Learning Cabin Safety through Play: Using Video Game Technology in Passengers' Education

Luca Chittaro

Human-Computer Interaction Lab
Department of Mathematics and Computer Science
University of Udine, Italy

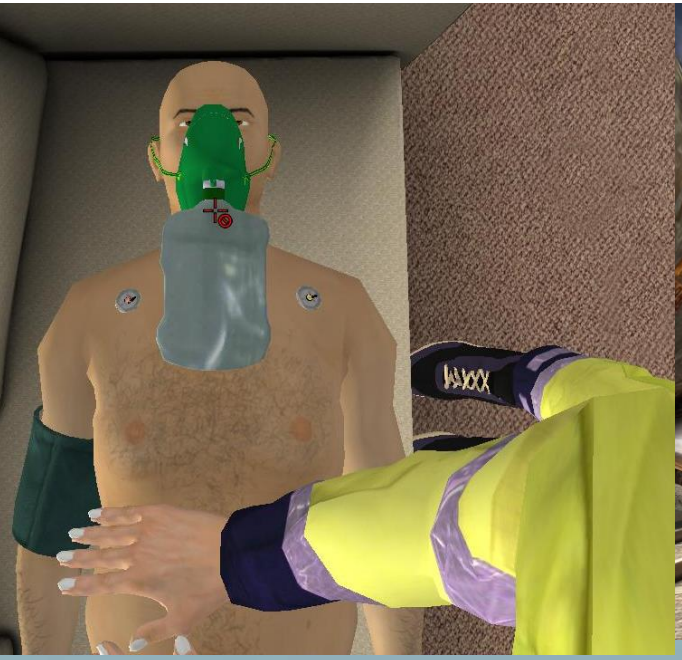
http://hcilab.uniud.it

Contents

- **Introduction:**
  - Issues in passengers' safety education
  - Proposal of a new approach based on game technologies
- **Case studies from our research:**
  - A "serious game" to teach an emergency evacuation procedure
  - Exploring low-cost body-tracking to recognize players' actions
  - A (deployed) app on Facebook to learn a brace position
- **Preliminary results on the effectiveness of the approach (**Passenger's Knowledge, Self-efficacy, Locus of Control, Fun,…**)**
- **On-going and future work**

Virtual Experiences of Risk

(@ our lab)



Aviation Safety Education

- Goals of Aviation Safety Education:
  - provide airline passengers with accurate cabin safety knowledge
  - cultivate positive passenger attitudes, to appropriately affect passenger behavior when emergencies occur

- Level of passengers' Aviation Safety Education affects:
  - probability of survival (Muir &Thomas, 2004)
  - level of stress and fear during the emergency (Edwards, 1990)
  - likelihood of "cognitive paralysis" phenomenon (Leach, 2004; 2005)
  - their knowledge, attitudes and behaviors (Chang & Liao, 2009)

Scarce efficacy of current approaches

- Current approaches:
  - safety card on seats
  - safety briefing after boarding
- Major limitations (Corbett, McLean & Cosper, DOT/FAA/AM-08/20, 2008):
  - passenger attention to them is poor at best
  - comprehension is below acceptable limits (even by passengers who pay attention)
- Interview-based studies of survivors (e.g. Chang & Yang, 2011): safety briefing not useful (86%), safety card not useful (84%)
- FAA reports, e.g. (Cosper & McLean, DOT/FAA/AM-04/19, 2004), call for improved, more creative methods to educate passengers about safety

Passenger Behavior in Aircraft Evacuations

- Aircraft evacuations must be fast and safe (e.g., aircraft cabin unsurvivable about 2 minutes after fire erupts)
- Official incident and accident reports describe a wide range of inappropriate behaviors, e.g. passengers:
  - try to bring luggage, slowing down the evacuation
  - engage in competitive behaviors, making the evacuation chaotic and slow
  - lack essential knowledge and ability such as:
    - assuming a correct brace position
    - going for the closest emergency exit
    - being able of opening doors
    - crawling below smoke
    - jumping on the emergency slide and then sliding

