



HoloCPR: Designing and Evaluating a Mixed Reality Interface for Time-Critical Emergencies

Janet Johnson, Danilo Gasques, Madhuri Gubbala, Nadir Weibel

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Could additional affordances in mixed reality "better" guide novices in performing a procedure?

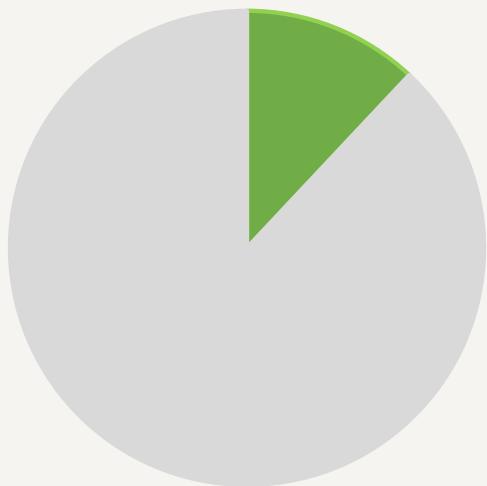
Especially in a stressful, time-constrained environment?



Cardiac arrest is a leading killer in the US.

350,000

Out-of-hospital cardiac arrests
per year in the U.S. [1]

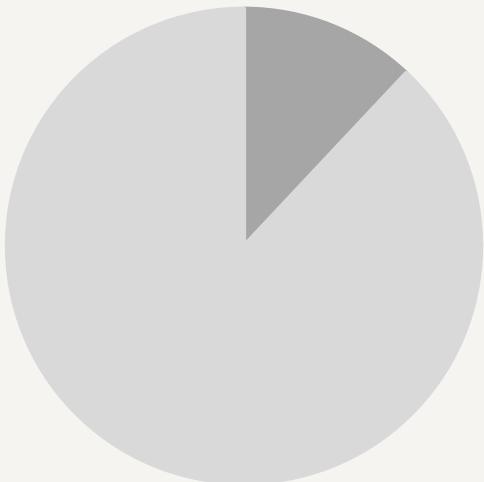


Only **12%** survive [1]

CPR Saves Lives

350,000

Out-of-hospital cardiac arrests
per year in the U.S.



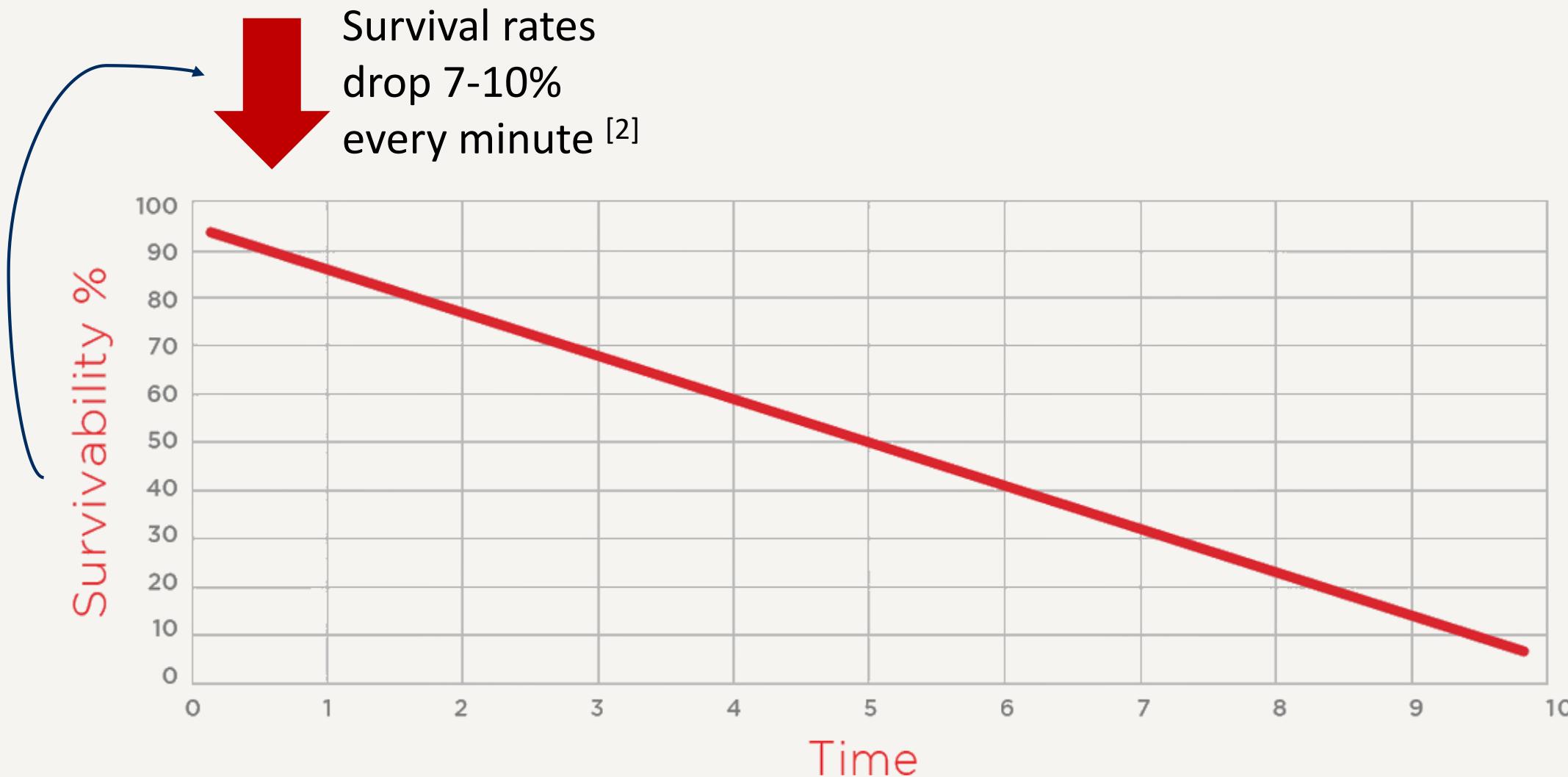
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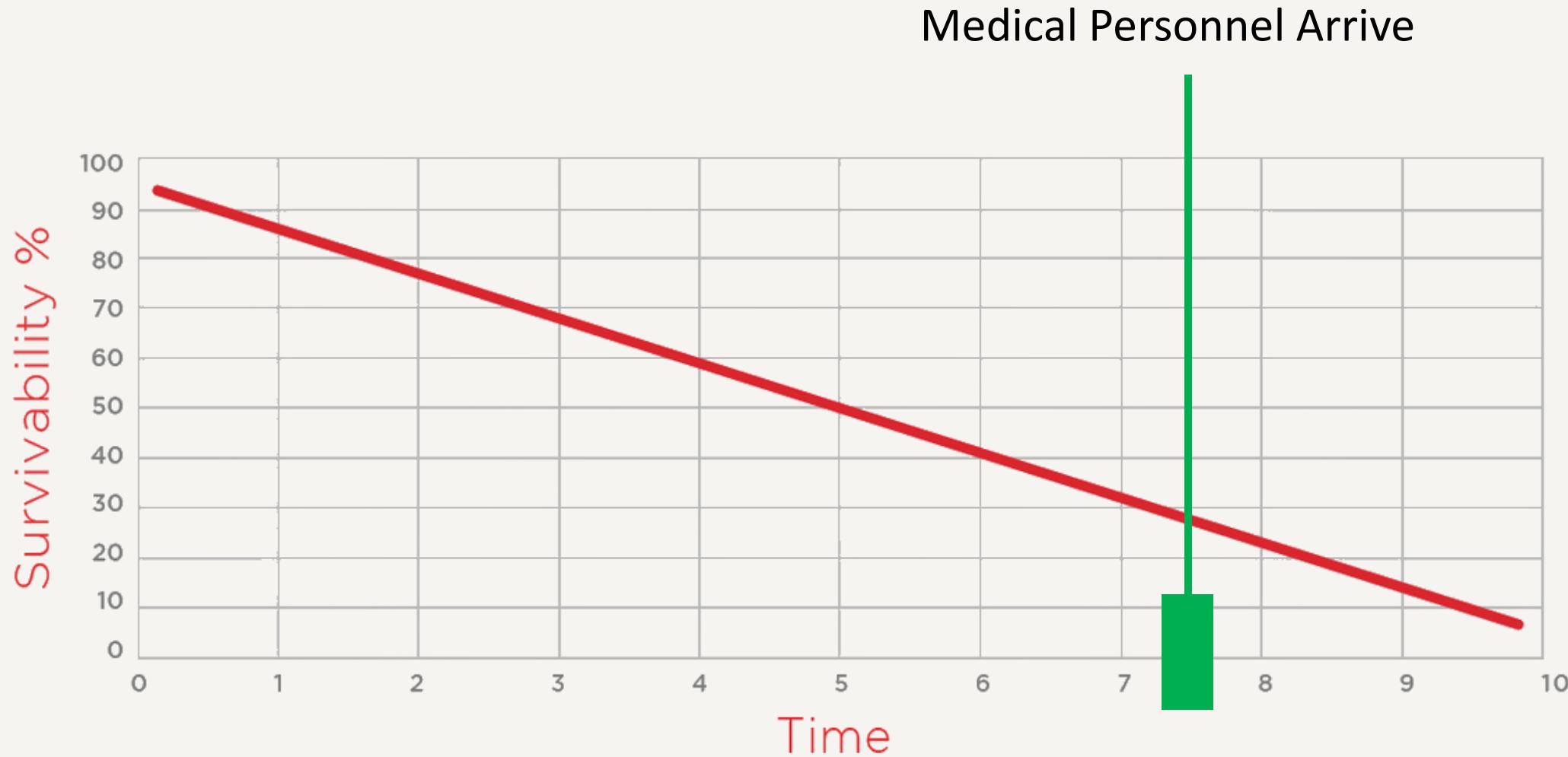
**Automated
External
Defibrillators**

Cardiopulmonary Resuscitation

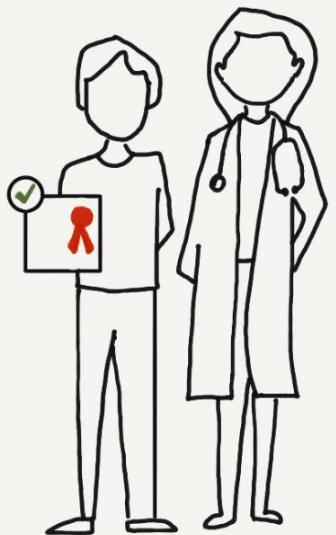
CPR Saves Lives ... If You Act Quickly



CPR Saves Lives ... If You Act Quickly



Emergency responders take time



Takes time



Bystanders can provide CPR earlier



Crucial for survival



Takes time



Bystanders can provide CPR earlier



Crucial for survival **but** administration rates are low (30-40%)) [3]

