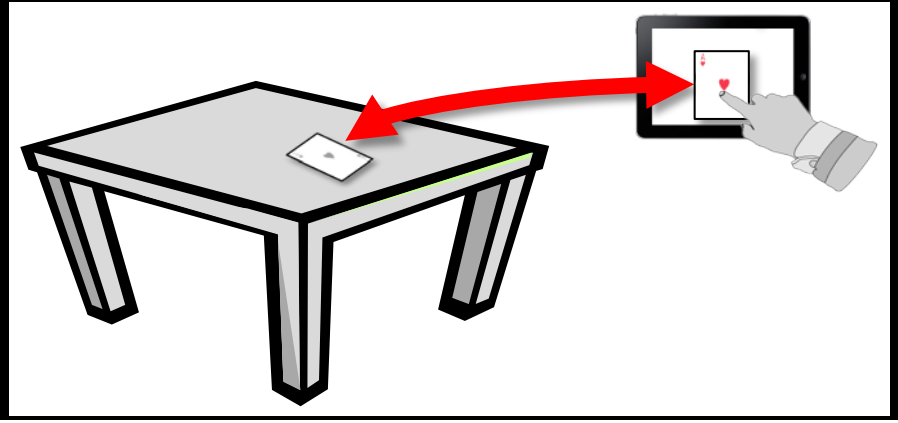

Cross-Device Transfer in a Collaborative Multi-Surface Environment without User Identification

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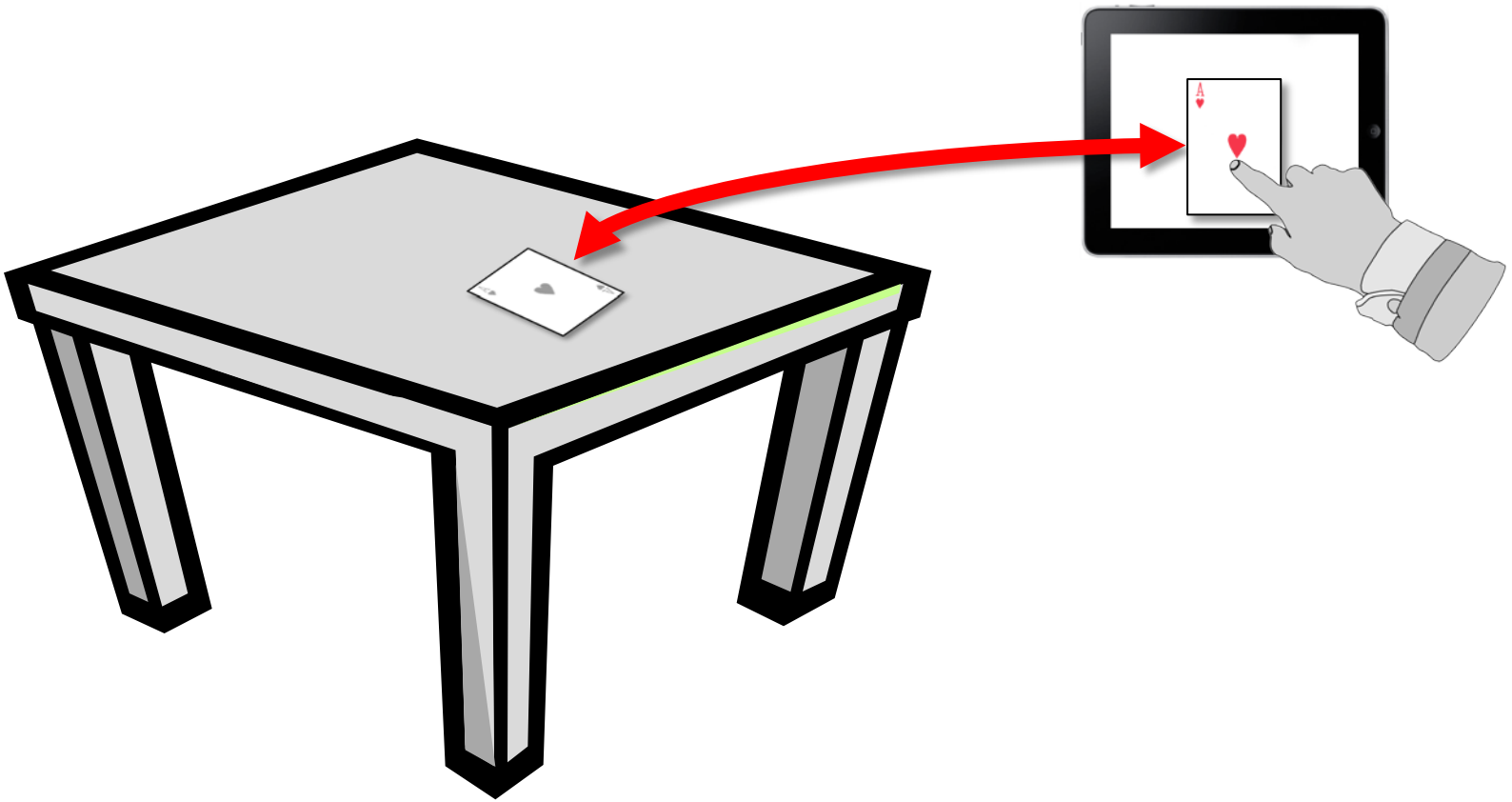
IMMERSE
The Research Network for Video Game Immersion