Self-efficacy and Passengers' Safety

- **Self-efficacy**:
  - Bandura's Social Cognitive Theory (self-efficacy as a predictor of future performance)
  - Roger's Protection Motivation Theory (threat-based persuasion is likely to fail if it does not address self-efficacy)
- Increasing self-efficacy is particularly important for airline passengers' safety:
  - passengers tend to be pessimistic and fatalistic about aircraft accidents, mistakenly believing that there is little hope
  - passengers tend to shift the responsibility and capability of their safety to the cabin crew
  - up to 40% of passengers is fearful of even normal flying conditions
- Unlike other risks in which persuasive interventions need to increase perceptions of risk severity, in this case people need to be persuaded about their ability to act

Project Goals

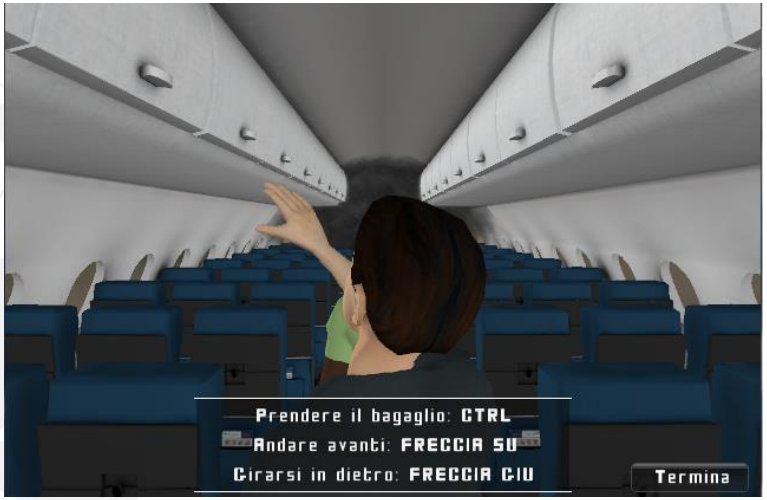
- Building novel, interactive tools for aviation safety education
  - **Serious games**, i.e. video games to further training and education objectives
  - **Gamification**, i.e. the application of digital game design techniques to non-game problems, such as social impact challenges
- Making aviation education materials more engaging and entertaining, to attract passengers' attention and to make passengers want to use them for extensive periods of time
  - It is interesting to note that some airlines are attempting to attract passengers' attention towards pre-flight safety video briefings by making them more engaging (e.g., making the videos humorous or fun, employing celebrities or attractive persons as presenters,…) but these tactics are limited by the non-interactive nature of the employed media
- Making aviation education materials more effective

Proposed Approach

- Educating passengers through a game-based approach would allow to:
  - make safety education materials more appealing
  - simulate aircraft emergencies, be more thorough and realistic than current methods
  - live the educational experiences whenever and how many times the player wants, also at home
  - keep attention alive
  - increase exposure time to personal safety content
  - promote repetitive rehearsal of safety procedures, which improves retention of knowledge

1st Prototype

- Choice points



- Cutscenes

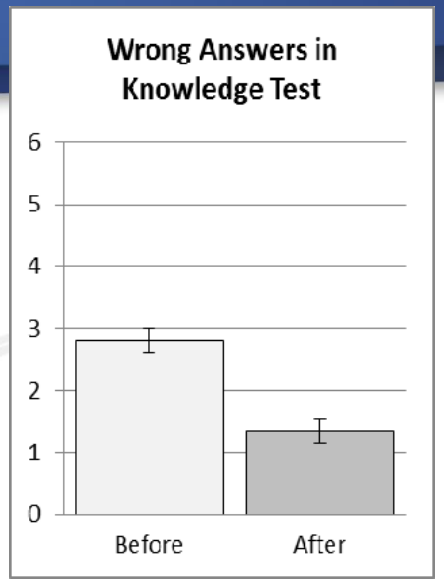
- Movement

1st Study

- **Participants**: 26 (19 M, 7 F), volunteer university students. Mean age: 23.85 (SD=2.51)
- **Task:** Participants played an emergency landing game level based on simple 3D graphics on a PC using keyboard controls (arrow keys + right CTRL key). Time to successfully complete level: 2-3 minutes.
- **Measures** (before and after playing the game):
  - **Knowledge.** Safety questionnaire with 6 multiple-choice items (wrong answers corresponded to typical passengers' errors)
  - **Self-efficacy.** 7-item questionnaire on (1=not at all, 5=very) scale
    - Examples of items: "I am confident that I could deal with an emergency evacuation of an aircraft", "I would be able to deal with an emergency evacuation of an aircraft even if there was smoke in the cabin",…
    - High internal reliability, assessed with Cronbach's Alpha (α =.94)

