Interaction Challenges

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Outline

Fragmented attention

- Interaction bursts
- Attention switches

Touchscreen use

- Fat finger problem
- Screen occlusion
- Reachability
- Grasp posture

Social factors

- Performative interaction
- Social acceptability

Intended Learning Outcomes

ILO1: Explain problems associated with human-computer interaction in mobile and ubiquitous usage contexts.

ILO2: Critically analyse a proposed mobile interactive system considering its intended usage context.

ILO3: Design usable mobile interactive systems for a given problem or application area.

Part 1 – Attention Span

Wall Street Journal ‘Chewbacca Test’ (2016): https://www.youtube.com/watch?v=VQPQ-OaJyhU

Attention Span

Users multi-task in mobile usage contexts:

- Spatial and social awareness
- Doing other activities
- Going to a destination
- Communicating with other people

Fragmented Attention

Users have fragmented attention

Think about situational impairment too…

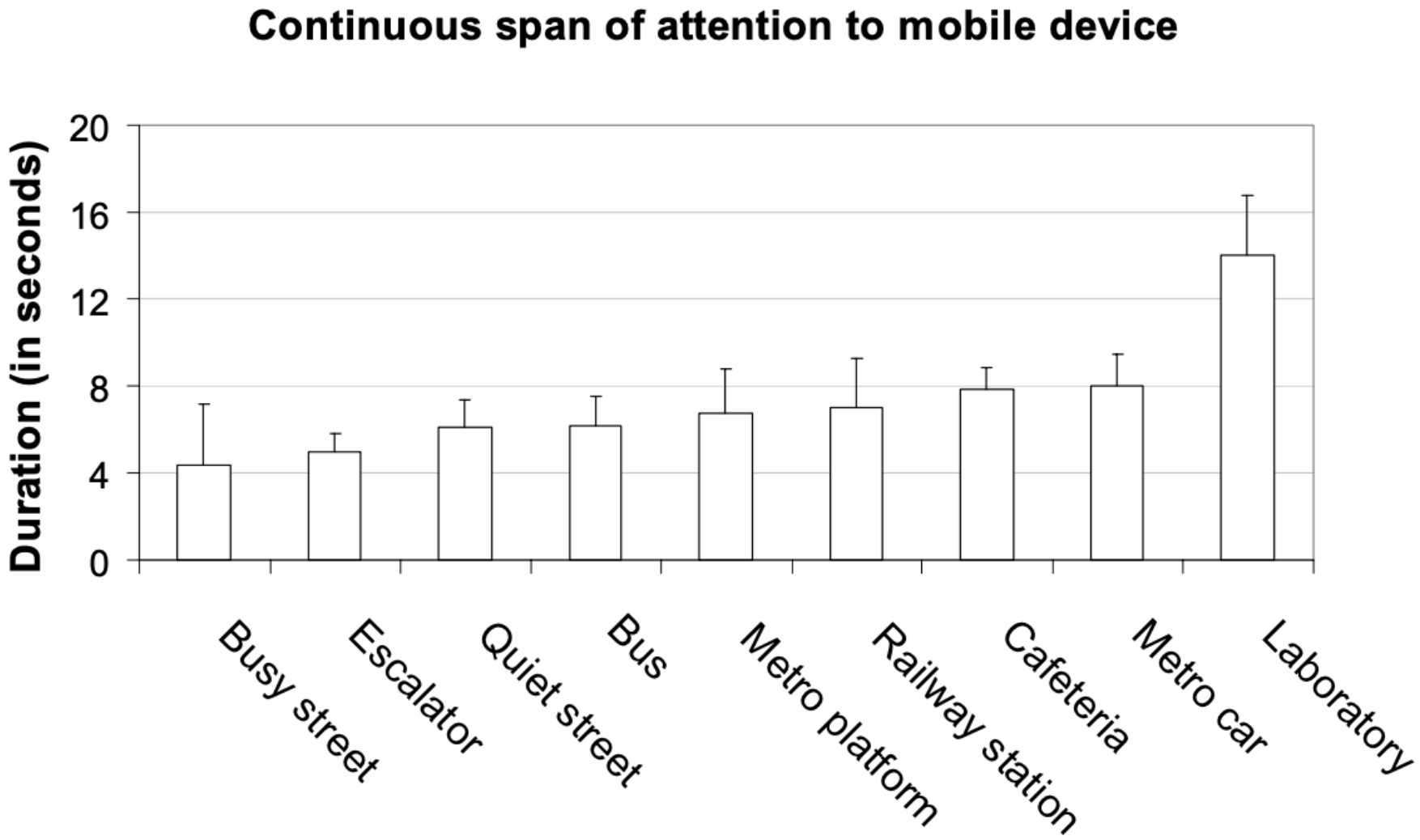
Attention Switches

Users interact in short bursts:

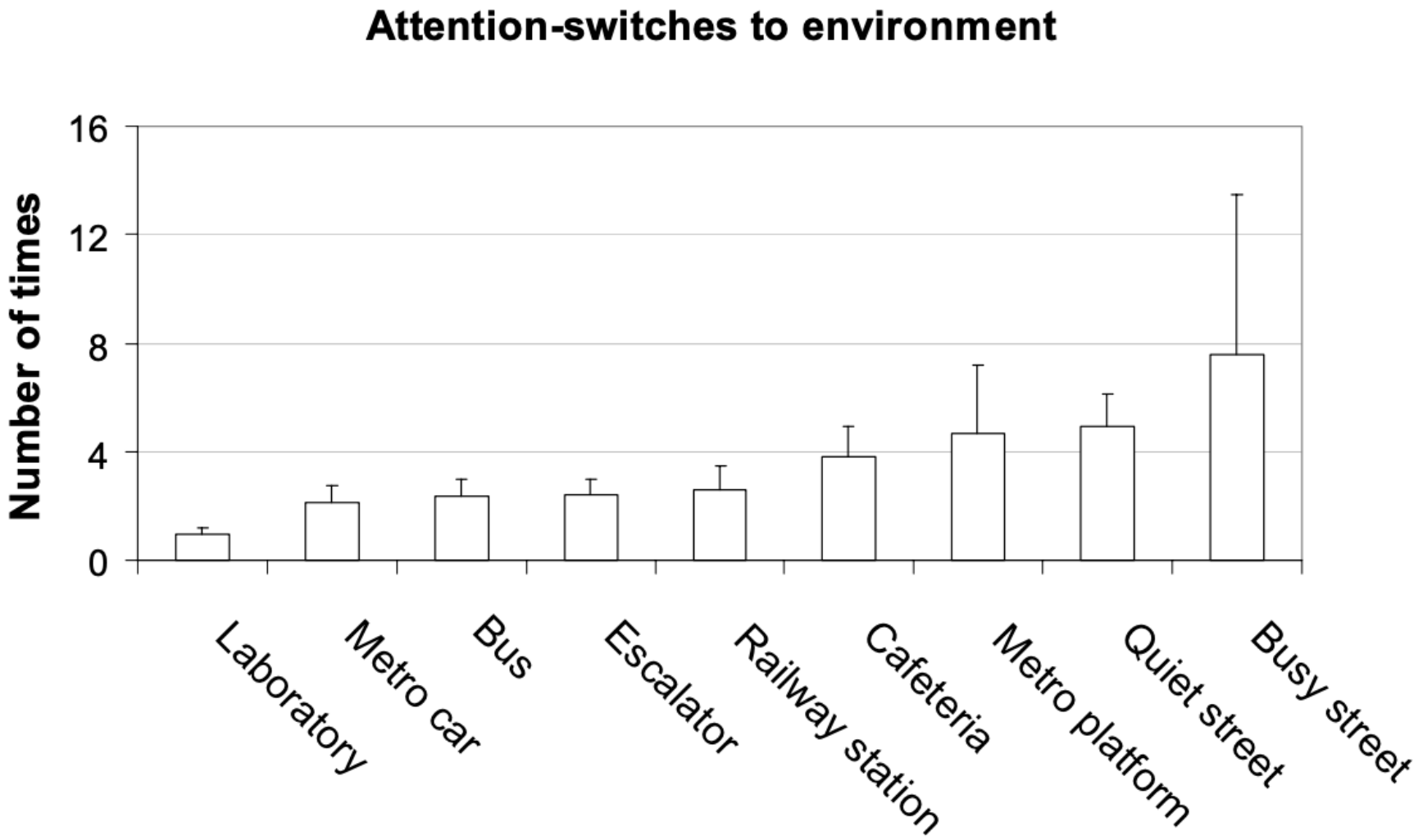
- From 4 to 14 seconds of attention

Frequent attention switches:

- Shift attention from device to environment
- … and back again



Interaction in 4-second bursts: the fragmented nature of attentional resources in mobile HCI
Antti Oulasvirta et al. Proceedings of CHI 2005
https://dl.acm.org/doi/10.1145/1054972.1055101



Interaction in 4-second bursts: the fragmented nature of attentional resources in mobile HCI
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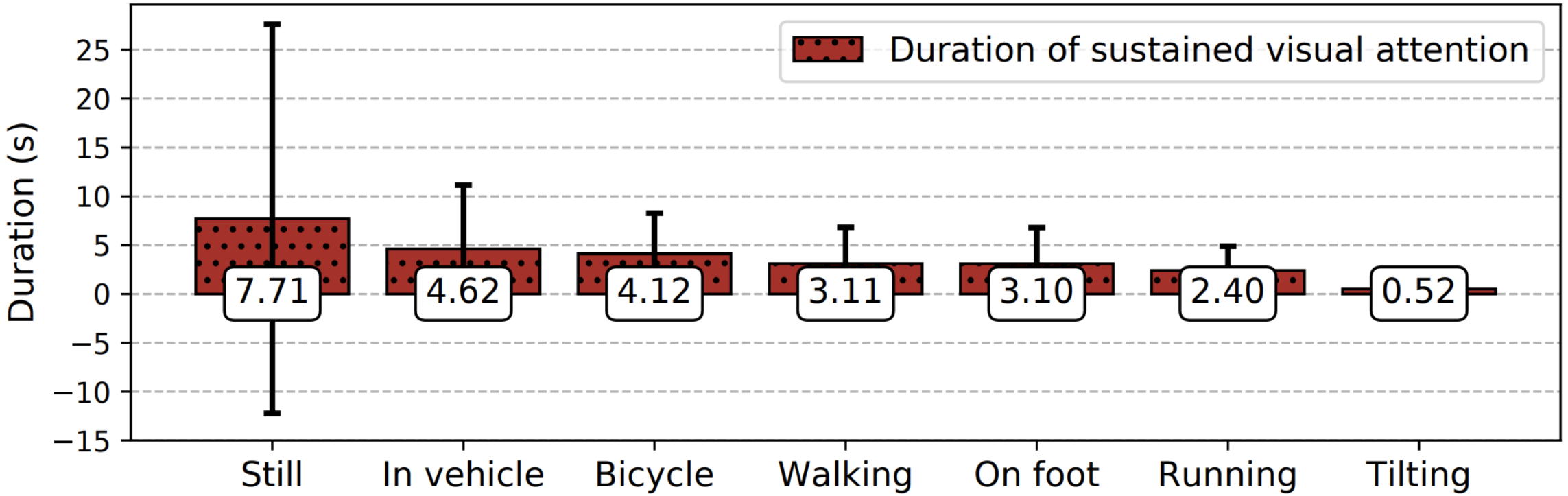
https://dl.acm.org/doi/10.1145/1054972.1055101

What about now?