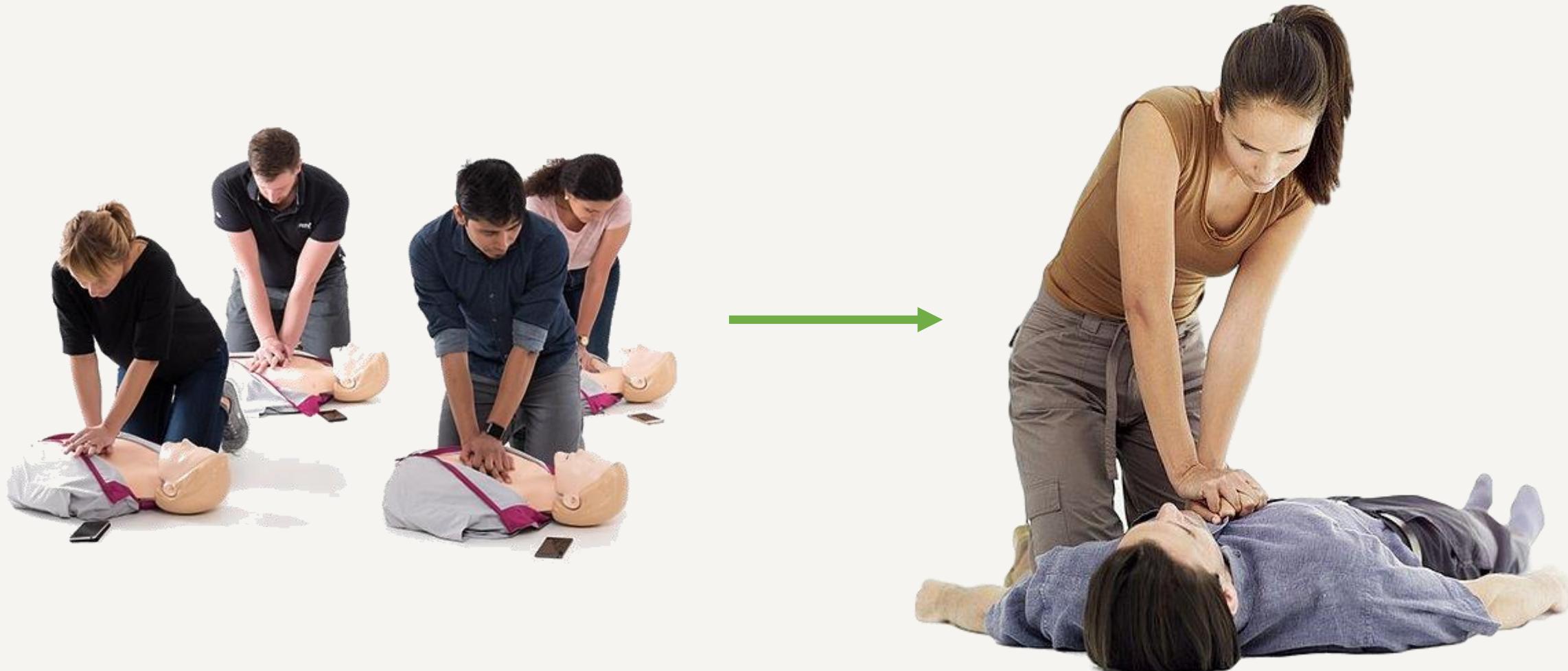


Takes time



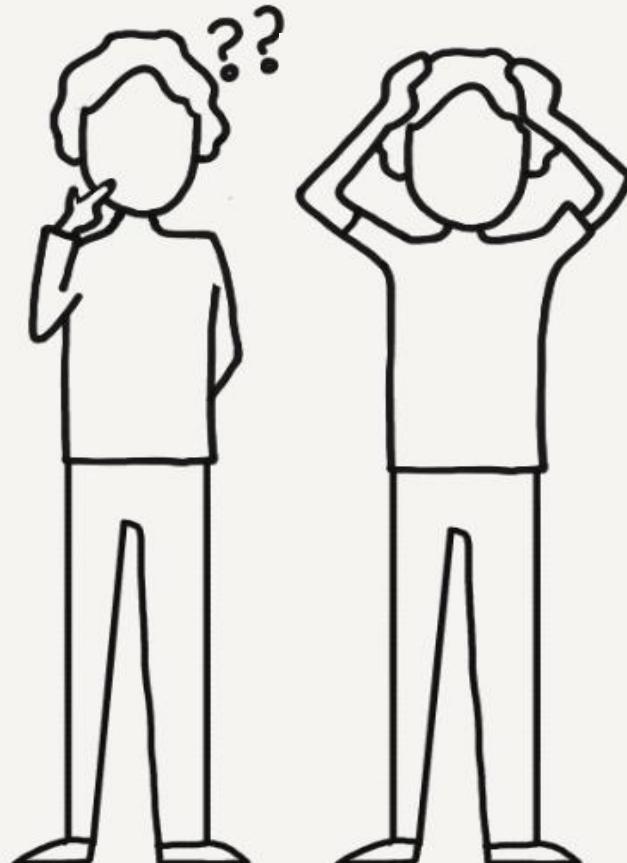
Bystander CPR

Expanding CPR training opportunities increases bystander-CPR rates [4]



Readiness to act

Previous CPR training can have no impact on likelihood performing CPR [5]



WHY [6]

1. Complexity of CPR instructions
2. Fear of hurting the victim
3. Panic or lack of confidence

Real-Time Resuscitation Aids

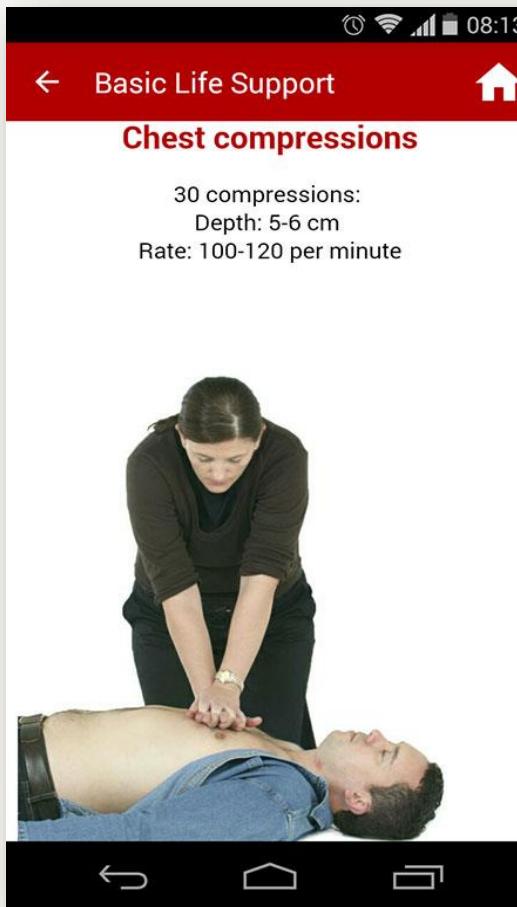
Real-Time Resuscitation Aids: Today

Step-by-step guides near first aid kits



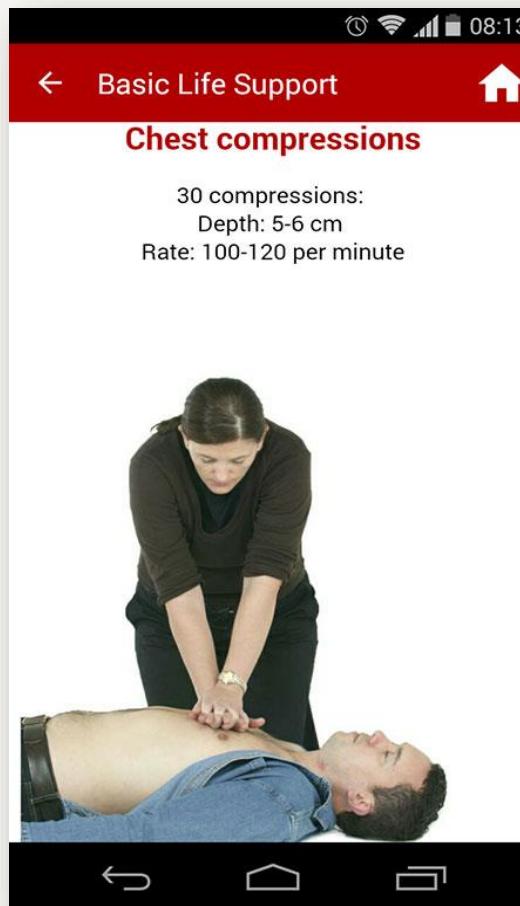
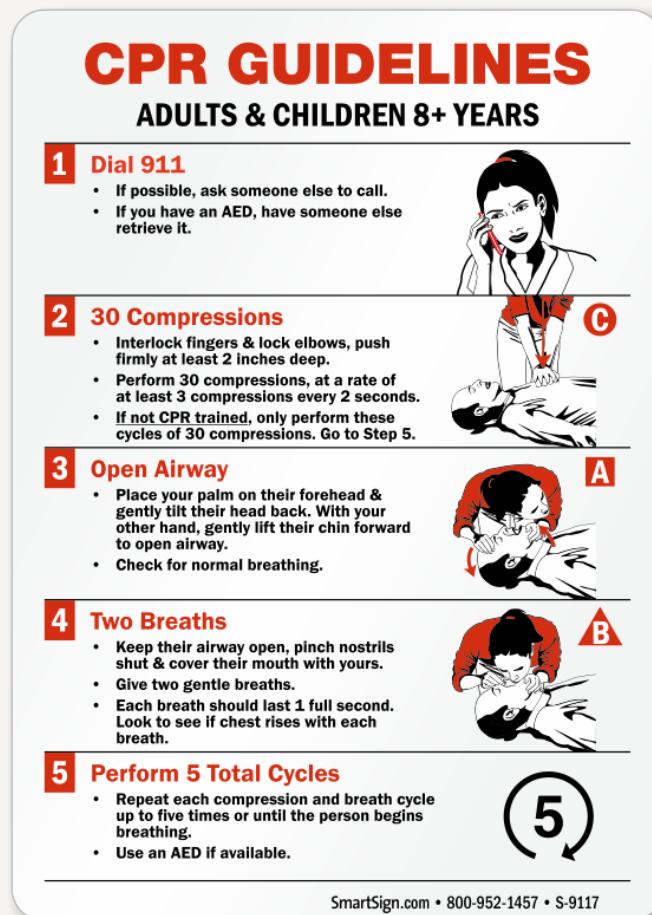
Real-Time Resuscitation Aids: Today

Step-by-step guides near first aid kits or on mobile devices



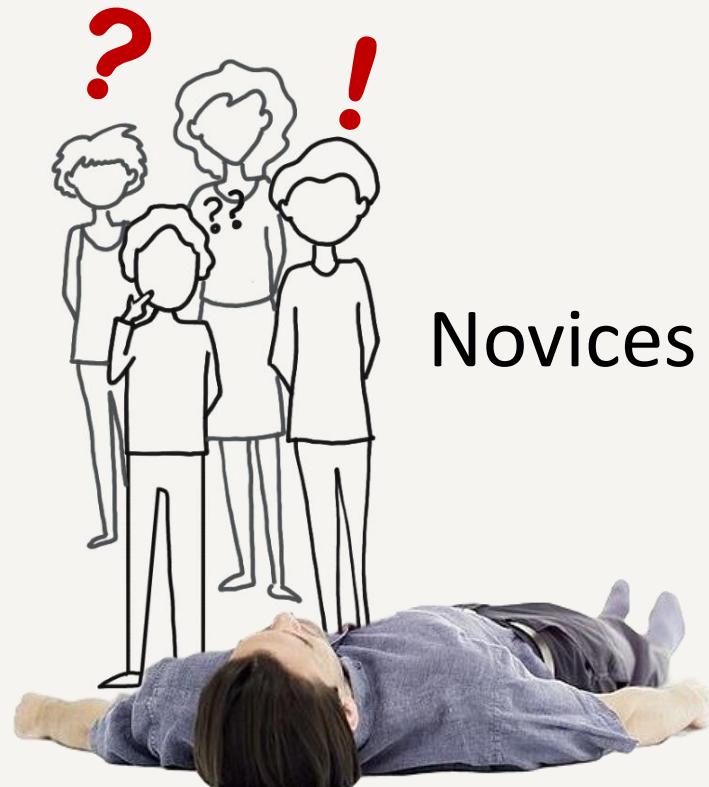
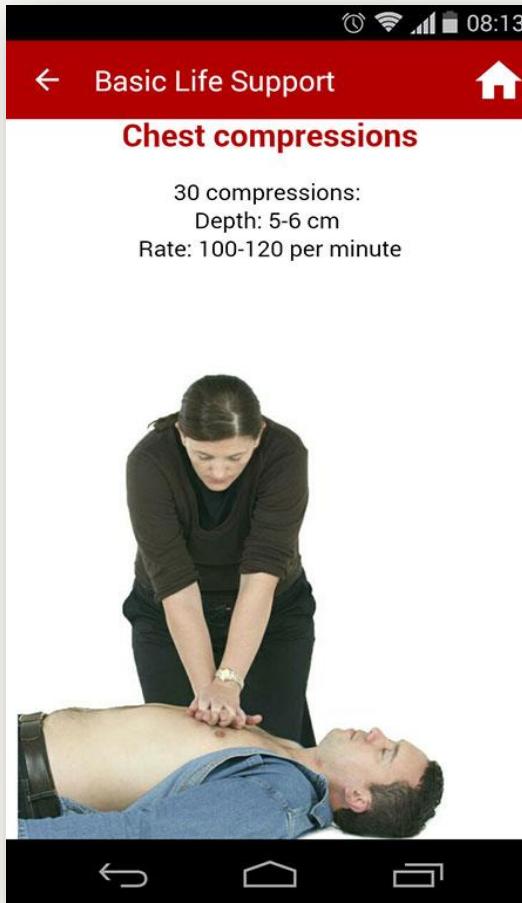
Real-Time Resuscitation Aids: Today

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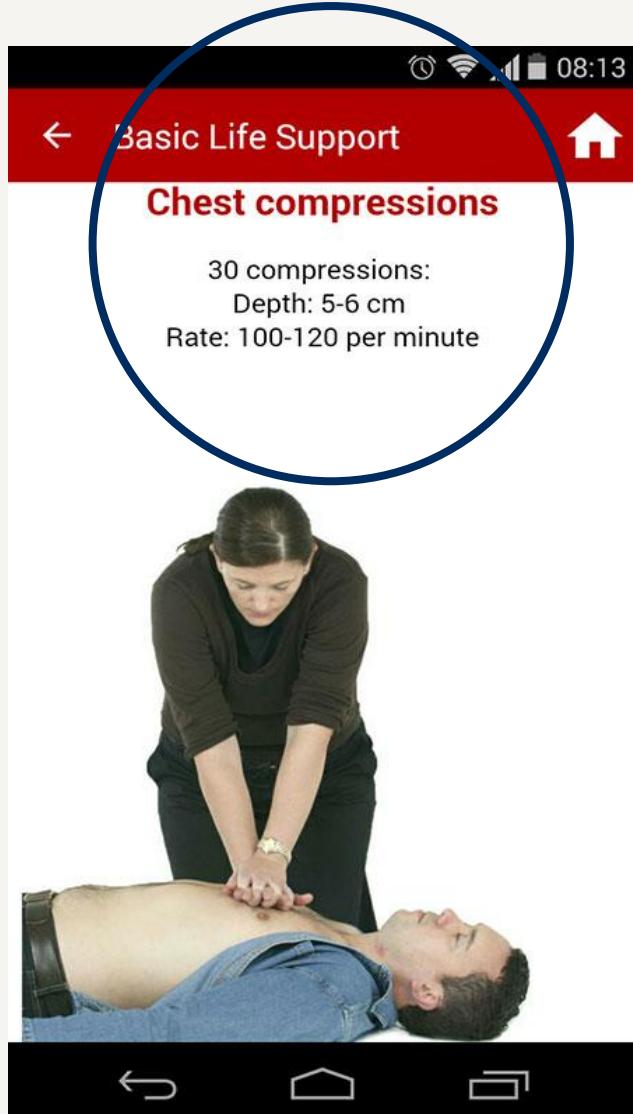
Real-time aids are not novice-friendly