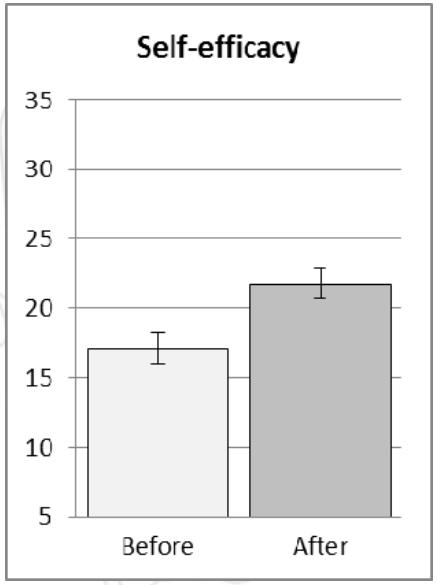
Main Results

- **Knowledge:**
  - wrong answers more than halved, from 2.85 (SD=.93) to 1.38 (SD=.98)
  - Wilcoxon test ($p<0.001$)



Capped vertical bars denote ±1 SE

- **Self-efficacy:**
  - a 27% increase, from 17.38 (SD=5.91) before to 22.27 (SD=5.27)
  - Wilcoxon test ($p<0.001$)



For more details on this 1st study, see:
Chittaro, L.: Passengers' Safety in Aircraft Evacuations: Employing Serious Games to Educate and Persuade. In: Bang, M., Ragnemalm, E. (eds.) PERSUASIVE TECHNOLOGY. LNCS vol. 7284, pp. 215–226. Springer, Heidelberg (2012)
http://hcilab.uniud.it/publications/2012-03.html

Main conclusions of the 1st study

- Serious games that simulate aviation risk experiences can be an effective tool:
  - playing a game for 2-3 minutes resulted in considerable improvement of self-efficacy and knowledge
- Limitations:
  - No comparison with traditional safety card
  - This game was developed as a first rough prototype, and it is thus limited in different game features such as quality of graphics and natural control of the character

Improving character control

- We built a second version of the game, in which we:
  - added the possibility to control the character with low-cost body-tracking (based on the Kinect sensor) instead of the common computer keyboard
  - introduced a simple cartoon character that can instruct the player about what his/her character should do

Low-cost body tracking of players' actions

- Oxygen Mask

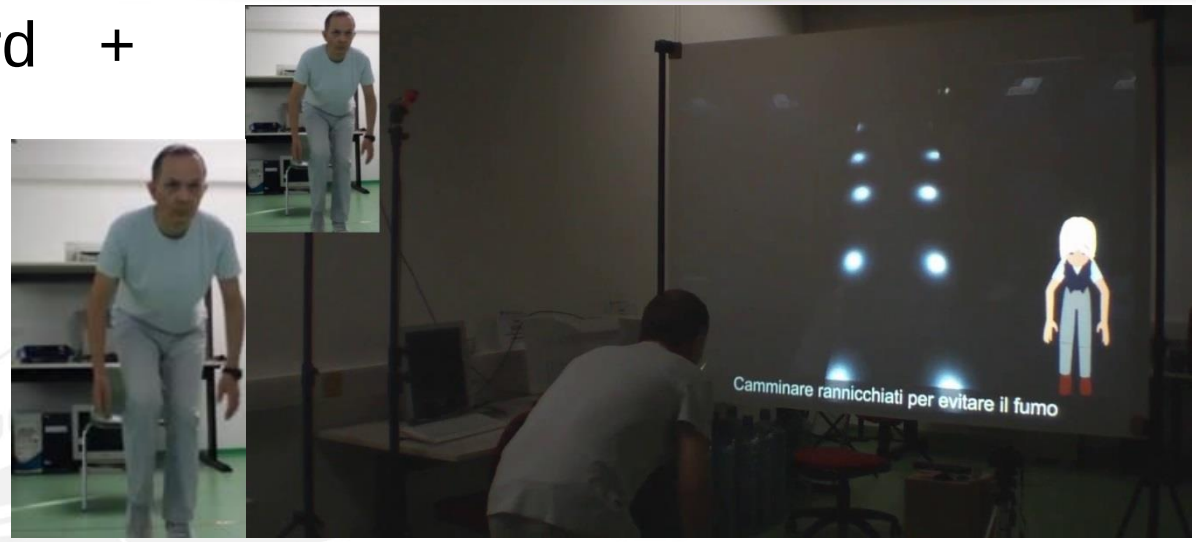
Low-cost body tracking of players' actions