“Consider the features and capabilities of a modern smartphone. Do you think user attention in a mobile interaction scenario is likely to be more or less fragmented than in 2005?” (2021 exam)



Quantification of Users' Visual Attention During Everyday Mobile Device Interactions
Mihai Bâce et al. Proceedings of CHI 2020
https://dl.acm.org/doi/abs/10.1145/3313831.3376449

Implications

You can expect:

- Lack of visual attention
- Change blindness
- Task interruption
- Fragmented input
- Slow responses

Help Users Engage

Avoid depleting attentional resources

- Attention is finite
- Users will switch off entirely

Designing for Fragmented Attention

Design user interfaces that are:

- Clear – help users find what they need, minimise reading time
- Patient – give users time, don’t demand continued attention
- Simple – don’t present too many features at once
- Multisensory – use other output modalities to reduce visual demand
- Flexible – use other input modalities to give convenient alternatives

Part 2 – Small Screens

Handheld Touchscreen Challenges

Touchscreens used for input and output

- Providing input can interfere with output

Smaller targets are more difficult to select

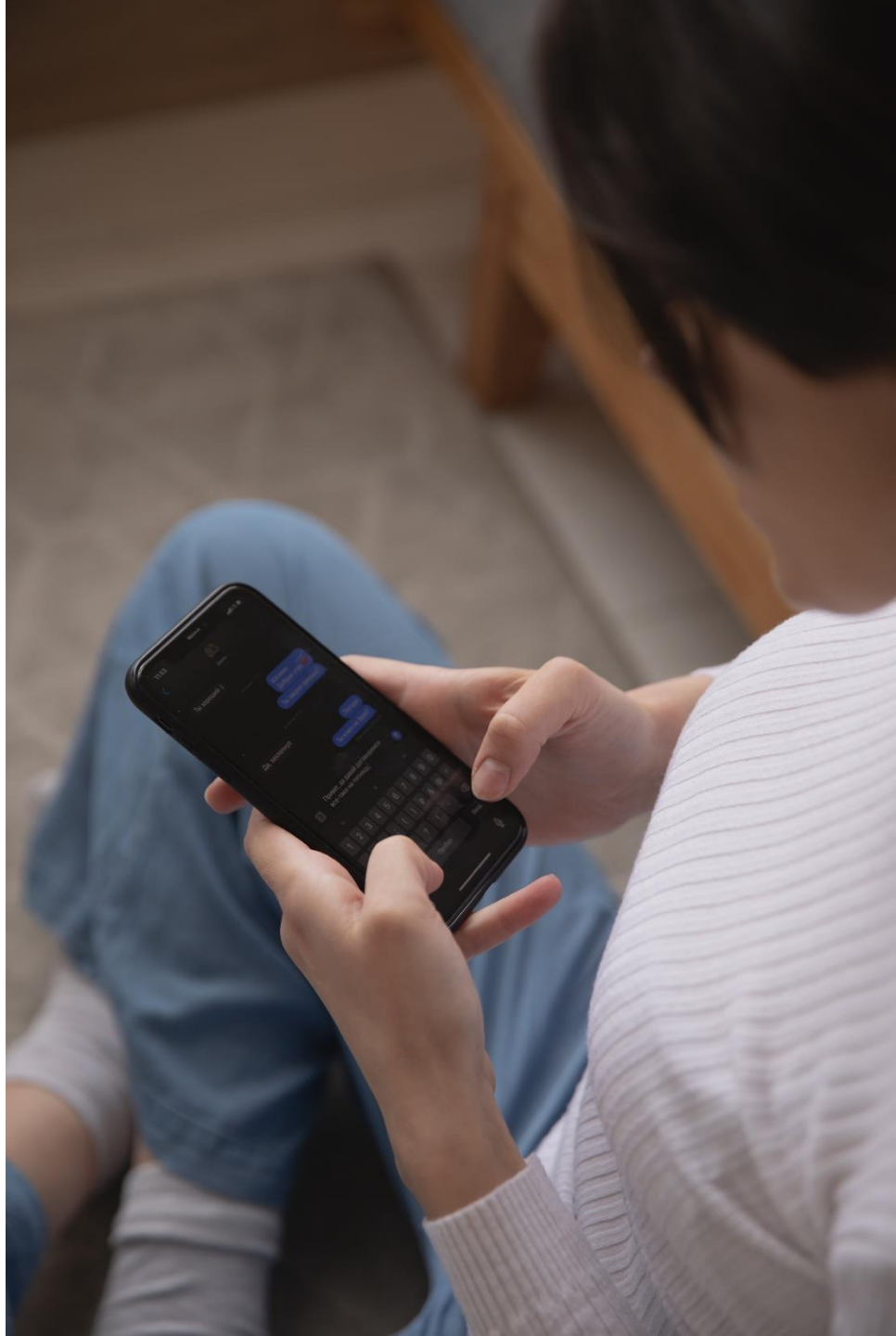
- Screen size affects target size
- Target density affects target size
- You only control one of those factors

Fat Finger Problem

Fingertip larger than on-screen targets

For example, smartphone keyboard:

- Phone 76mm wide, 1440px wide
- Finger 18mm wide, 1px touch location
- Keys 7.6 to 8.4mm wide (9-10 keys per row)



Fat Finger Solutions?

Increase target size?

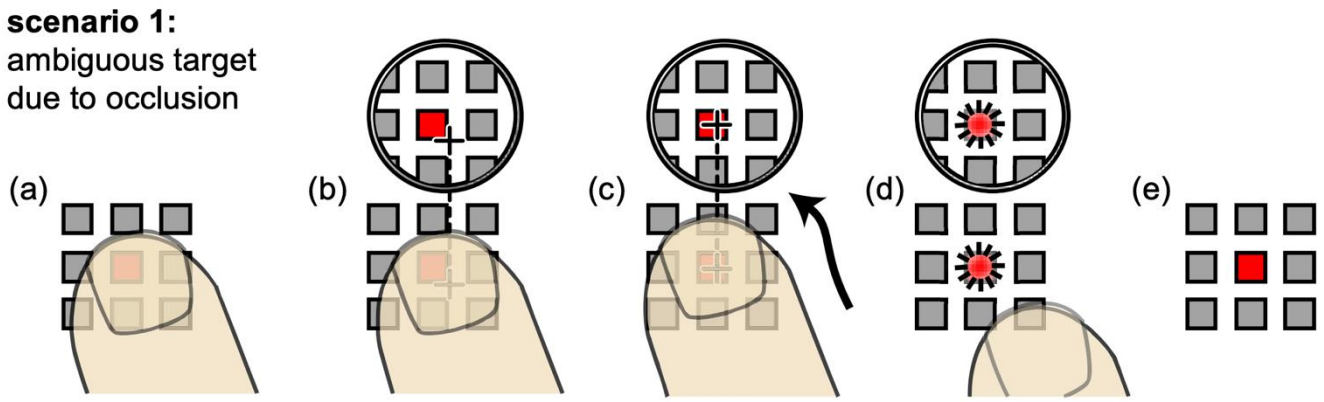
More space between targets?