Step-by-step guides near first aid kits or on mobile devices



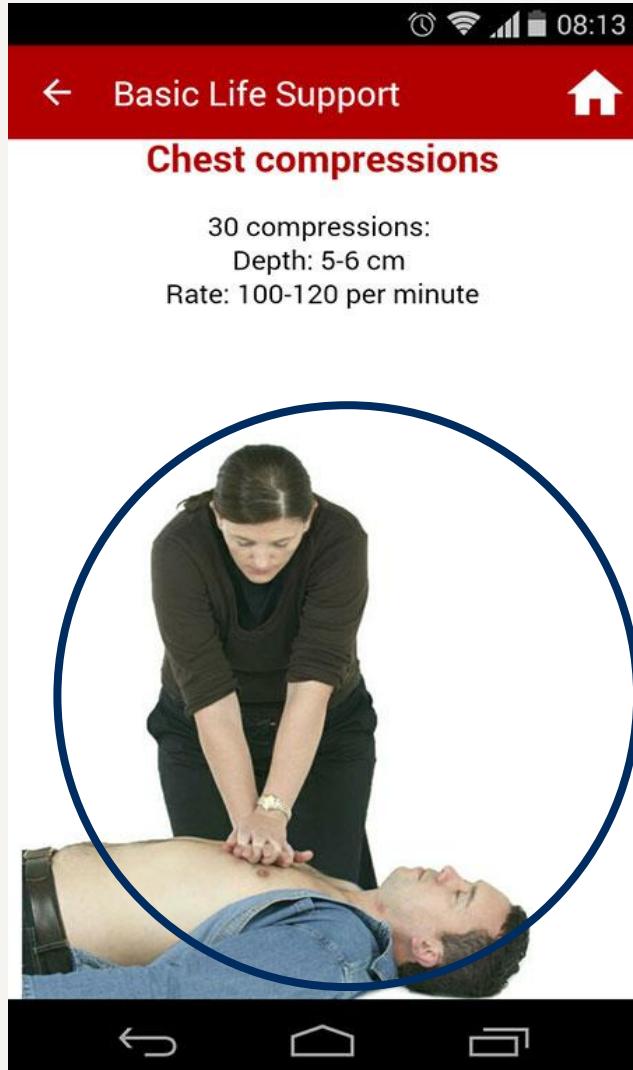
Novices

Real-time aids are not novice-friendly



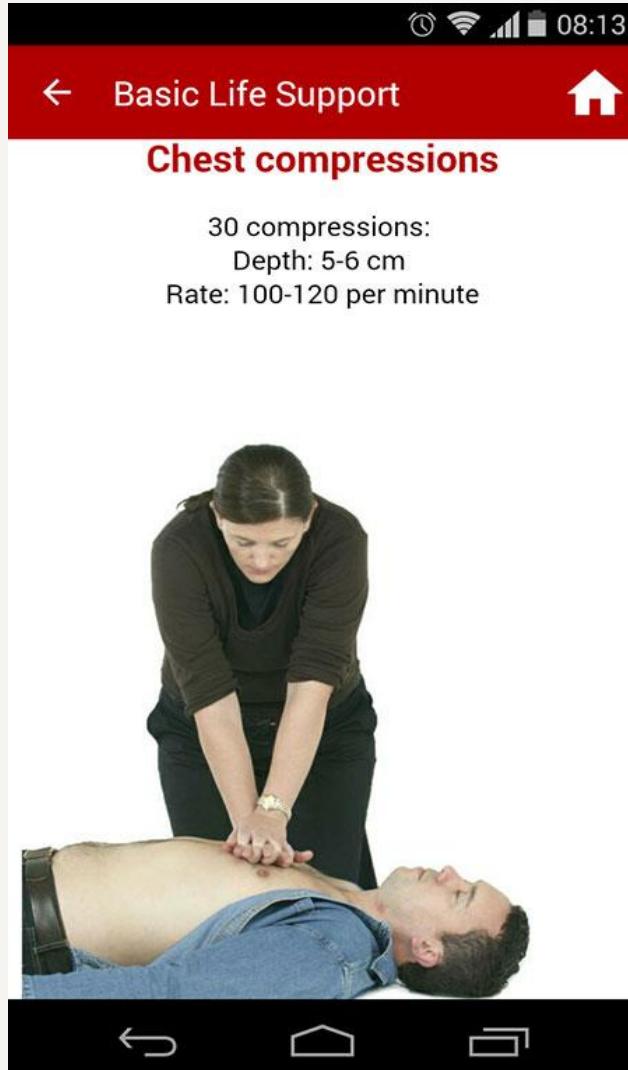
- Hard to read, interpret, and act upon

Real-time aids are not novice-friendly



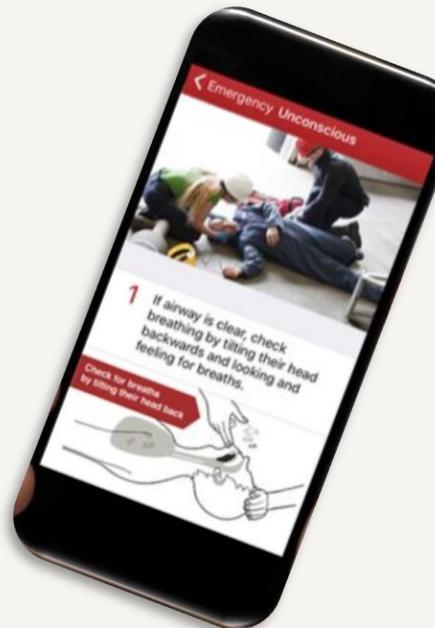
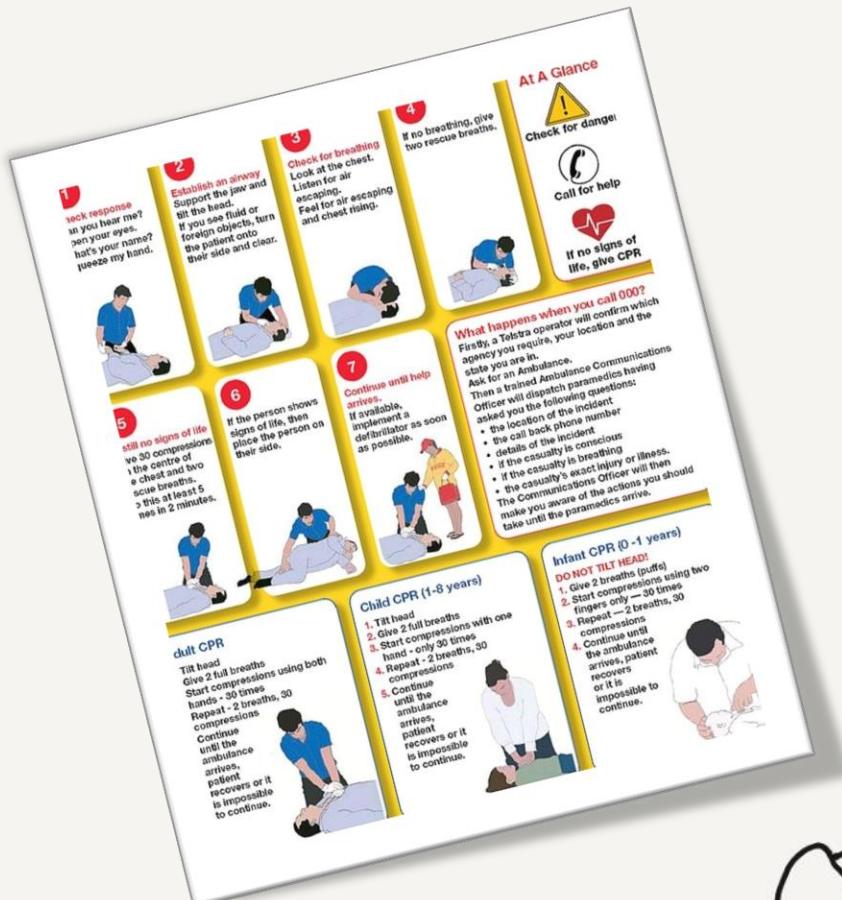
- Hard to read, interpret, and act upon
- Pictures don't fully convey technique

Real-time aids are not novice-friendly

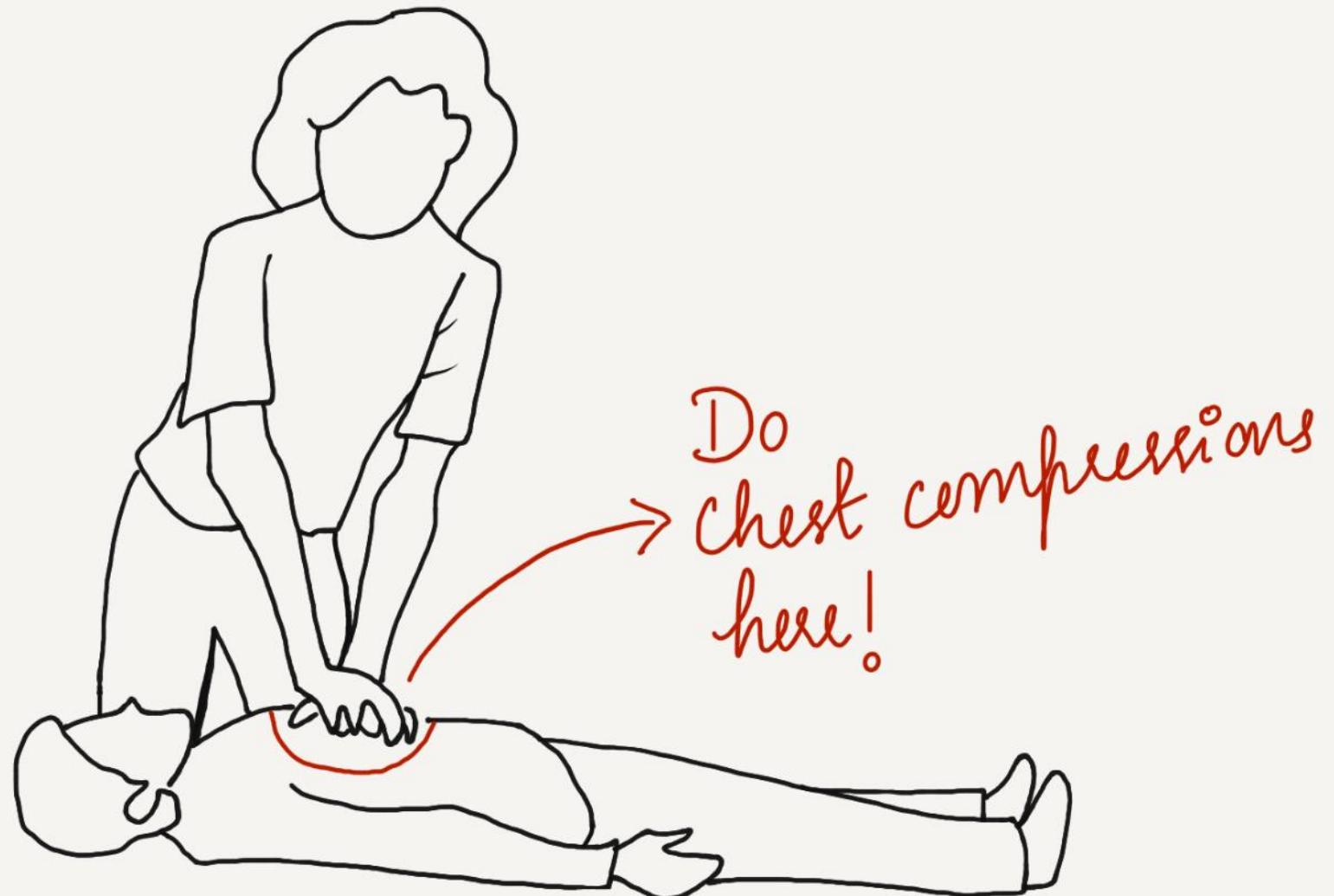


- Hard to read, interpret, and act upon
- Pictures don't fully convey technique
- Need to switch focus between victim and media

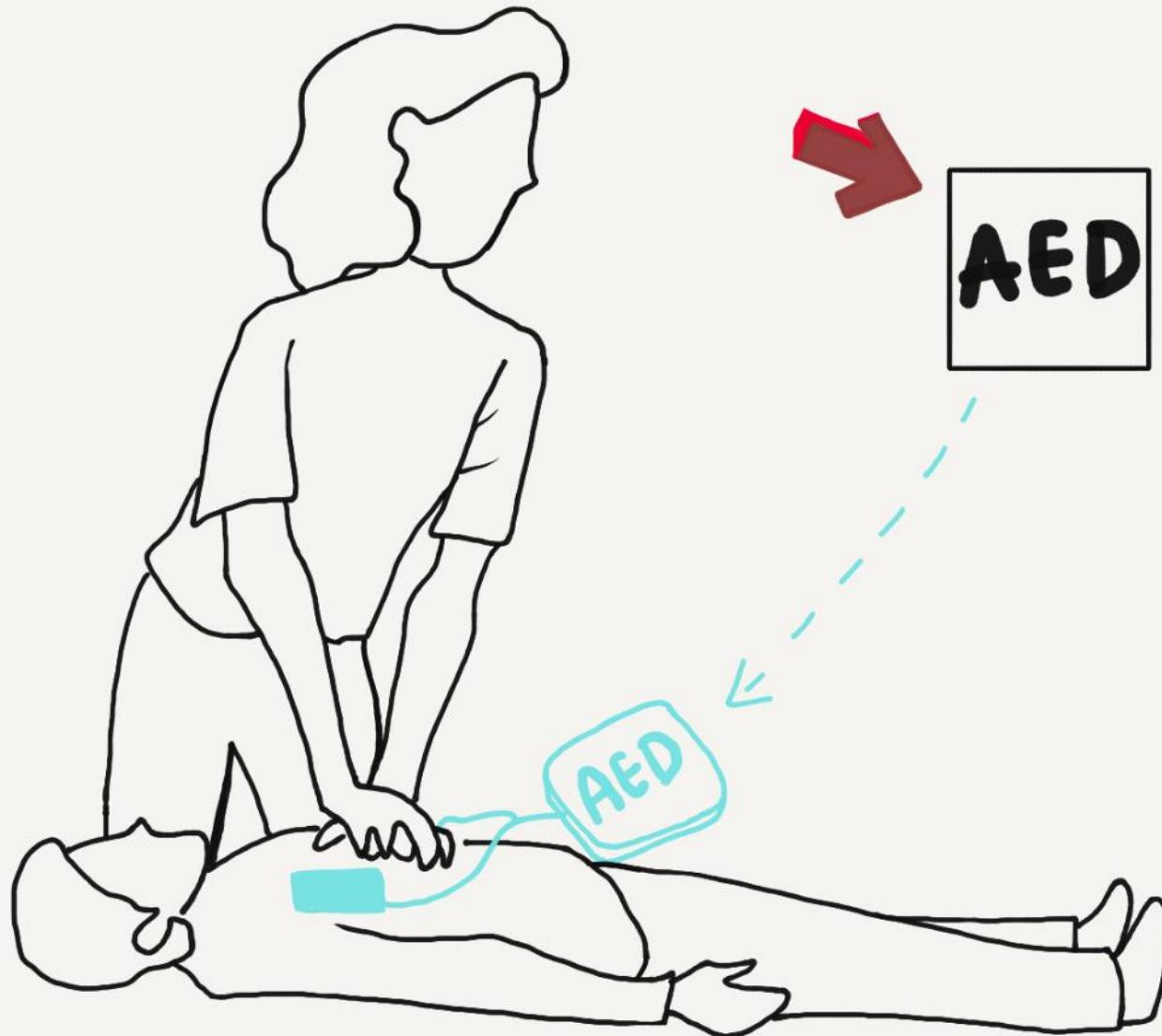
Is there a better way?