- Brace

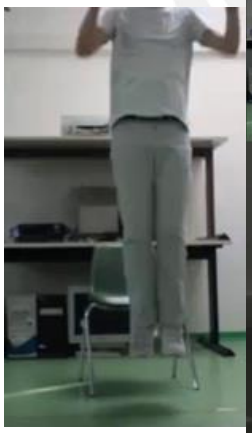
- Walk

Low-cost body tracking of players' actions

- Bend forward + walk



- Jump



2nd Study

- **Materials:** Two versions of the game, that differed only in the way players controlled the character: keyboard or body tracking
- **Participants:** 24 (12 M, 12 F), volunteer university students. Mean age: 22.96 (SD=2.18)
- **Design:** Between-subjects
- **Task:** Players were asked to play the game level until they got out of the aircraft
- **Measures:** self-efficacy before and after the experience, recall of the actions of the illustrated procedure

2nd Study

- **Results:**
  - Significant increase in self-efficacy confirmed (about 29%) as in the 1st study (Wilcoxon test, $p<0.01$)
  - better recall of the actions in the body-tracking condition. Means of recalled actions 8.25 (SD=1.22) vs. 6.67 (SD=0.89), Mann-Withney test $p<0.01$. The actions in the procedure were 10.
  - the more natural way of controlling the character was more fun (M=6.00, SD=0.89) than pressing keyboard buttons (M=4.17, SD=1.85), Mann-Withney test $p=0.01$. The rating scale ranged from 1 (boring) to 7 (fun).

2nd Study

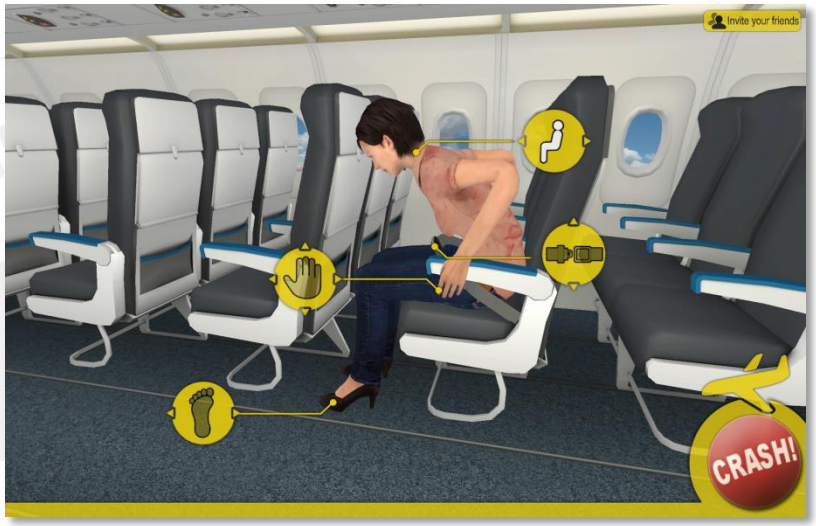
- Limitations of the sensor:
  - the Kinect is not accurate enough to recognize if some important safety actions such as assuming the brace position are performed correctly
  - Only a minority of users have the sensor in their home (while they have more traditional hardware such keyboard and mouse)
- Limitations of the study design:
  - No comparison with traditional safety card
- New research goals derived from the study:
  - Testing the new version of the Kinect (will be available in 2014) to assess if and how it might improve action recognition for passenger education
  - But especially, coming up with ways to teach physical actions (such as assuming the brace position) very precisely, using a mouse-based approach to accurately control the character
  - Including a traditional safety card condition in new studies