UNIVERSITY OF WATERLOO

NSERC CRSNG
SurfNet

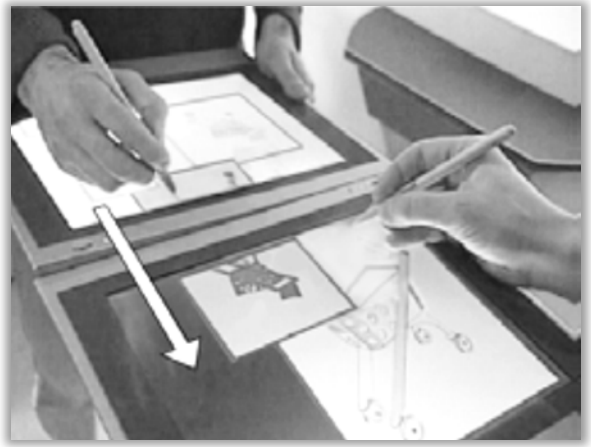
Utilizing Private Data at a Shared Tabletop

- Need for effective mechanisms to move content across devices (cross-device transfer)



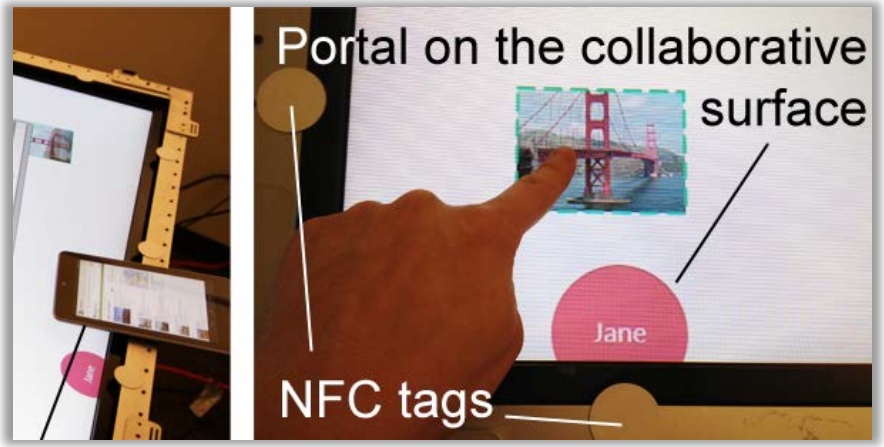
Existing Cross-Device Transfer Techniques

contiguous virtual workspace



ConnecTables [Tandler et al. 2001]