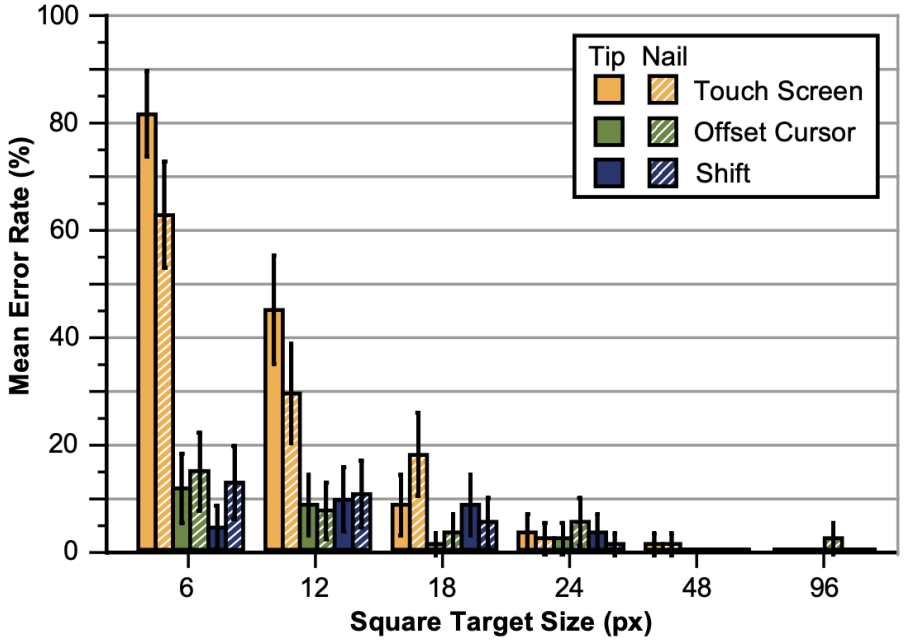
Occlusion

Screen is occluded during touch input

- e.g., targets not visible when pressed
- e.g., regions of screen hidden by rest of hand

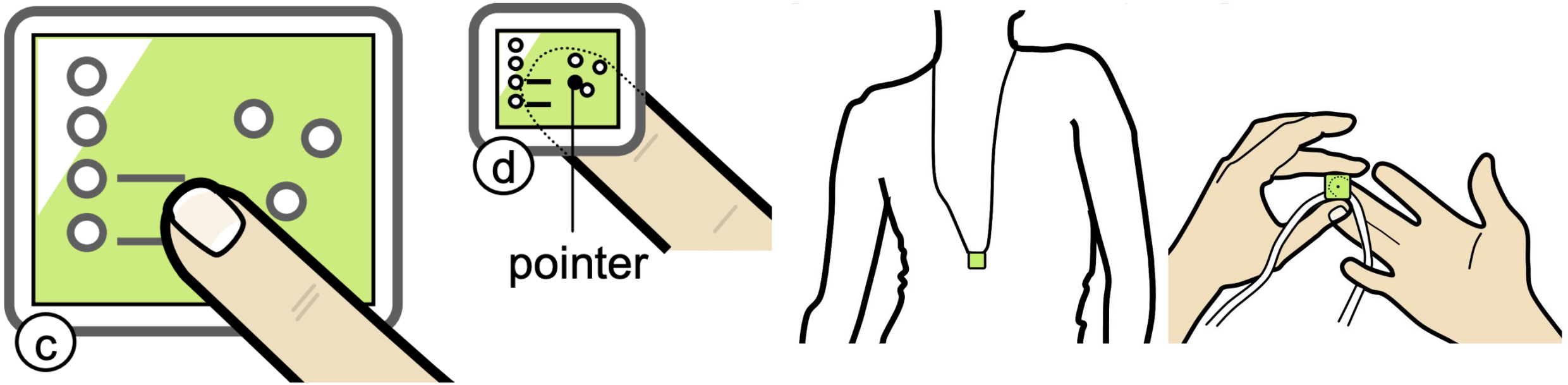
Shift Offset Cursor Technique





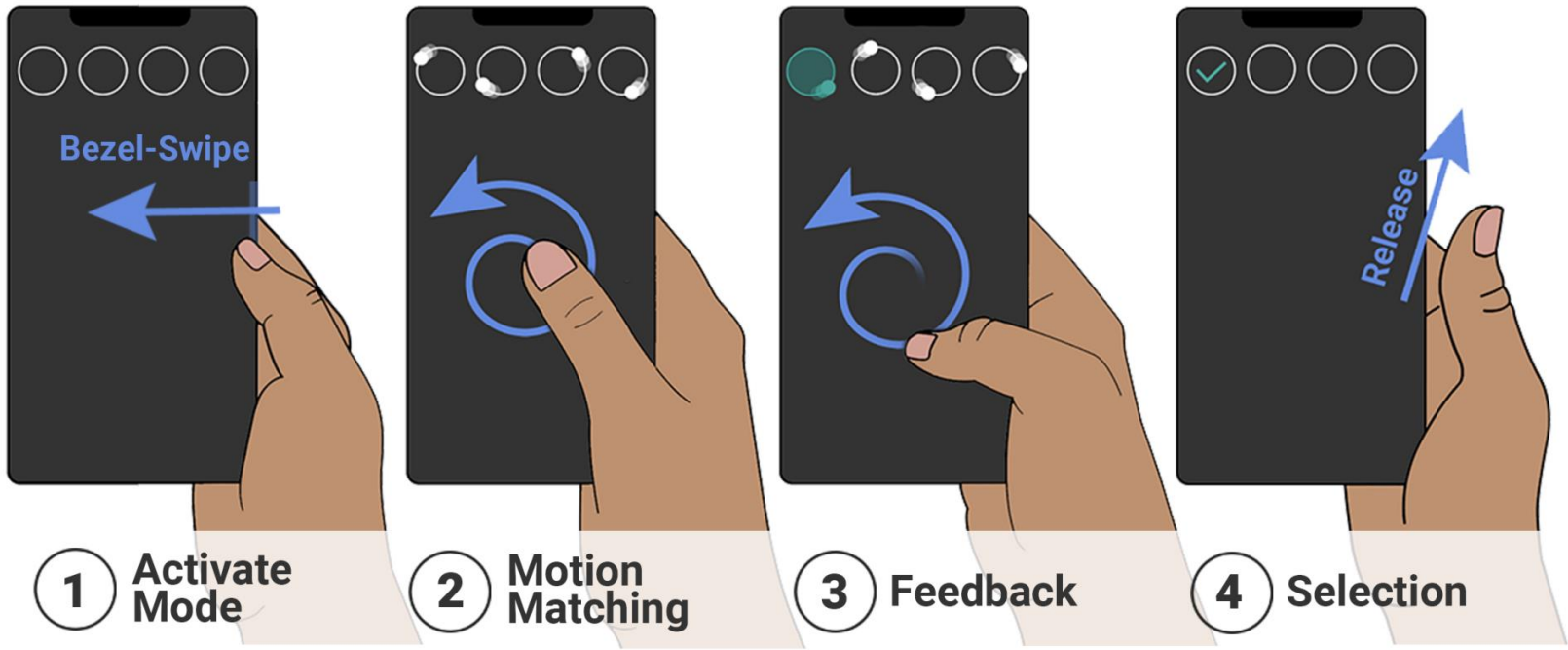
Shift: a technique for operating pen-based interfaces using touch
Daniel Vogel and Patrick Baudisch. Proceedings of CHI 2007
https://dl.acm.org/doi/abs/10.1145/1240624.1240727