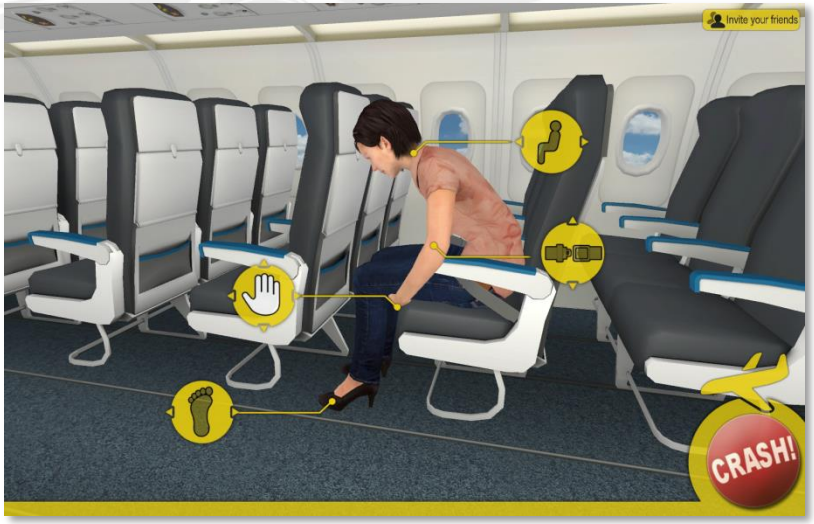
Learning the brace position with a game app

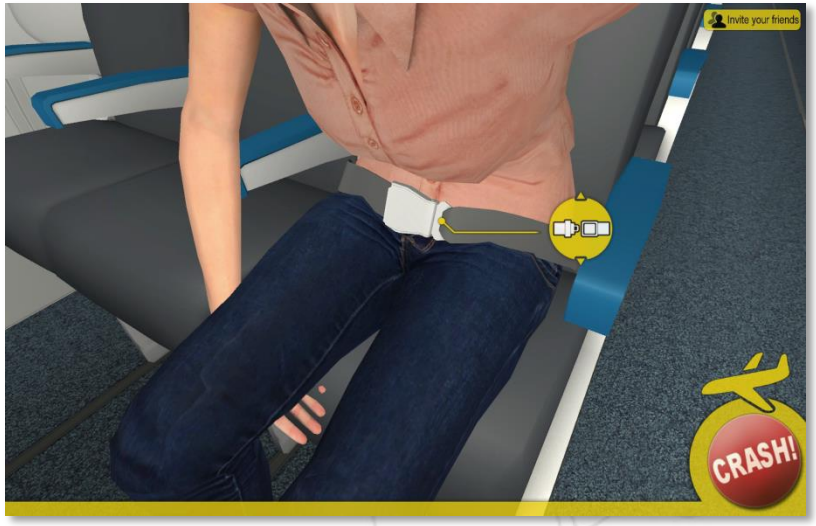
- We created the “Learn to Brace” app
- First version just deployed on Facebook at the address:

  https://apps.facebook.com/learntobrace
- How it works:
  - It allows the player to accurately pose a 3D human character sitting in the cabin of an aircraft, in an intuitive way using the mouse
  - It visually simulates the effects of a crash landing on the character
  - It provides a damage report and hints about how to improve the position
- Since this application (unlike the previous two prototypes) was meant for public use, we devoted a lot of attention to the quality of the graphics and sound and to build a realistic-looking environment and characters