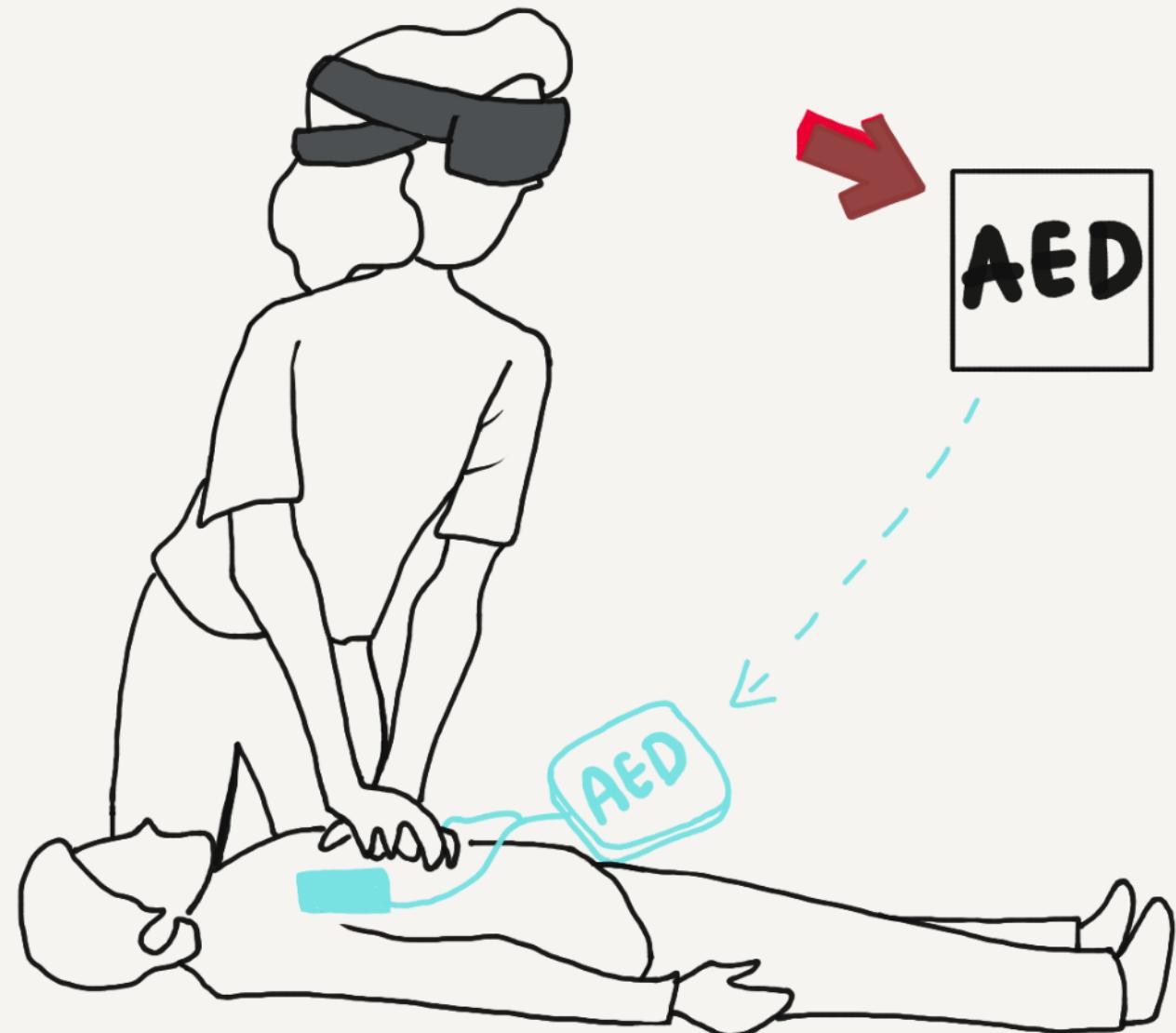
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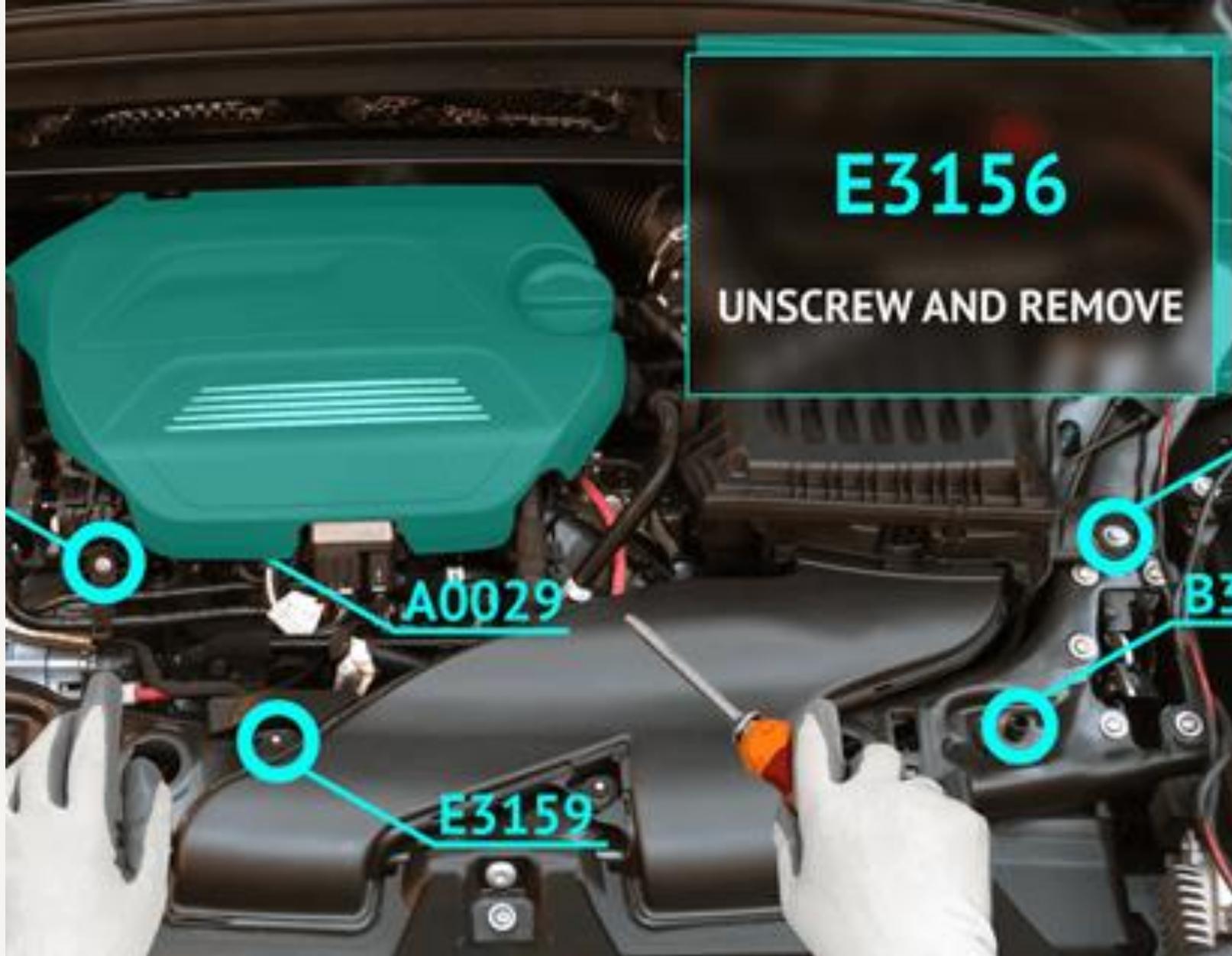
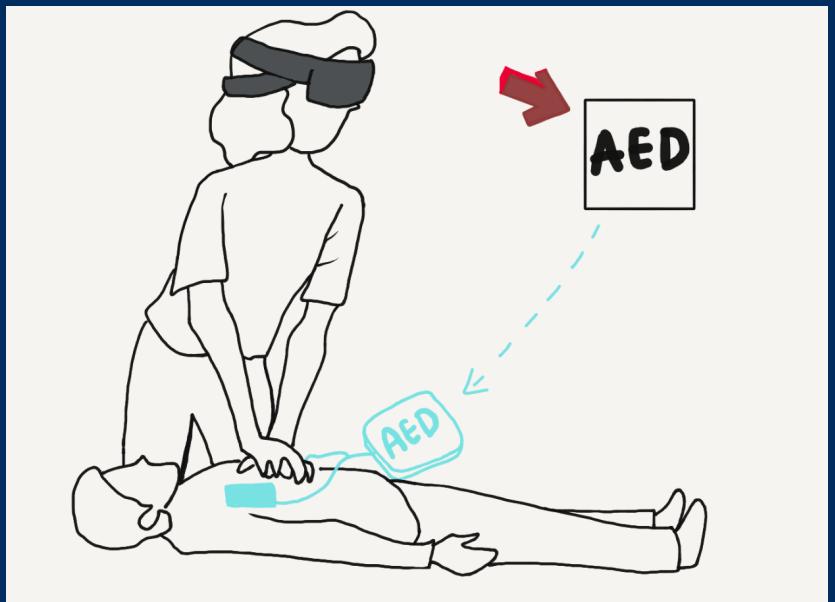
Is there a better way?



Can Mixed Reality help?



Can Mixed Reality help?



Mixed reality used for task guidance

What is Mixed Reality?

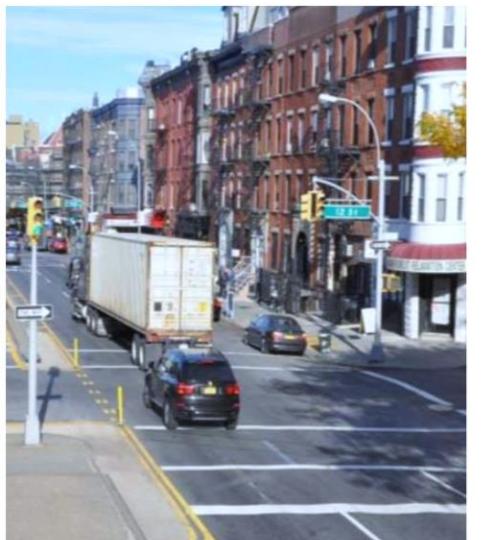
REAL
ENVIRONMENT



What is Mixed Reality?



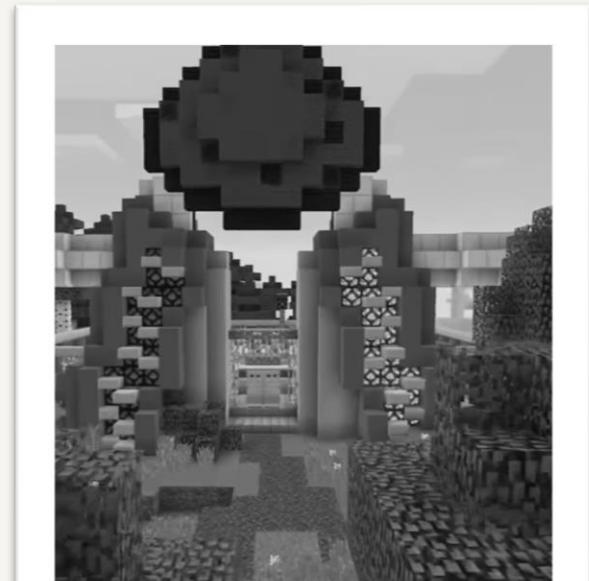
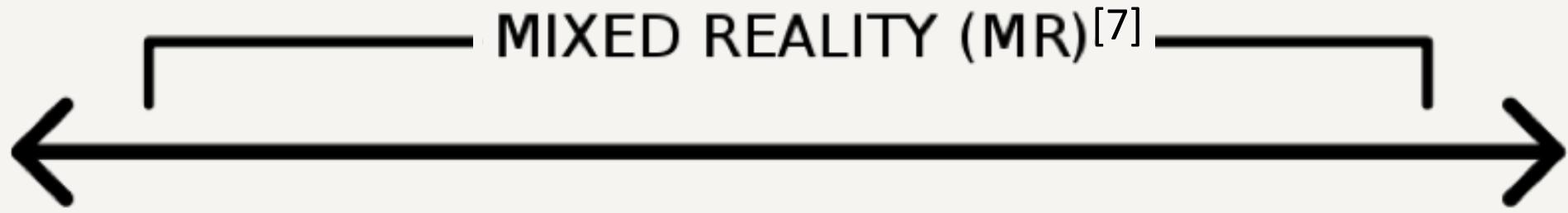
REAL
ENVIRONMENT



VIRTUAL
ENVIRONMENT



What is Mixed Reality?