virtual portals



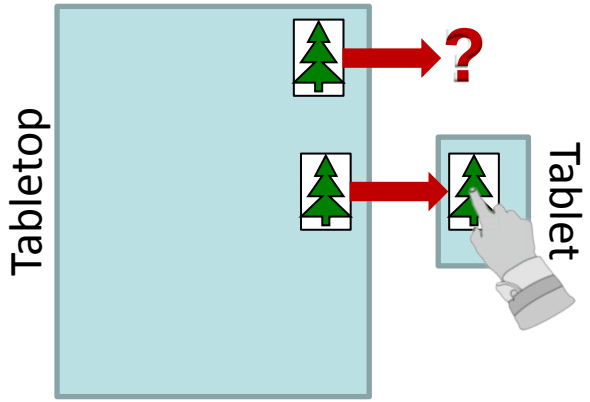
Surface Portals [Fei et al. 2013]

physical proxy

Pick-and-Drop [Rekimoto 1997]

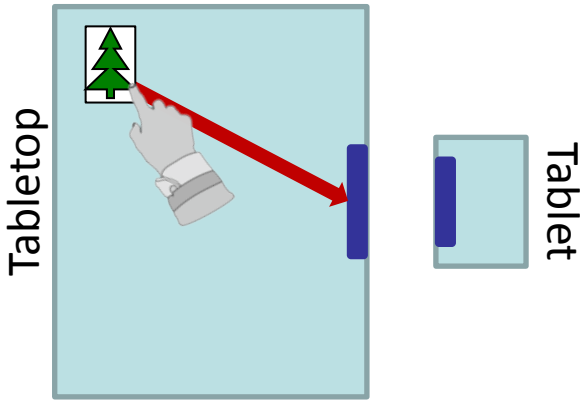
Limitations for Multi-touch Tabletop and Tablets