Back-of-Device Input Technique



Back-of-device interaction allows creating very small touch devices
Patrick Baudisch and Gerry Chu. Proceedings of CHI 2009
https://dl.acm.org/doi/abs/10.1145/1518701.1518995

Motion Correlation Input Technique



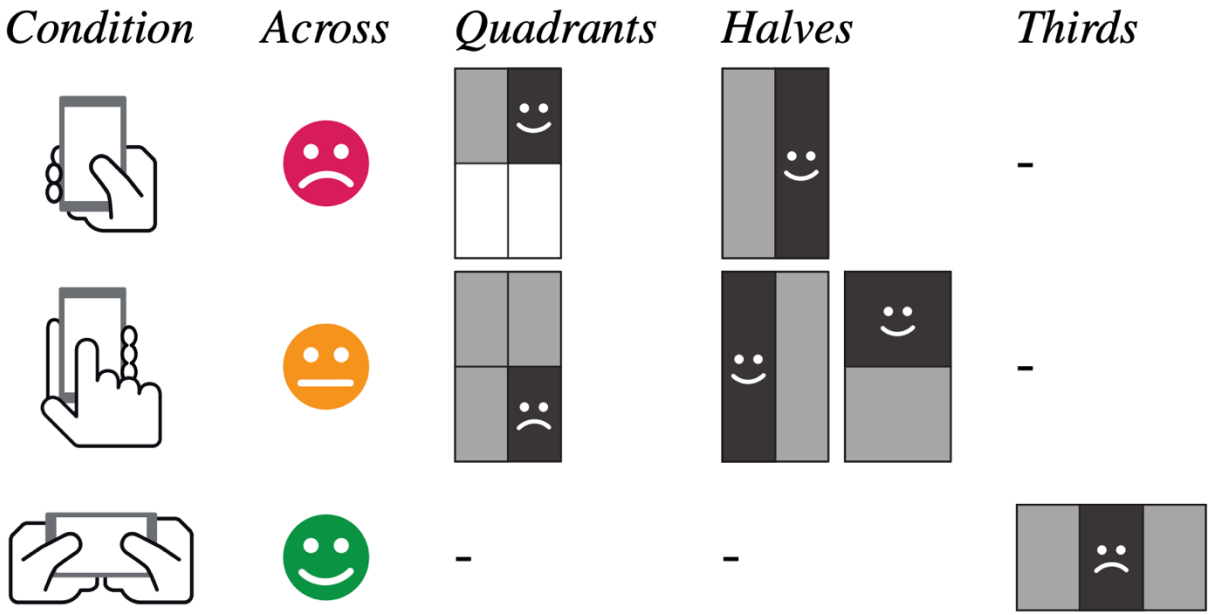
One-handed Input for Mobile Devices via Motion Matching and Orbits Controls
Augusto Esteves et al. ACM IMWUT 6(2), 2022.
https://dl.acm.org/doi/abs/10.1145/3534624