Gameplay: posing the virtual human

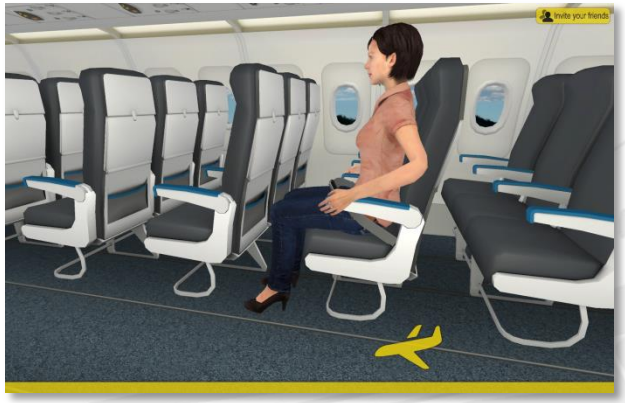






Gameplay: Simulating a crash landing

- Real-time visualization



- Slow-motion replay with damage highlight

Gameplay:
Damage report and hints

DEMO

3rd Study

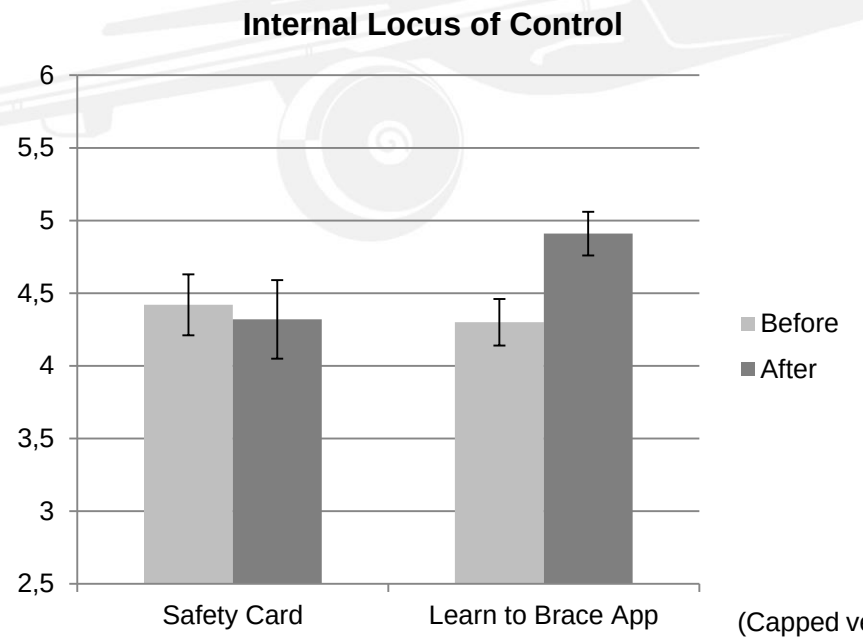
- **New condition**: traditional safety card
  - “Learn to Brace” app vs. traditional safety card pictogram. To avoid confounding variables, the graphics of the pictogram were exactly the same of the app, with the virtual human posed in the correct position
  - In choosing a correct brace position, we referred to (Taylor, Moorcroft & DeWeese, 2013)
- **New measure**: passenger’s locus of control
  - Locus of control = the degree to which an individual perceives that the outcomes of the situations (s)he experiences are under his/her personal control
  - In aviation safety, there are studies of locus of control in pilots (Hunter, 2002; Hunter & Stewart, 2009; You, Ji & Han, 2013)
  - Importance of locus of control in passengers
  - We developed a questionnaire to measure passenger’s locus of control with items about aircraft accidents such as "Surviving is a matter of luck, chance or fate", "Most injuries and deaths are inevitable", "Passengers can prevent injuries if they follow safety procedures", "Some injuries are due to errors made by passengers",… (reliability: Cronbach’s alpha = 0.8)