contiguous virtual workspace



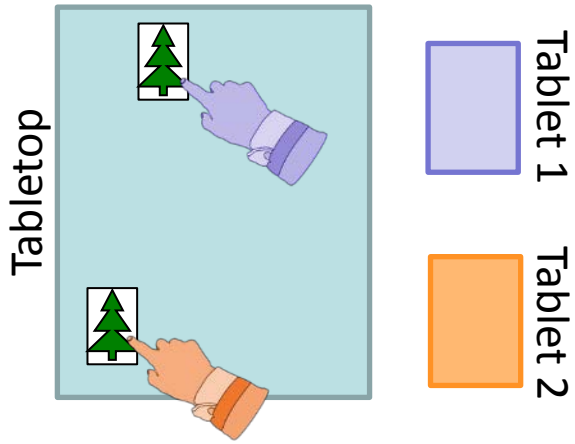
Display size discrepancy

virtual portal



Physical fatigue over long distances

physical proxy

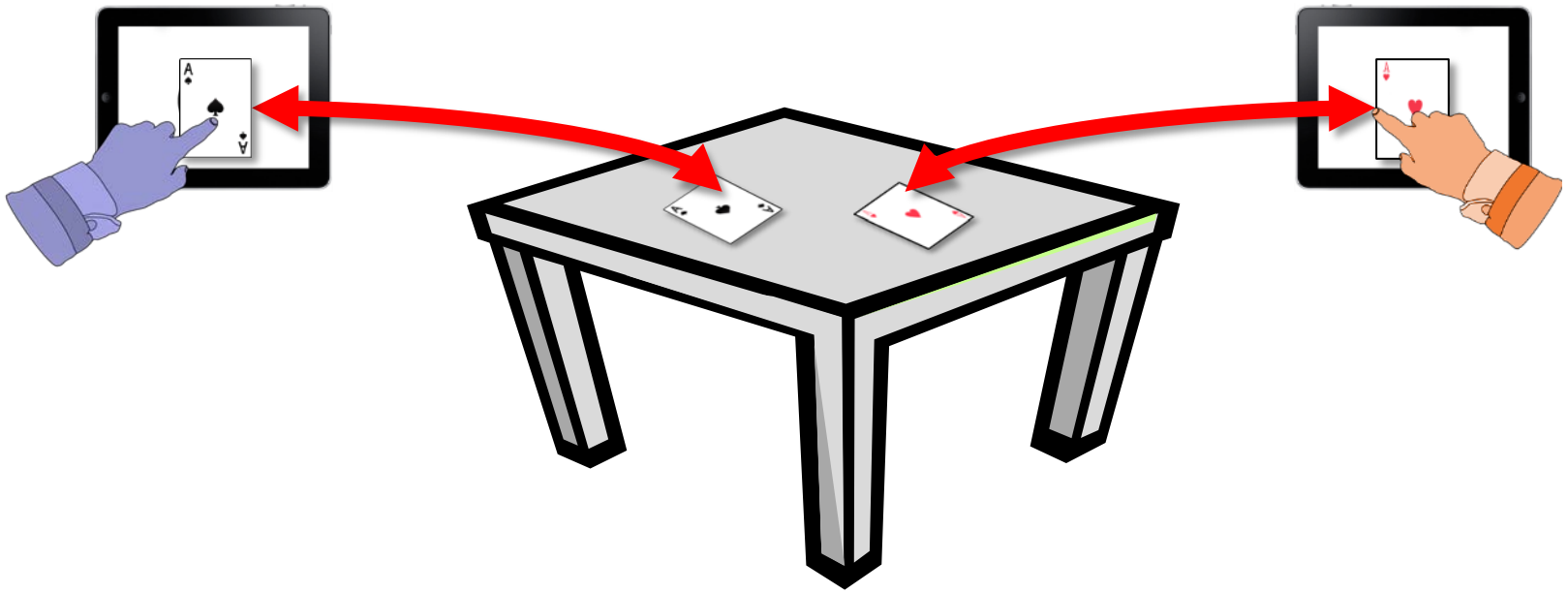


1. No physical proxy (e.g. pen) readily available for many multi-touch devices
2. No user identification on shared tabletop creates confusion during multi-user transfers

Investigating Existing Techniques on Multi-touch Surfaces

Research question:

How effective are existing cross-device transfer techniques for **multi-user cross-device transfer** on a digital tabletop **without user identification**?



Study of Cross-Device Transfer in Digital Tabletop Game

- Popular commercial card game, ***Dominion***, was converted to digital tabletop and tablet application
- Requires frequent transfer of cards between **shared resources** (on tabletop) and **hand-of-cards** (on tablet)