Stylus Input

Input Posture

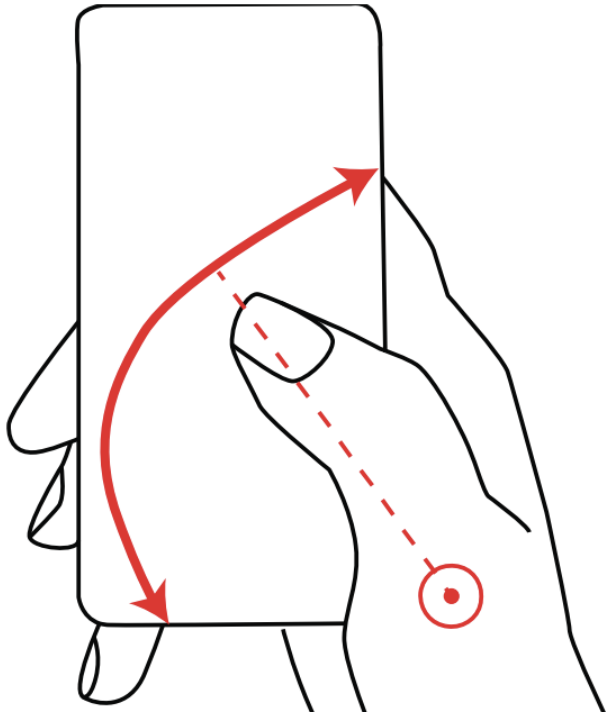
Device grasp affects touch input

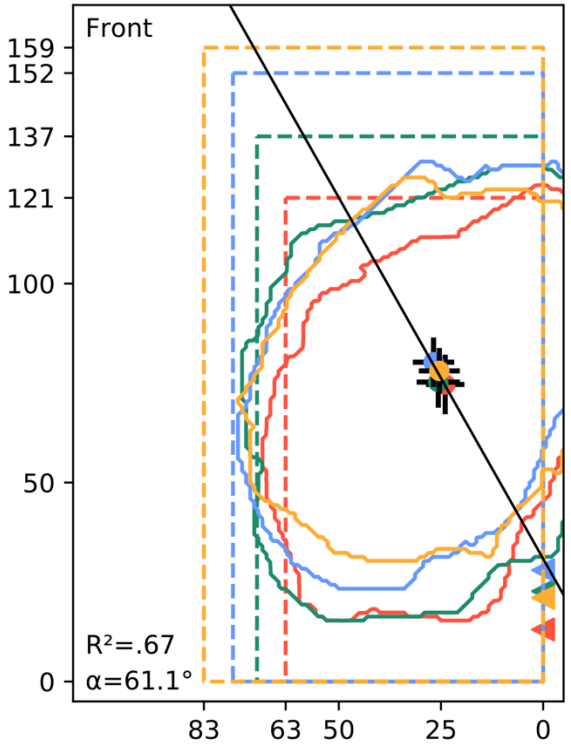
- One-handed ⇒ poorer input
- ‘Best’ region varies with posture



How to Hold Your Phone When Tapping
Florian Lehmann et al. Proceedings of ISS 2018
https://dl.acm.org/doi/abs/10.1145/3279778.3279791

Thumb Reach





Fingers' Range and Comfortable Area for One-Handed Smartphone Interaction Beyond the Touchscreen
Huy Viet Le et al. Proceedings of CHI 2018
https://dl.acm.org/doi/10.1145/3173574.3173605

Anticipate Posture

Optimise layout for varied input posture

- e.g., common actions in reachable areas
- e.g., larger targets in hard-to-reach places

Give alternatives to tap input

- e.g., touchscreen swipe gestures

Alternative input modalities?

- e.g., back-of-device input, gaze input?

Posture Detection?

Adapt user interface for posture

- e.g., scale user interface to fit reachable area
- e.g., rearrange targets for easier selection

Posture Detection Examples

ReflecTouch: Detecting Grasp Posture of Smartphone Using Corneal Reflection Images
Xiang Zhang et al. Proceedings of CHI 2022
https://dl.acm.org/doi/abs/10.1145/3491102.3517440

SmartGrip: grip sensing system for commodity mobile devices through sound signals
Namhyum Kim et al. Personal & Ubiquitous Computing (24) 2020
https://link.springer.com/article/10.1007/s00779-019-01337-7

iGrasp: grasp-based adaptive keyboard for mobile devices
Lung-Pan Cheng et al. Proceedings of CHI 2013
https://dl.acm.org/doi/abs/10.1145/2470654.2481422

Part 3 – Social Factors

Performative Interaction

Mobile interactions are performative:

- *"influenced by or affected by the spectacle resulting from its use, the public setting where it is used, or the presence of spectators as an audience"*

'Audience' who may see your 'performance':

- e.g., other pedestrians on a busy street
- e.g., other passengers on a bus or train
- e.g., other drivers on the road

Julie Williamson et al.: *Understanding performative interactions in public settings*. Personal and Ubiquitous Computing. 2014. https://doi.org/10.1007/s00779-014-0819-7

Performative Interaction

Think about the ‘performance’:

- What actions or outcomes are noticeable?
- What aspects of device use are noticeable?

Performative Interaction

Think about the ‘performance’:

- How might other people react?
- How might the ‘performer’ feel?

People often assume they are being noticed by others: spotlight effect

T. Gilovich et al. *The spotlight effect in social judgment: An egocentric bias in estimates of the salience of one's own actions and appearance*. Journal of Personality and Social Psychology, 78(2). https://psycnet.apa.org/doi/10.1037/0022-3514.78.2.211

Social Acceptability

Acceptance of technology by people

- Both performers and spectators

Influences willingness to use technology

- Won’t use something that makes them feel uncomfortable
- Won’t use something that makes others feel uncomfortable
  - e.g., Google Glass “glassholes”

Social Acceptability

User perspective:

- Does doing the action make them uncomfortable, awkward, embarrassed?

Spectator perspective:

- Do they understand what the user is doing?
- Do they have a negative impression of an action – e.g., is an action weird?

Calkin Montero et al.: *Would you do that?: understanding social acceptance of gestural interfaces*. Proc. Mobile HCI 2010. https://dl.acm.org/doi/10.1145/1851600.1851647

Social Acceptability

Many factors contribute to social acceptance, including:

- Visibility: e.g., does an action draw attention?
- Setting: e.g., is an action appropriate in this situation?
- Interaction: e.g., are people comfortable doing this action?
- Device: e.g., do people have a negative impression of this device?
- Familiarity: e.g., do people recognise what an action/behaviour/device is for?
- Behaviour: e.g., are people acting in socially inappropriate ways?

Interaction Visibility

Interaction may be visible or noticeable:

- Input actions may be highly visible (e.g., gestures, speech)
- Device output may be highly visible (e.g., loud audio)

Visible interaction may draw unwanted attention:

- Unusual actions: e.g., tapping on face, waving hands around
- Attention-grabbing actions: e.g., waving hands, speaking aloud
- Disruptive actions: e.g., speech input, clicking fingers, tapping on surfaces

Calkin Montero et al.: *Would you do that?: understanding social acceptance of gestural interfaces*. Proc. Mobile HCI 2010. https://dl.acm.org/doi/10.1145/1851600.1851647

Interaction Visibility

Recognition as an interaction may improve spectator acceptance

- Familiarity: “I know what that is”
- Occam’s Razor: “it *has* to be interaction, surely?”

Is there a causal relationship between action and outcome?

- e.g., a highly visible action with no discernible response?
- e.g., a subtle action with an obtrusive response?

Situation

Depends on situation (usage context) in which interaction occurs:

- Audience: alone, family, friends, colleagues, strangers?
- Location: home, office, train, street, pub?

