, G. (2007), "Combating Terrorism", *Griffith Law Review*, **16**, 27-54, DOI: 10.1080/10383441.2007.10854581

European Commission, (2020), "A Counter-Terrorism Agenda for the EU: Anticipate, Prevent, Protect, Respond", COM (2020) 795 final.

European Union Agency for Fundamental Rights (FRA), (2020), "Your rights matter: Security concerns and experiences", *Fundamental Rights Survey, Luxembourg, Publications Office*.

Ezell, B.C., et al. (2010), "Probabilistic Risk Analysis and Terrorism Risk", *Risk Analysis*, **30**, 575-589, DOI: 10.1111/j.1539-6924.2010.01401.x

Fahy, R. F. (2011), "How did people respond and evacuate in WTC Twin Towers in 2001?", *Journal of Disaster Research*, **6**, 620-628, DOI: https://doi.org/10.20965/jdr.2011.p0620

Feng, Q. et al. (2019), "Quantitative Research on Global Terrorist Attacks and Terrorist Attack Classification", *Sustainability*, **11**, 1487; DOI:10.3390/su11051487

Gallagher, M. J. (2022), "Lone Wolf Terrorists: Examining Motives and Methods of Stand Alone Terrorists", *In book: Indoctrination to Hate: Recruitment Techniques of Hate Groups and How to Stop Them.*

Goss-Sampson, M. A. (2022), "Statistical Analysis in JASP 0.16.1: A Guide for Students".

Grant, M. and Stewart, M. G. (2015), "Probabilistic Risk Assessment for Improvised Explosive Device Attacks That Cause Significant Building Damage", *Journal of Performance of Constructed Facilities*, **29**, B4014009, DOI: 10.1061/(ASCE)CF.1943-5509.0000694

Grimm, A. et al. (2014), "Behavioural, emotional, and cognitive responses in European disasters: results of survivor interviews", *Disasters*, **38**, 62-83, DOI:10.1111/disa.12034

Gruszczak, A. (2022), "The European Union's Counter-Terrorism Policy Twenty Years After 9/11: What Has Really Been Done?", *Studia Politologiczne*, **63**, 24-39, DOI: 10.33896/SPolit.2022.63.2

Haghani, M. and Sarvi, M. (2017), "Following the crowd or avoiding it? Empirical investigation of imitative behaviour in emergency escape of human crows", *Animal Behaviour*, **124**, 47-56, DOI: http://dx.doi.org/10.1016/j.anbehav.2016.11.024

Kinateder, M. and Warren, W. H. (2016), "Social influence on evacuation behavior in real and virtual environments", *Frontiers in robotics and AI*, **3**, DOI: 10.3389/frobt.2016.00043

Kuligowski, E. D. (2011), "Terror Defeated: Occupant Sensemaking, Decision-Making and Protective Action in the 2001 World Trade Center Disaster", Dissertation, University of Colorado at Boulder, https://scholar.colorado.edu/socy_gradetds/4/

Levine, E.S. (2012), "Estimating Conditional Probabilities of Terrorist Attacks: Modeling Adversaries with Uncertain Value Tradeoffs", *Risk Analysis*, **32**, 294-303, DOI: 10.1111/j.1539-6924.2011.01655.x

McConnell, N. C. et al. (2010), "The UK 9/11 evacuation study: Analysis of survivors' recognition and response phase in WTC1", *Fire Safety Journal*, **45**, 21-34, DOI:10.1016/j.firesaf.2009.09.001

McGrattan, K. et al. (2013), "Fire Dynamics Simulator User's Guide", Sixth Edition, Special Publication (NIST SP), National Institute of Standards and Technology, Gaithersburg, MD, [online], DOI: https://doi.org/10.6028/NIST.sp.1019

Megahed, A. (2019), "The Stackelberg differential game for counter-terrorism", *Qual Quant*, **53**, 207-220, DOI: https://doi.org/10.1007/s11135-018-0742-5

National Consortium for the Study of Terrorism and Responses to Terrorism (START), (2021), "Global Terrorism Database [Data file]", retrieved from https://www.start.umd.edu/gtd

Pathfinder – Technical Reference (2022), Thunderhead Engineering, https://support.thunderheadeng.com/docs/pathfinder/2022-1/technical-reference-manual/

Quagliarini, E. and Bernardini, G. (2021), "Terrorist acts and pedestrians' behaviours: First insights on European contexts for evacuation modelling", *Safety Science*, **143**, 105405, DOI: https://doi.org/10.1016/j.ssci.2021.105405

Reniers, G. and Zhang, L. (2016), "A Game-Theoretical Model to Improve Process Plant Protection from Terrorist Attacks", *Risk Analysis*, **36**, 2285-2297, DOI: 10.1111/risa.12569

Rios, J., Rios, D. and Banks, D. (2016), "Modeling Opponents in Adversarial Risk Analysis", *Risk Analysis*, **36**, 742-755, DOI: 10.1111/risa.12439

Ruggiero, L. et al. (2022), "Exit choice in built environment evacuation combining immersive virtual reality and discrete choice modelling", *Automation in Construction*, **141**, 104452, DOI: https://doi.org/10.1016/j.autcon.2022.104452

Sardi, I., Amiruddin, A. and Parman, L. (2019), "Policy in Combating Terrorism Crimes", *International Journal of Multicultural and Multireligious Understanding*, **6**, 307-316, DOI: http://dx.doi.org/10.18415/ijmmu.v6i4

Stoet, G. (2010), "PsyToolkit - A software package for programming psychological experiments using Linux", *Behavior Research Methods*, **42**, 1096-1104.

Stoet, G. (2017), "PsyToolkit: A novel web-based method for running online questionnaires and reaction-time experiments", *Teaching of Psychology*, **44**, 24-31.

Torres-Soriano, M. R. (2019), "How Do Terrorists Choose Their Targets for an Attack? The View from inside an Independent Cell", *Terrorism and Political Violence*, DOI: 10.1080/09546553.2019.1613983

van der Wal, C. N. et al. (2021), "Evacuation behaviors and emergency communications: An analysis of real-world incident videos", *Safety Science*, **136**, 105121, DOI: https://doi.org/10.1016/j.ssci.2020.105121