MR let's you pin content



Spatially localized instructions for CPR

Give **30** chest compressions



Push hard in the middle of the chest.

What

How

Where

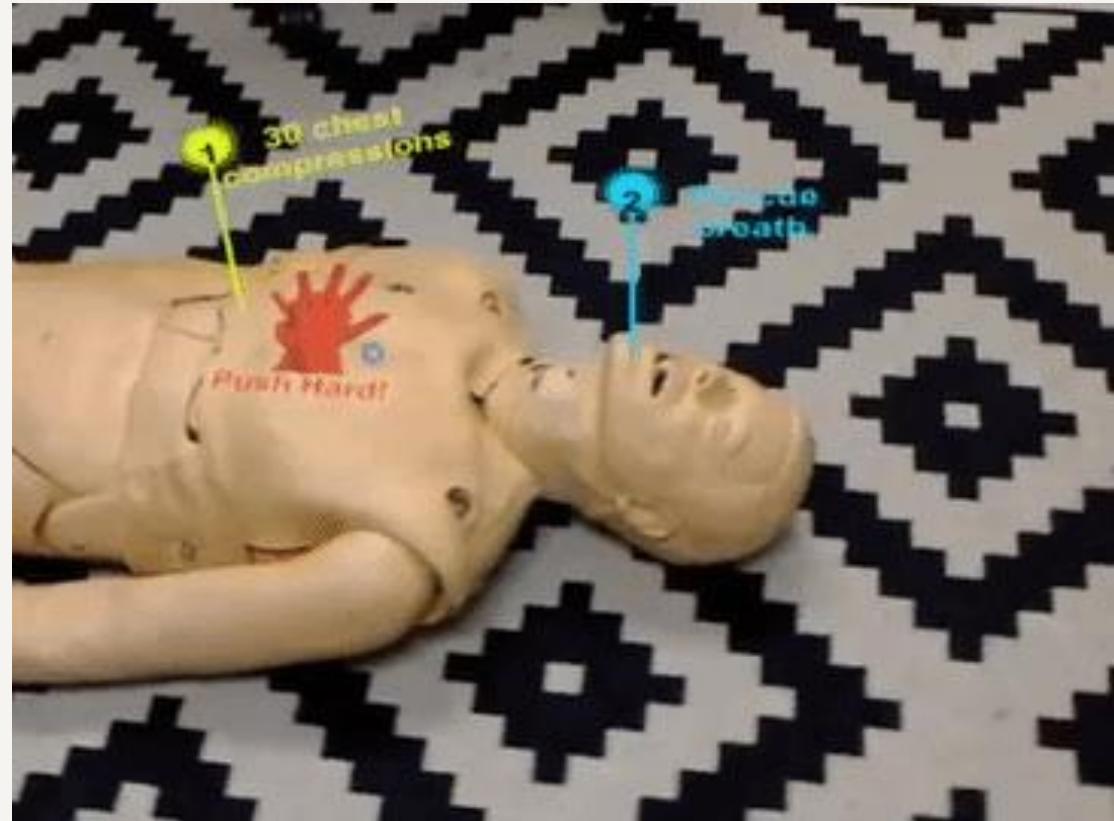
Spatially localized instructions for CPR

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What How Where

Push hard in the middle of the chest.



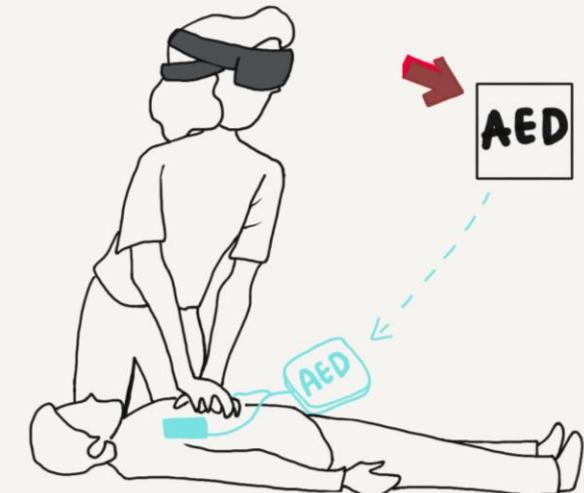
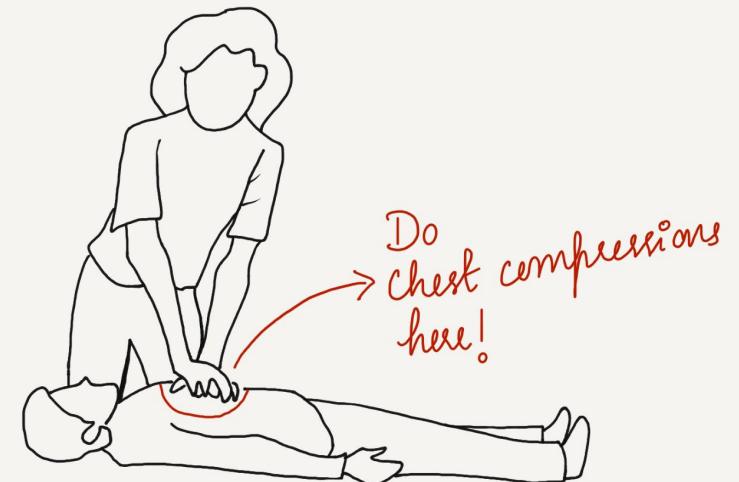
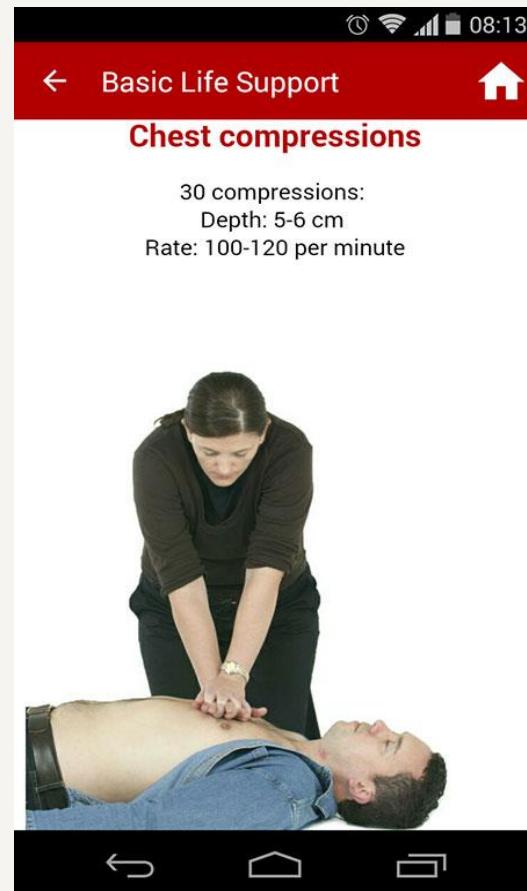
Understanding the use of MR systems

Are spatially localized instructions "better" than those on a two-dimensional screen?

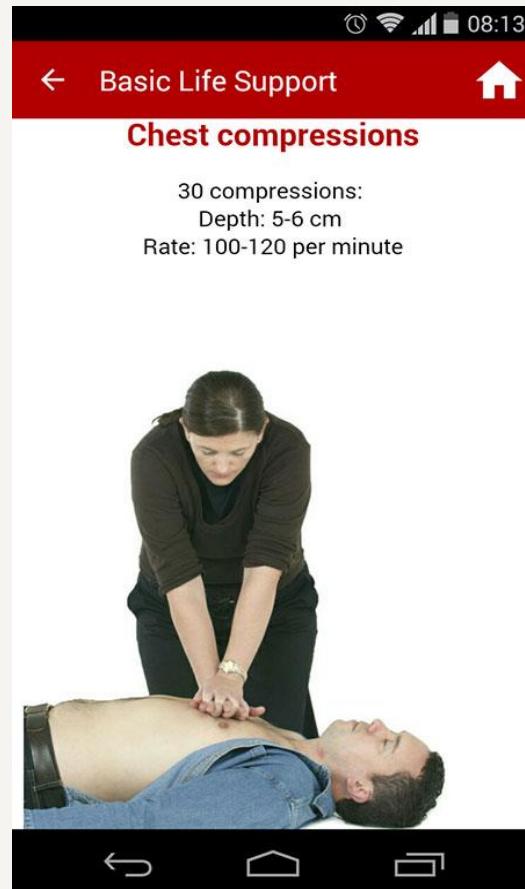
Should visual instructions be complemented with voice commands?

How much feedback should the system provide?

Are spatially localized instructions better than those on a two-dimensional screen?



Are spatially localized instructions better than those on a two-dimensional screen?



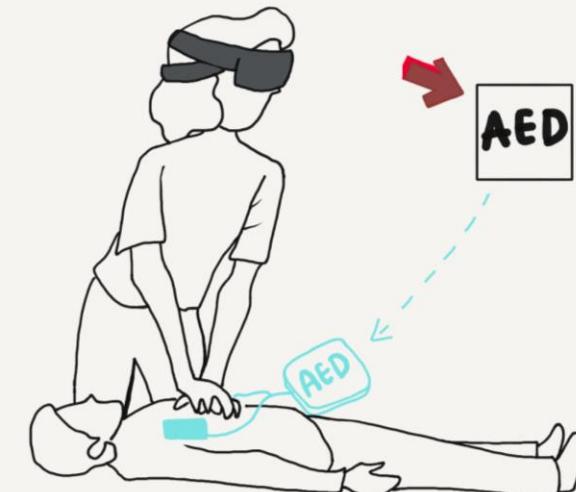
More helpful?

Can novices follow?

To resuscitation

To mixed reality

Does it save time?



We used the Microsoft HoloLens...



...and instructions from American Red Cross...