Julie Rico (Williamson) et al.: *Usable gestures for mobile interfaces: evaluating social acceptability*. Proc. CHI 2010. https://dl.acm.org/doi/abs/10.1145/1753326.1753458

Situation

Depends on situation in which interaction occurs (e.g., gestures):

- Combination of location and audience

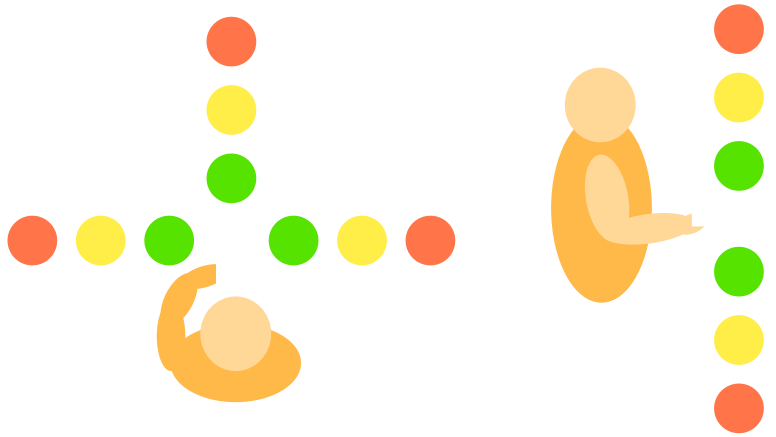
Situation	Acceptability	Situation	Acceptability
Home alone	89%	Home around family	78%
Work alone	86%	Work around colleagues	72%
Public around strangers	60%	Public around friends	66%

Euan Freeman et al.: *Towards Usable and Acceptable Above-Device Interactions*. Proc. Mobile HCI 2014. https://dl.acm.org/doi/10.1145/2628363.2634215

Interaction Design

Depends on interaction design (e.g., gestures):

- More acceptable: hands near torso, small movements, short duration;
- Less acceptable: hands away, from body large movements, long duration;



David Ahlström et al.: *Are you comfortable doing that?: acceptance studies of around-device gestures in and for public settings*. Proc. Mobile HCI 2014. https://dl.acm.org/doi/abs/10.1145/2628363.2628381

Device Location

Depends on device design (e.g., wearables):

- More acceptable: wrist, forearm, hands;
- Less acceptable: neck, waist, torso;

Halley Profita et al.: *Don't mind me touching my wrist: a case study of interacting with on-body technology in public*. Proc. ISCW 2013. https://dl.acm.org/doi/abs/10.1145/2493988.2494331

Spectator Familiarity

Depends on device familiarity:

- Smartphones: more established, more easily explainable user behaviour;
- Smart glasses: less familiar, fear of the unknown, assume the worst;

However, attitudes can and do change…

Marion Koelle et al.: *Don't look at me that way!: Understanding User Attitudes Towards Data Glasses Usage*. Proc. Mobile HCI 2015. https://dl.acm.org/doi/abs/10.1145/2785830.2785842

User Behaviour

Design for Social Acceptability

Avoid unusual input or output:

- Is there a clear explanation for it?
- e.g., tapping your nose, using elephant noises for button-press feedback;

Avoid input or output that may draw attention:

- Minimise interaction that might catch attention;
- e.g., clapping your hands, having a watch that flashes bright colours;

Design for Social Acceptability

Avoid actions that do not have a clear target:

- Is it obvious that an action is directed at a device?
- e.g., “is he waving at me or is he shaking his wrist?”

Consider more subtle alternatives:

- Can you minimise action visibility?
- e.g., twisting a ring vs tapping on a watch
- e.g., haptic feedback vs audio feedback

Evaluating Social Acceptability

Typically evaluated via surveys, for example:

- What would you think if you saw someone else performing this gesture (for example, when walking down the street)?
- How would you feel performing this gesture in the following situations?
  - A) In public places
  - B) At home
  - Rating scale from 1 (“embarrassed”) to 6 (“comfortable”)

Calkin Montero et al.: *Would you do that?: understanding social acceptance of gestural interfaces*. Proc. Mobile HCI 2010. https://dl.acm.org/doi/10.1145/1851600.1851647

Evaluating Social Acceptability

Typically evaluated using surveys, for example:

- In which locations would you use this gesture? (tick all)
  - Home, Pavement, Driving, Bus/Train, Pub or Restaurant, Workplace
- Who would you perform this gesture in front of? (tick all)
  - Alone, Partner, Friends, Colleagues, Strangers, Family

Julie Rico (Williamson) et al.: *Usable gestures for mobile interfaces: evaluating social acceptability*. Proc. CHI 2010. https://dl.acm.org/doi/abs/10.1145/1753326.1753458

Evaluating Social Acceptability

Typically evaluated using surveys, for example:

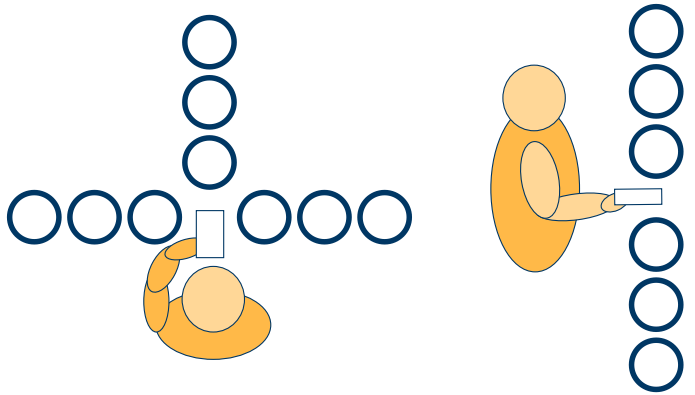
- When would it be appropriate to use this gesture? (tick all)
  - Home Alone, Home with Family, At Work Alone, At Work with Colleagues, In Public Around Strangers, In Public With Friends

Euan Freeman et al.: *Towards Usable and Acceptable Above-Device Interactions*. Proc. Mobile HCI 2014. https://dl.acm.org/doi/10.1145/2628363.2634215

Evaluating Social Acceptability

Typically evaluated using surveys, for example:

- Write a number from 1 to 5 in each of the circles to indicate how comfortable you felt performing a gesture at that particular position?



David Ahlström et al.: *Are you comfortable doing that?: acceptance studies of around-device gestures in and for public settings*. Proc. Mobile HCI 2014. https://dl.acm.org/doi/abs/10.1145/2628363.2628381

Social Acceptability

Social acceptance is dynamic – social norms change over time

- Google Glass launched in 2013 to much controversy
  - Privacy concerns: device will look and listen without noticeable cues
  - Social concerns: perceived rudeness of not paying attention
- But new smart glasses (e.g., from Ray Ban + Meta) aren't causing a fuss?