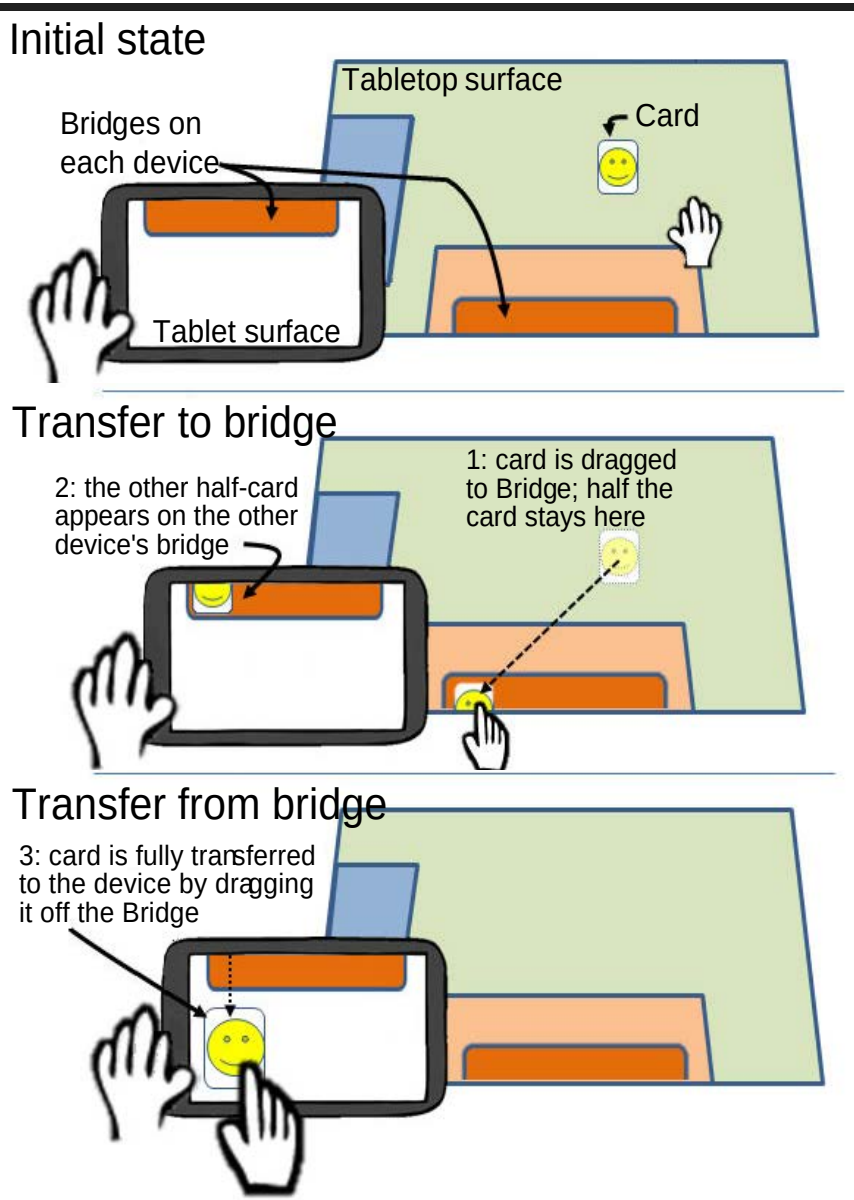
Digital tabletop **Dominion**[1] game

[1]Published by Rio Games, used with permission.

Studied Transfer Techniques I

Bridges

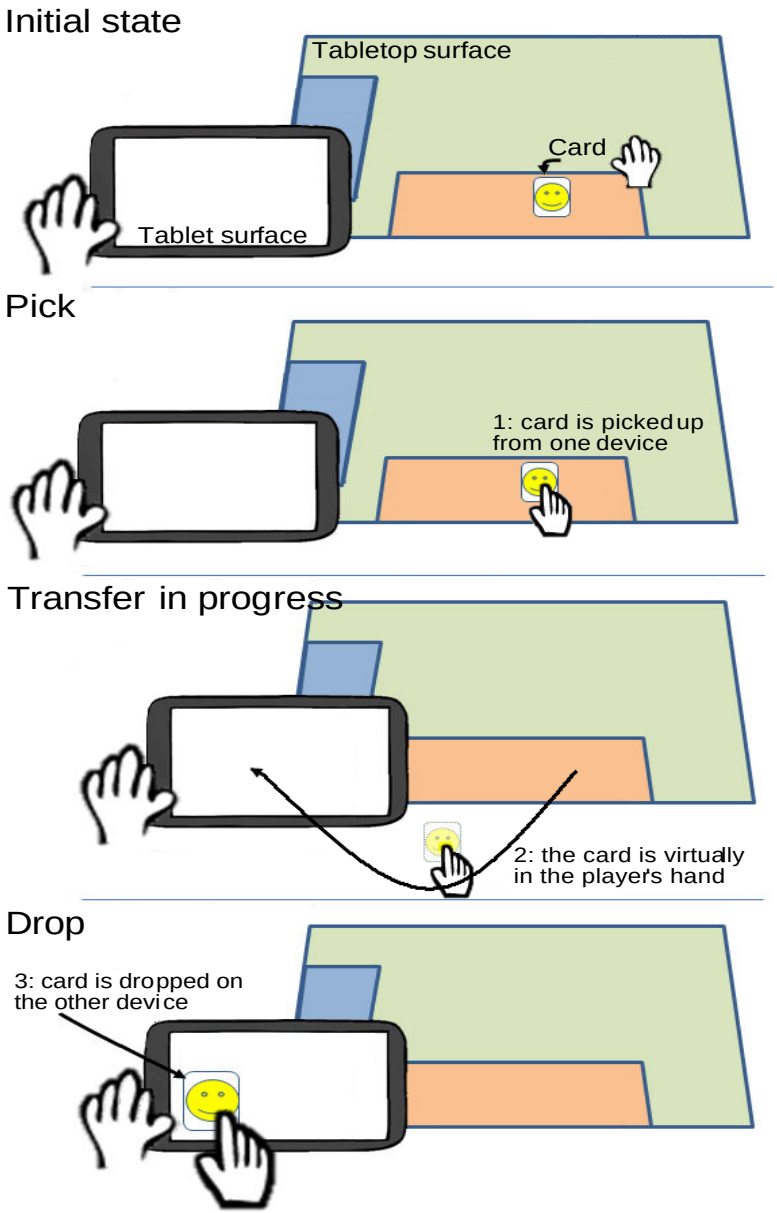
(virtual portals technique)