1 GIVE 30 CHEST
COMPRESSIONS



American [8]
Red Cross

2 GIVE 2 RESCUE BREATHS



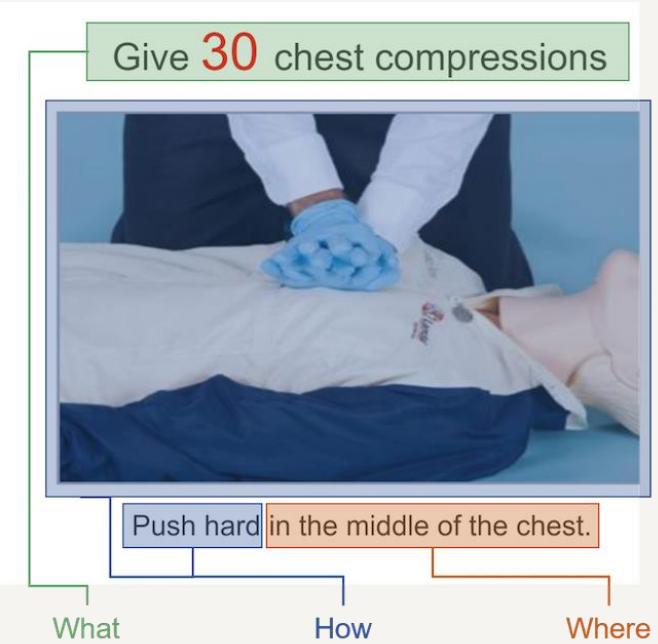
3 ATTACH PADS



To build a real-time resuscitation aid



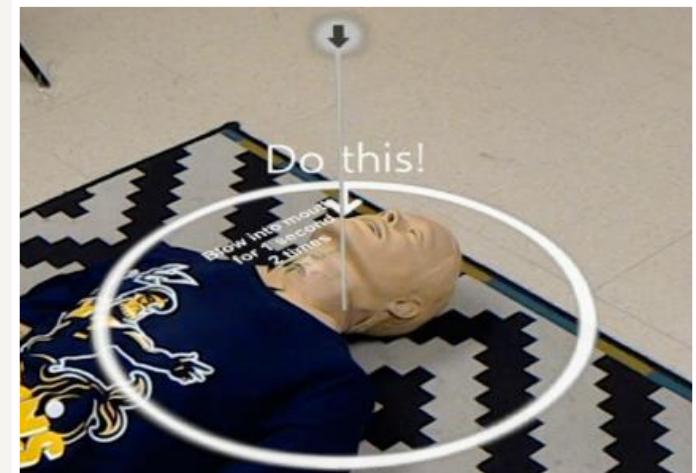
+



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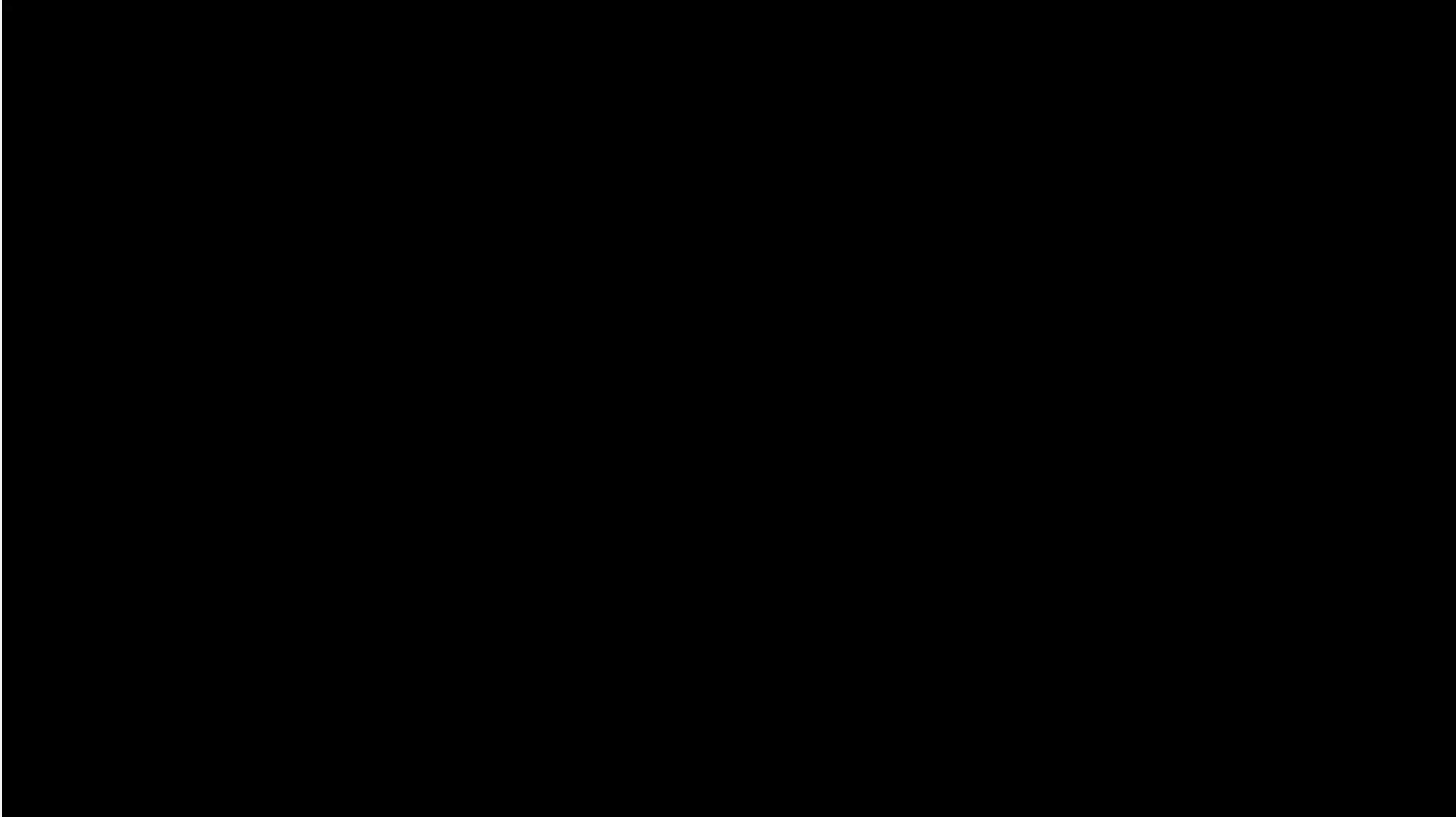
HoloCPR



How does HoloCPR work?



How does HoloCPR work?



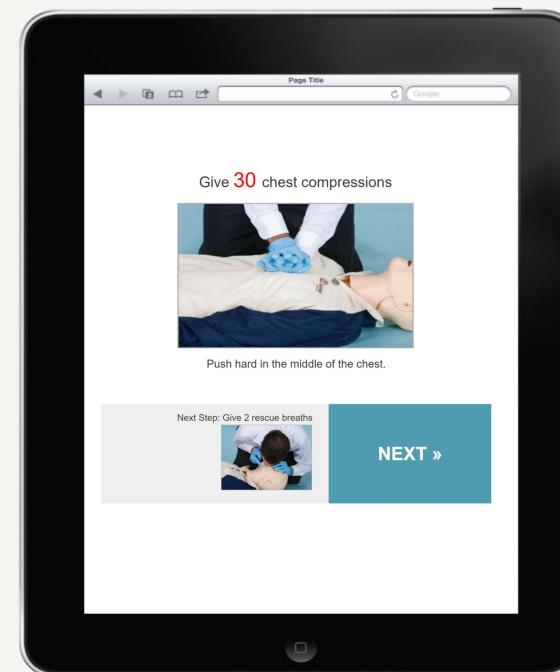
Evaluating HoloCPR

Are spatially localized instructions better than those on a 2D screen?

More helpful? Can novices follow? Does it change anything?



VS



The tablet interface

Give **30** chest compressions



Push hard in the middle of the chest.

Next Step: Give 2 rescue breaths



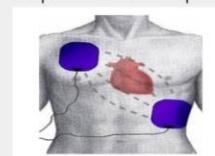
NEXT »

Locate and bring the AED [8]



The AED is be kept on the table next to the whiteboard.

Next Step: Attach AED pads



NEXT »

Study Design

Between-subjects experiment

Blind to medium

Participants didn't know they had to perform CPR

HoloCPR: 21		Tablet: 21	
Had CPR experience	Had no CPR experience	Had CPR experience	Had no CPR experience
Male	Female	Male	Female
5	16	5	16
15	6	15	6

Study Design

Between-subjects experiment / Blind to medium

HoloCPR: 21

Tablet: 21

Enter Room

Fill pre-experiment survey

Researcher role-play + Give device

Researcher leaves room

Alarm starts at random time

Resuscitation

Post-experiment survey



Study Design

Between-subjects experiment / Blind to medium

HoloCPR: 21

Tablet: 21

Enter Room

Fill pre-experiment survey

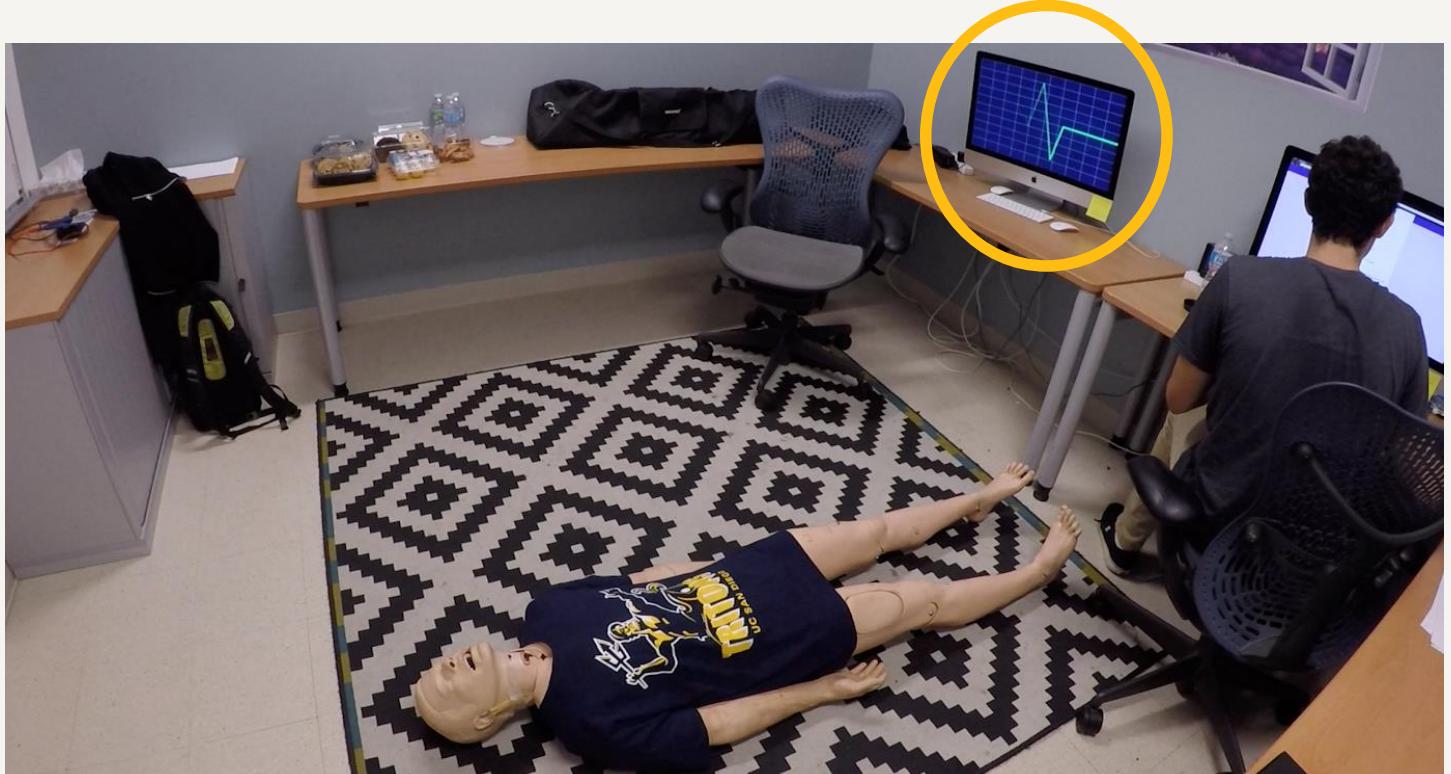
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Study Design

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HoloCPR: 21

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Researcher role-play + Give device

Researcher leaves room

Alarm starts at random time

Resuscitation

Post-experiment survey



What did we measure?