Lecture Summary

User attention is fragmented in mobile contexts

- Users not always paying attention – interact in short bursts

Touchscreen use isn't straightforward

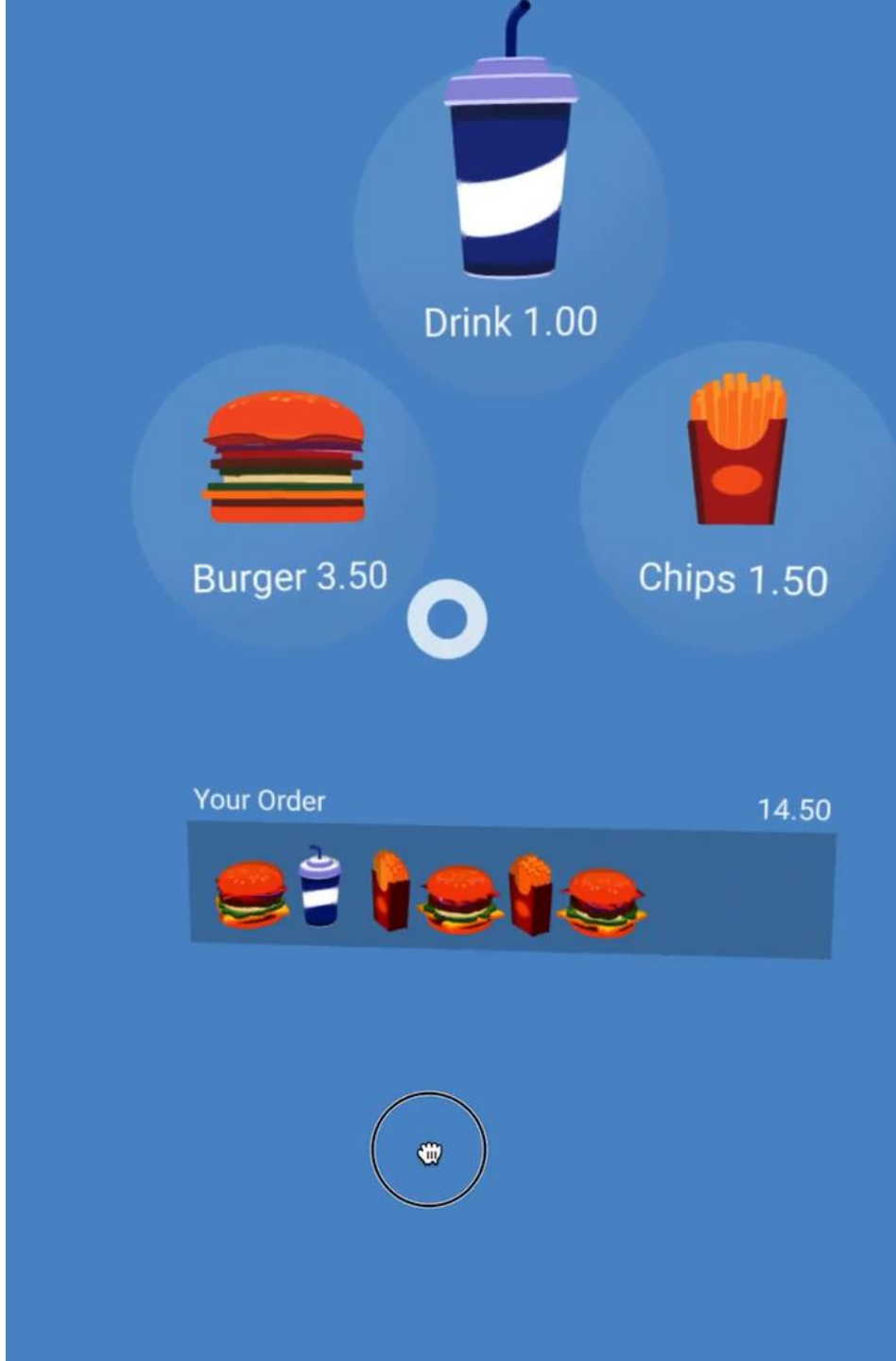
- Fat finger problem and occlusion are challenges for small screens
- Touch performance affected by posture amongst other things

Social factors affect willingness to interact

- Using a computing device is a 'performance' seen by others

Lab Exercise Review

Using animations and 3D content to create more engaging and usable interactions



Lab Exercise Review

Task 2: enable animations when user targets the menu item

- Need to emit the ‘begin’ and ‘pause’ events at the appropriate time

```
// Cursor enter: start or resume rotation animation, depending on prior animation state
element.addEventListener("mouseenter", function () {
    element.querySelector(".icon").emit("rotation-begin");
});

// Cursor leave: pause rotation animation
element.addEventListener("mouseleave", function () {
    element.querySelector(".icon").emit("rotation-pause");
});
```

Lab Exercise Review

Task 3: extra visual feedback animations

- Define new animations to change visual properties at appropriate times

```
animation="property: components.material.material.color; type: color; from: green; to:
white; dur: 500; loop: false; easing: linear; startEvents: flash-begin;”

animation__click="property: scale; from: 3 3 3; to: 5 5 5; dur: 500; easing: linear; loop:
false; startEvents: scale-begin;"

// Cursor click: start the scale animation
element.addEventListener("click", function () {
    element.querySelector(".icon").emit("scale-begin");
    element.emit("flash-begin");

    ...
});
```

Lab Exercise Review

Task 4: instantiate and add new elements to DOM

```
// Create new icon entity to add to basket
var icon_entity = document.createElement("a-entity");
icon_entity.setAttribute("position", x_offset + " -0.06 0");
...

// Select and scale the appropriate model for adding to basket
switch (data.item_id) {
    case "1":
        icon_entity.setAttribute("gltf-model", "#model-burger");
        icon_entity.setAttribute("scale", "0.5 0.5 0.5");
        break;
    ...
}

// Add new icon as a child of the basket entity
document.querySelector("#basket").appendChild(icon_entity);
```

Lab Exercise Preview

Next week you'll implement motion interactions using accelerometer and gyroscope sensors.

Getting the sensor data is straightforward

- But mapping it onto interface actions is not
- A more experimental fine-tuning approach needed