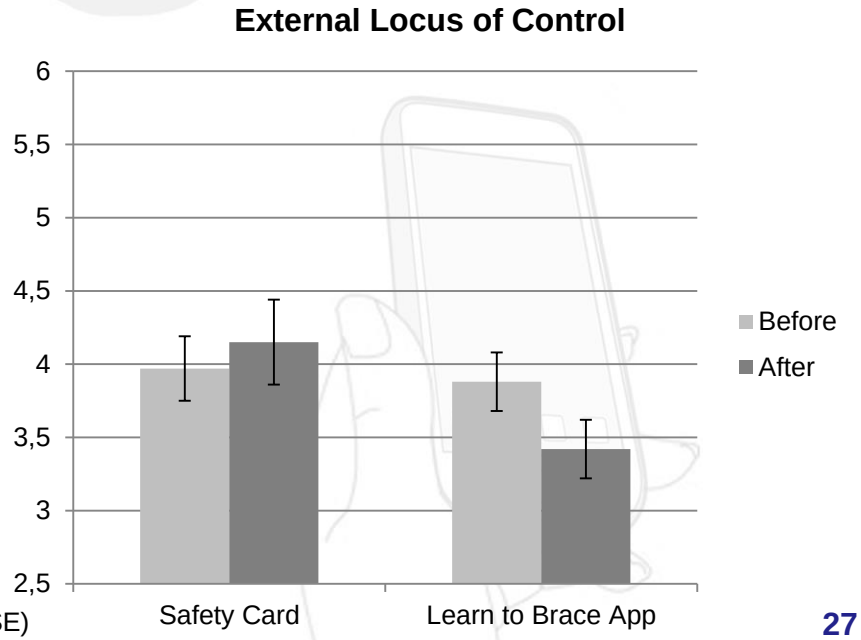
3rd Study

- **Participants:** 44 (23 M, 25 F), volunteers from various occupations
- **Age**: from 19 to 55 (M=29.88, SD=12.49)
- **Flights (last 2 years):** from 0 to 15 (M=3.27, SD=3.75)
- **Design:** Between-subjects
- **Procedure:** Half of the players played the game, while the other half examined the safety card. They were told to take the time they deemed appropriate to learn the position
- **Measures (before and after the task):**
  - locus of control questionnaire
  - knowledge (4 questions about the position of head, hands/arms, feet, seat belt)

Main Results

- **Locus of control**: interaction between time and condition for both internal ($p<0.01$) and external ($p<0.05$) locus of control in ANOVA analysis
  - locus of control improves (internal increases, external decreases) with the "Learn to Brace" app, while it does not improve at all with the safety card, i.e. **participants feel the outcomes of an emergency landing are more under their personal control after using the app, not the card**

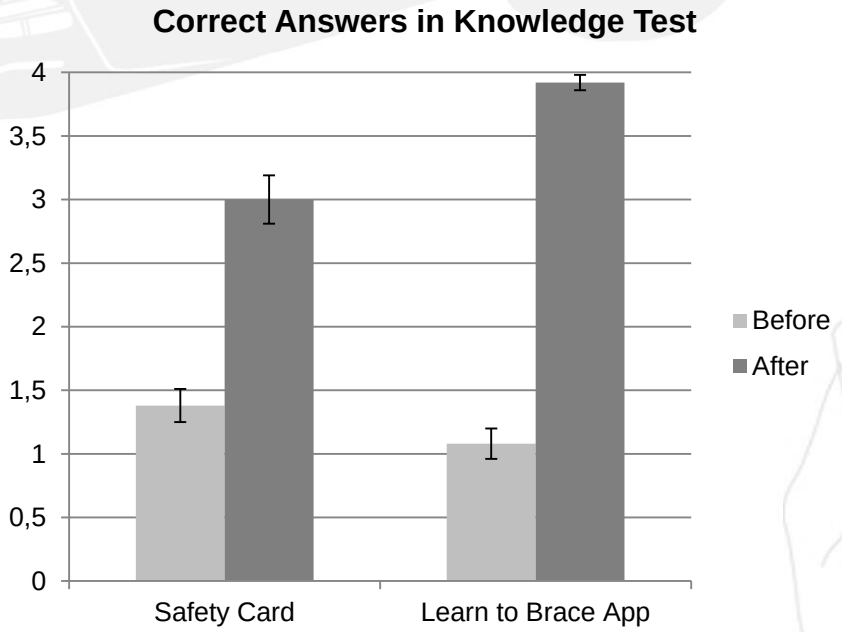




(Capped vertical bars: ±1 SE)

Main Results

- **Knowledge**:
  - significant increase in both conditions (Wilcoxon, $p<0.001$)
  - **improvement with "Learn to Brace" larger than safety card (and very close to the best possible result)**: difference between the two groups before the task not significant, difference after the task significant (Mann Withney, $p<0.001$)



On-going and future work

- New Platforms:
  - Building new versions of “Learn to Brace” for the major mobile platforms (iPhone, iPad, Android phones and tablets, Windows 8 mobile,…)
- New Applications:
  - Additional games illustrating single actions (e.g., donning oxygen mask, donning life jacket, opening emergency exits,…)
  - Integration with navigation aids (see our other presentation in this session)
  - Games that allow to experience aircraft emergencies from in-flight inception to reaching safety, with all the in-between events and possible right/wrong passengers’ actions
- New Studies:
  - Lab studies of the new serious games
  - Studying the deployed “Learn to brace” application “in the large” by collecting data from on-line users. For example, how do Facebook (or mobile device) users actually use the app? Does its effectiveness change with individual differences? What do users think about the app?