Response Time

- Guidance Initiation
- Initial Response

Transition Time

Task Time

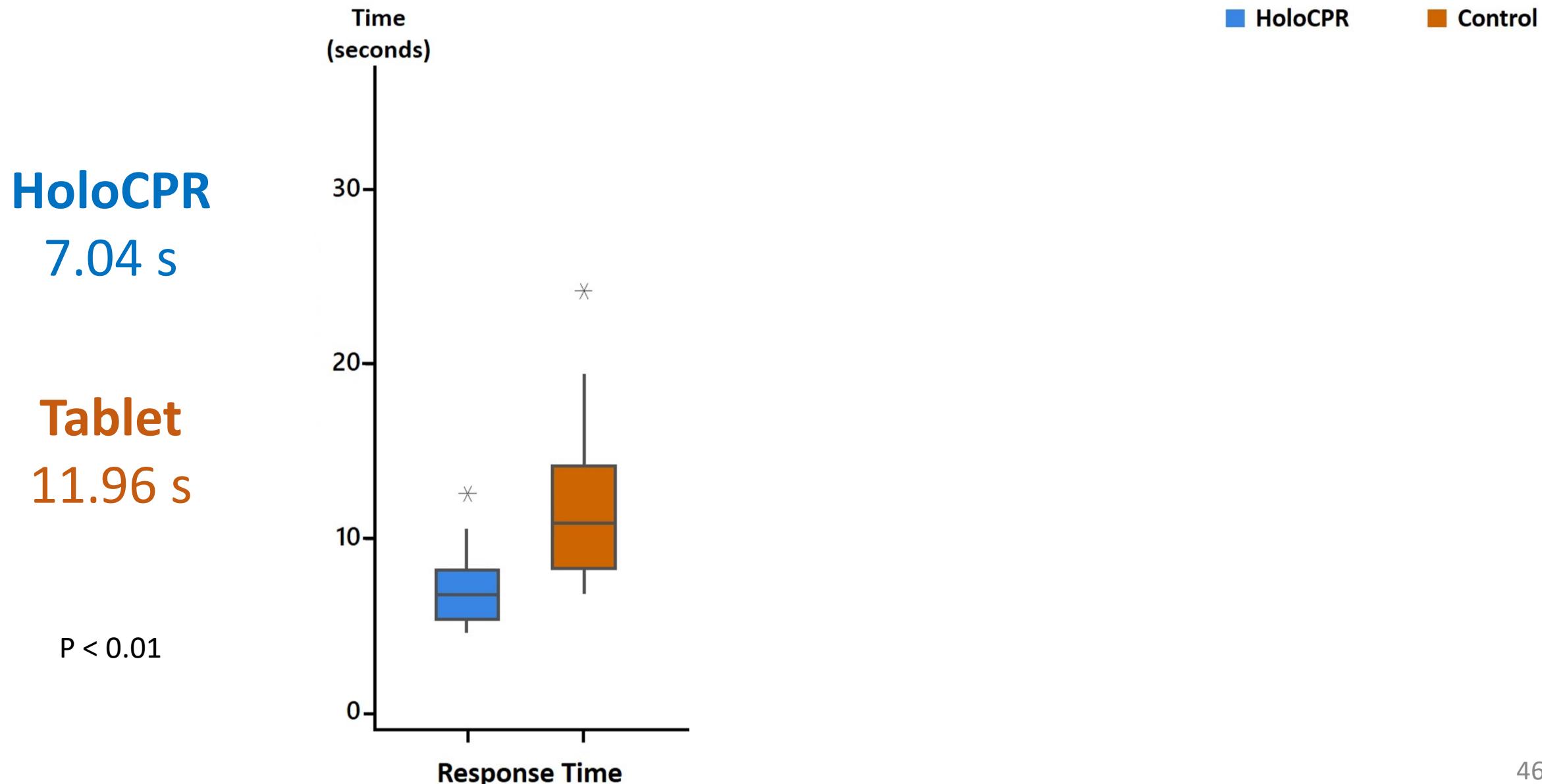
- Searching for AED
- Placing AED pads

Procedural Adherence

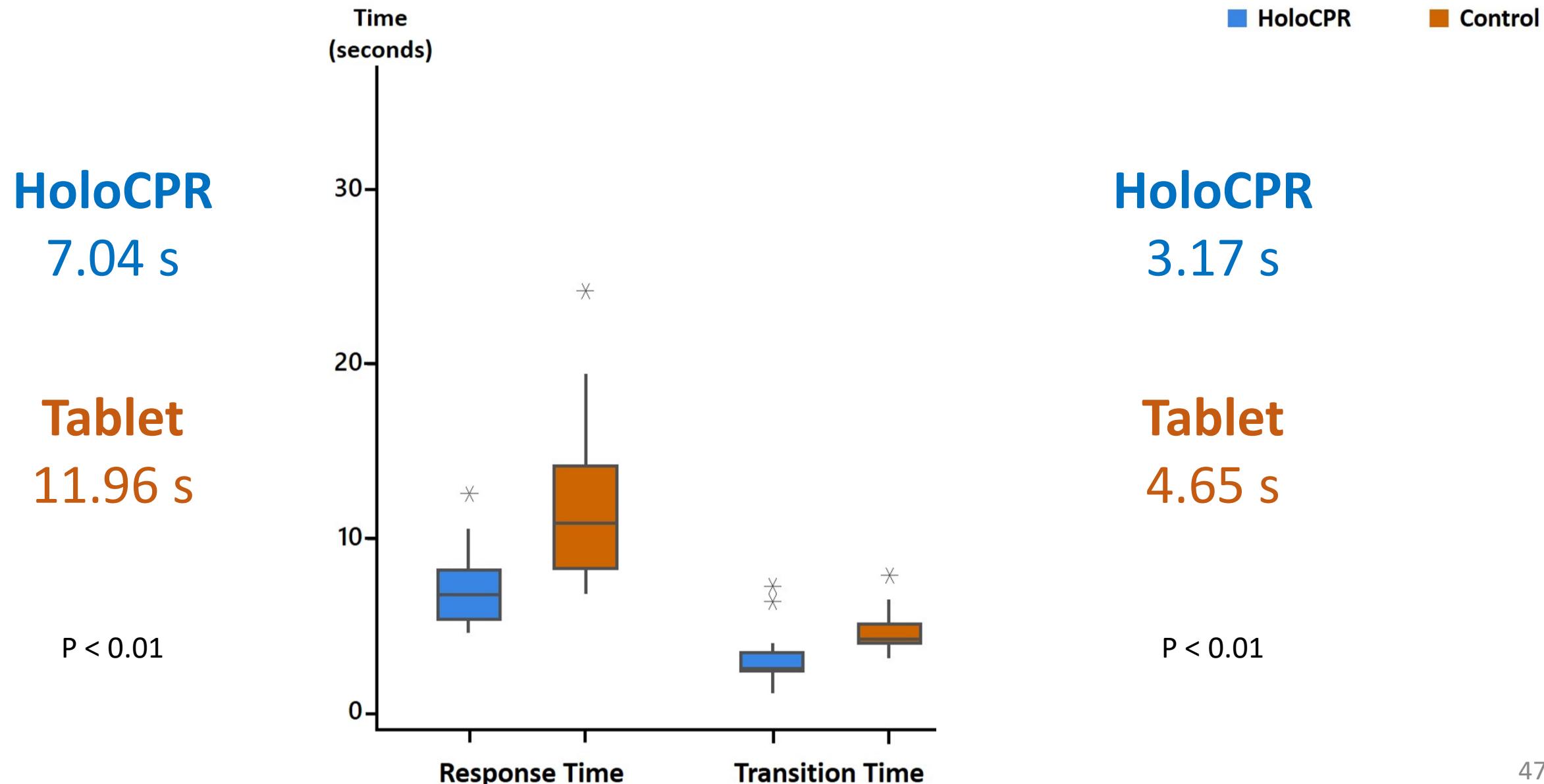
- Technique
 - Chest compression
(hand position)
 - AED pad placement
- Deviation from steps
(Additional / missing)

Subjective Feedback

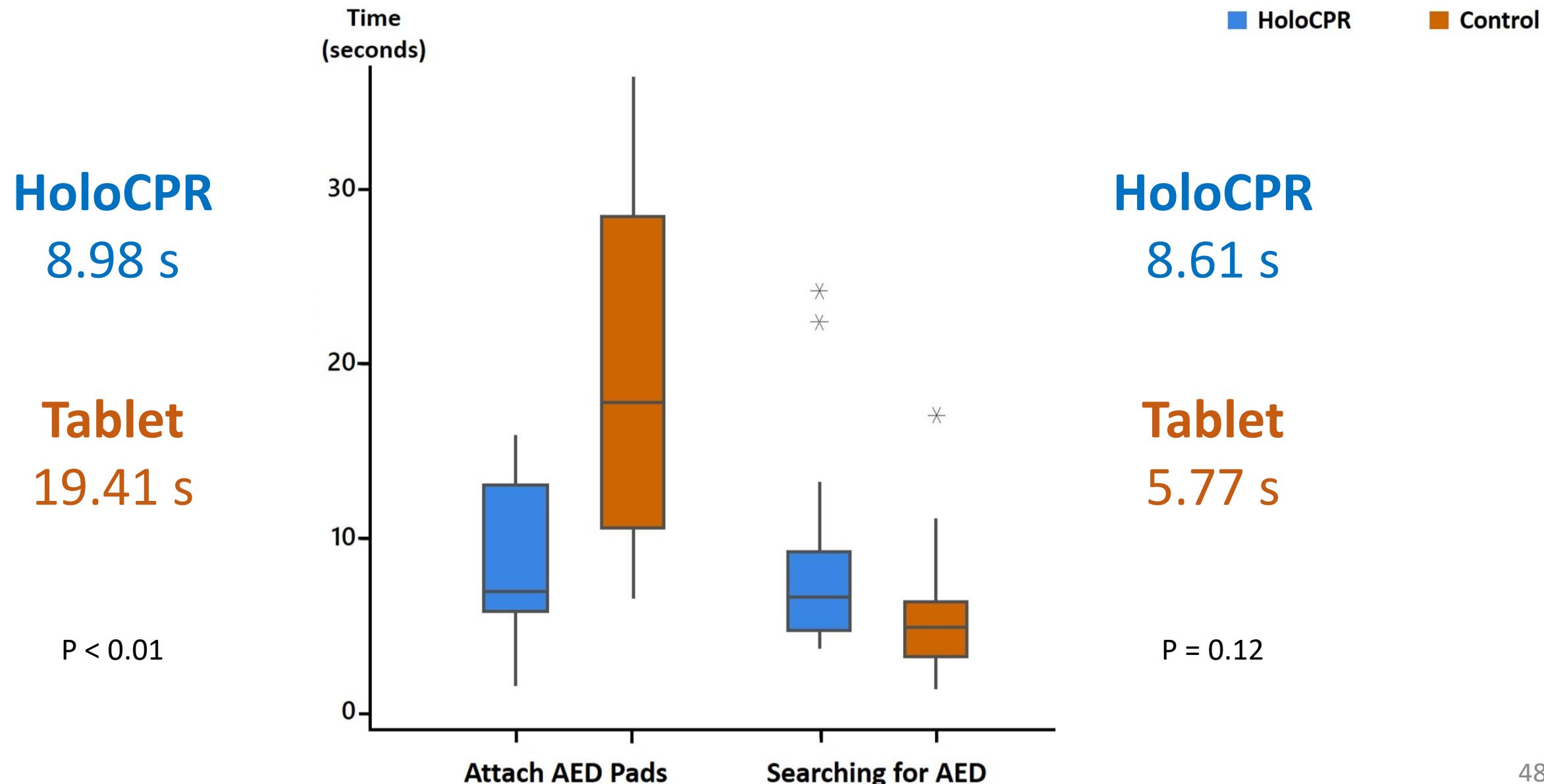
HoloCPR users respond faster



HoloCPR users respond and transition faster



HoloCPR users attach AED pads faster but take longer to find them



HoloCPR helps with adherence

Starting Hand Position

HoloCPR

41%

Tablet

12.5%



HoloCPR helps with adherence

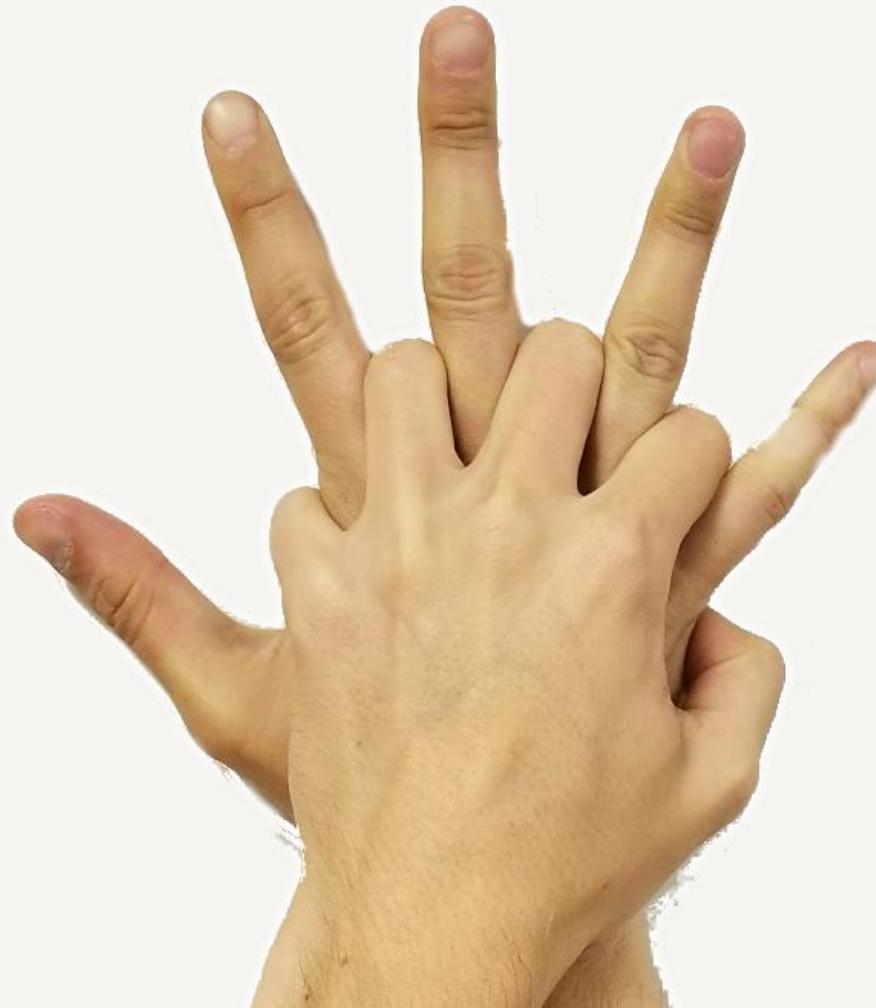
Starting Hand Position

HoloCPR

41%

Tablet

12.5%



Corrected Hand Position

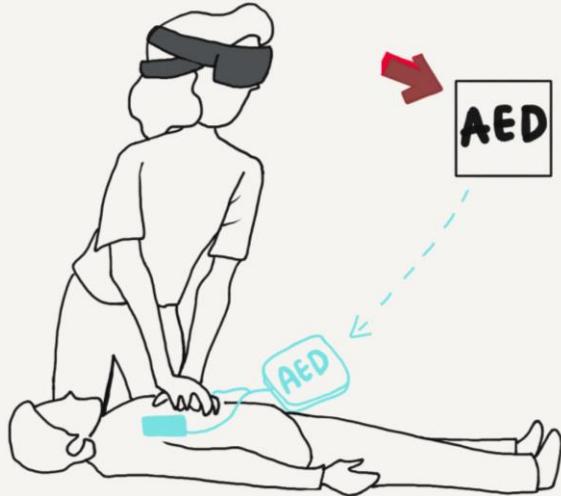
HoloCPR

30%

Tablet

0%

Do spatially localized instructions help?

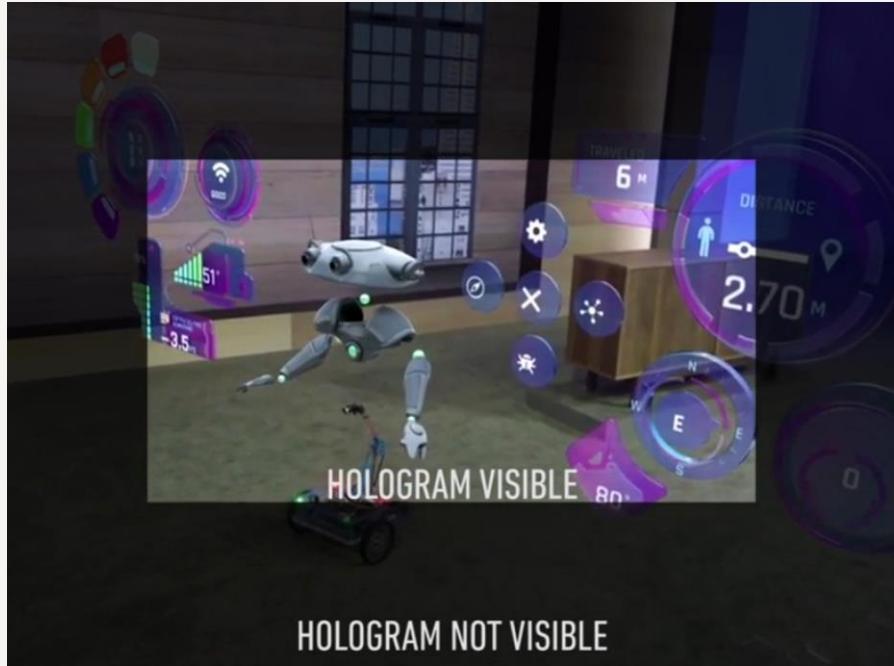


Does it change anything?

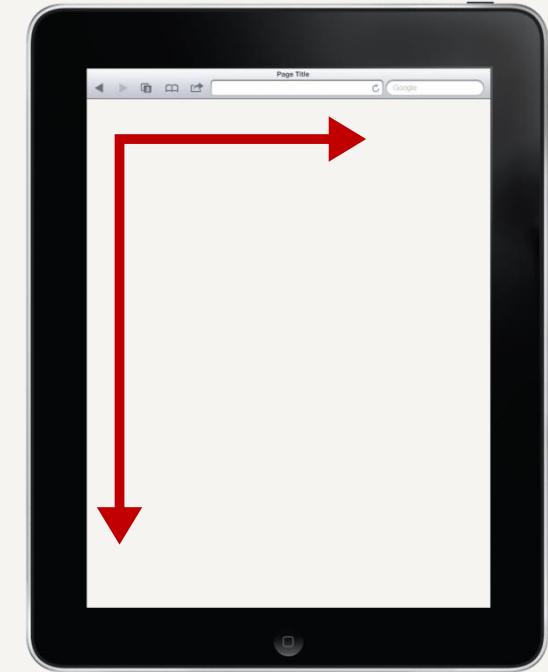
- Users respond and transition faster.
- Users follow steps and technique more closely.

Challenges with MR interfaces ?

Challenges with mixed reality

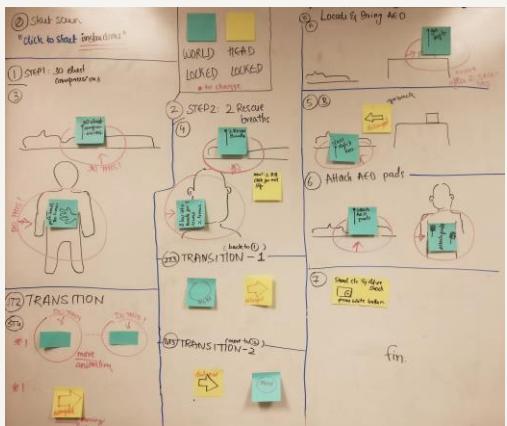
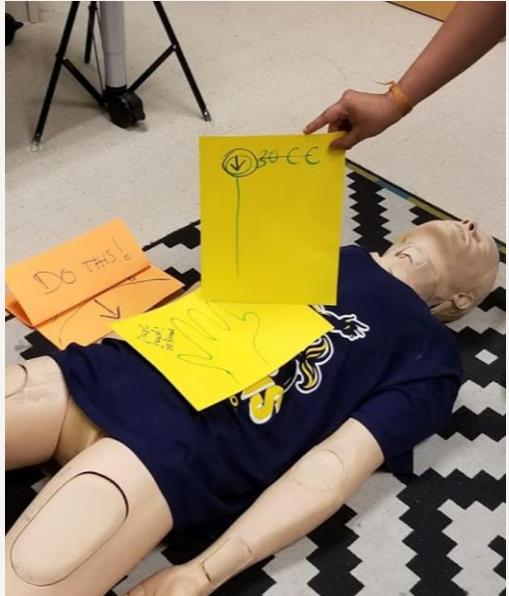


Limited field of view
+ disappearing holograms

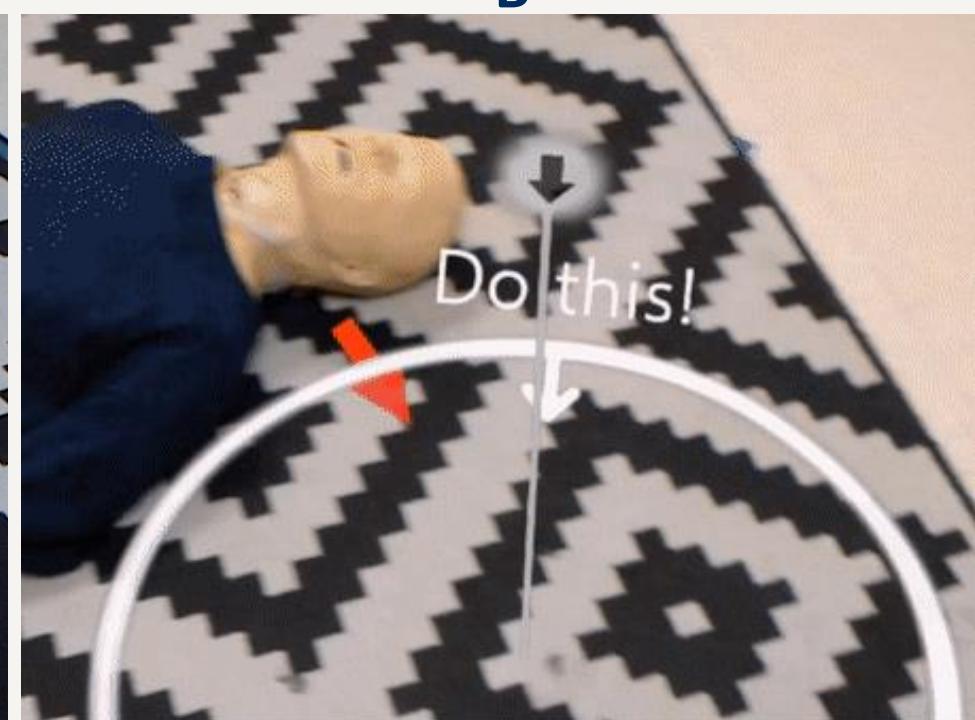
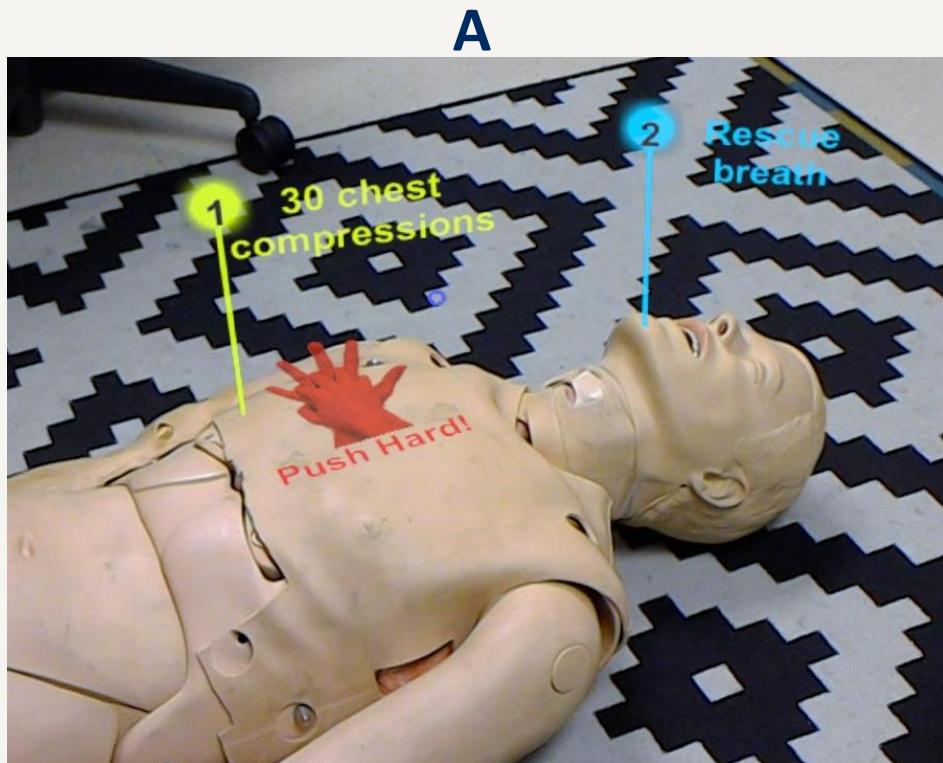


Lack of familiar design patterns

It took multiple iterations

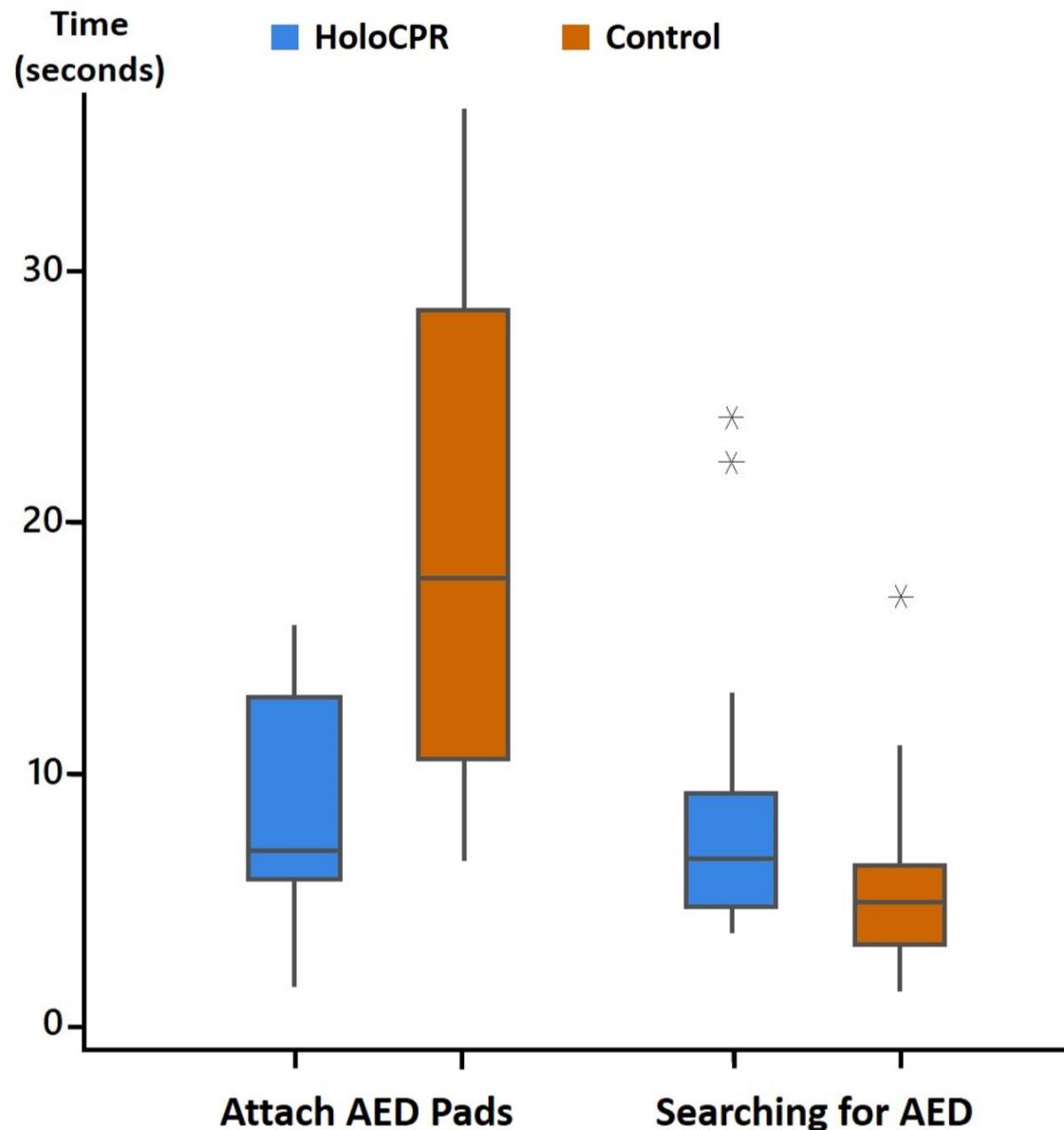


Iterative design: 16 participants



Circle of Attention, movement, arrows

Attention Bias



Interface did not indicate what the users had to look for

Attention Bias^[9]
Focus on highlighted areas at the cost of other areas

Attention Bias

A



VS



B

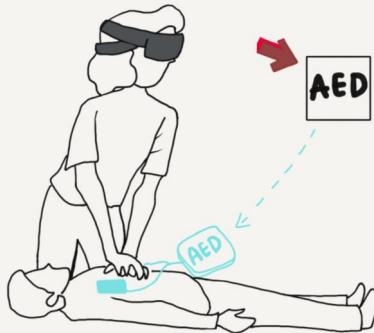
What's next ?



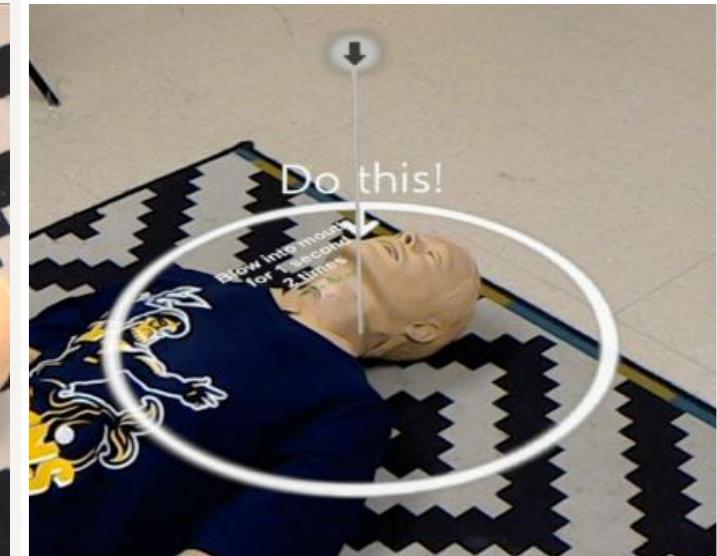
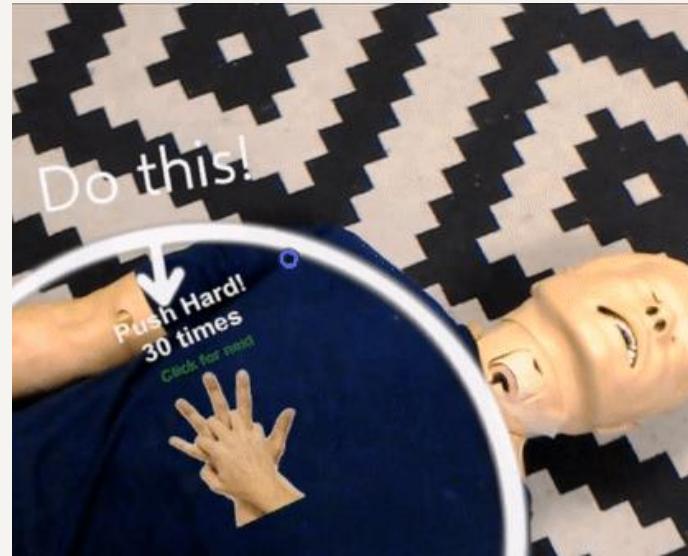
- Understand the effects of visual cues and design around attention bias
- Automatically track user actions
 - E.g. count chest compressions, feedback on technique
- Explore the use of sound

Summary and Questions

Could spatially localized instructions better guide bystanders in providing resuscitation?



Between-subjects experiment
HoloCPR: 21 Tablet: 21



Faster response times
Better technique, and adherence

Next Steps:

User action recognition and tracking
Design around attention bias

Meet us at our demo at 4 pm!

jgj007@ucsd.edu

ubicomp@ucsd.edu



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