Studied Transfer Techniques II

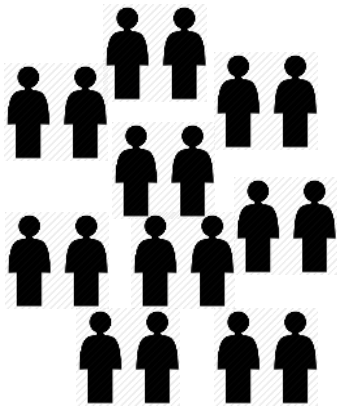
Adapted Pick-and-Drop (A-PND)

(physical proxy technique)



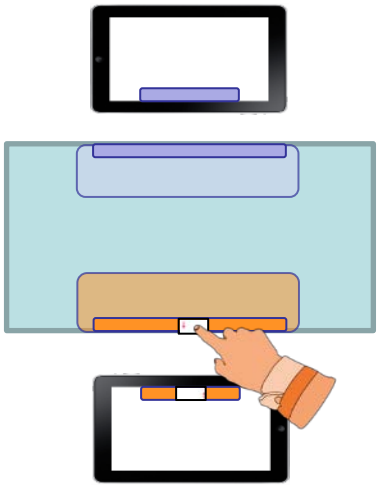
Comparative User Study: Study Design

within subjects / counter-balanced
(~30mins per condition)

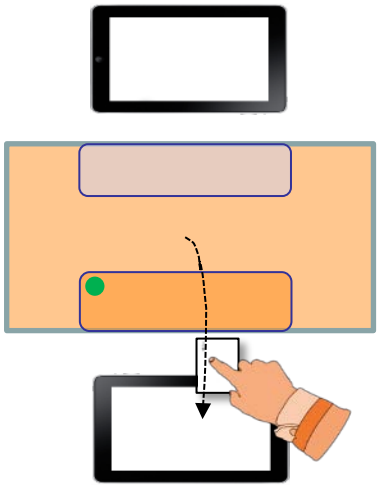


14 pairs
(28 participants
in total)

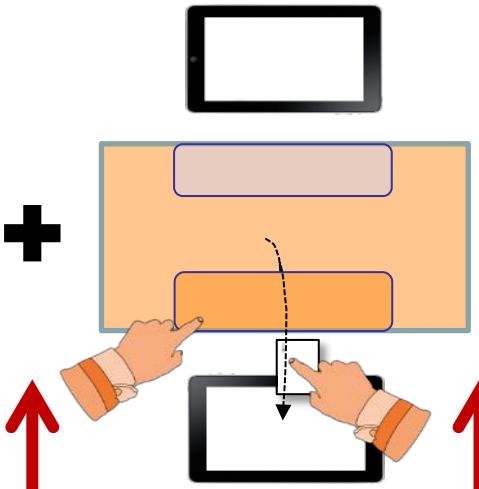
Bridges



A-PND Explicit



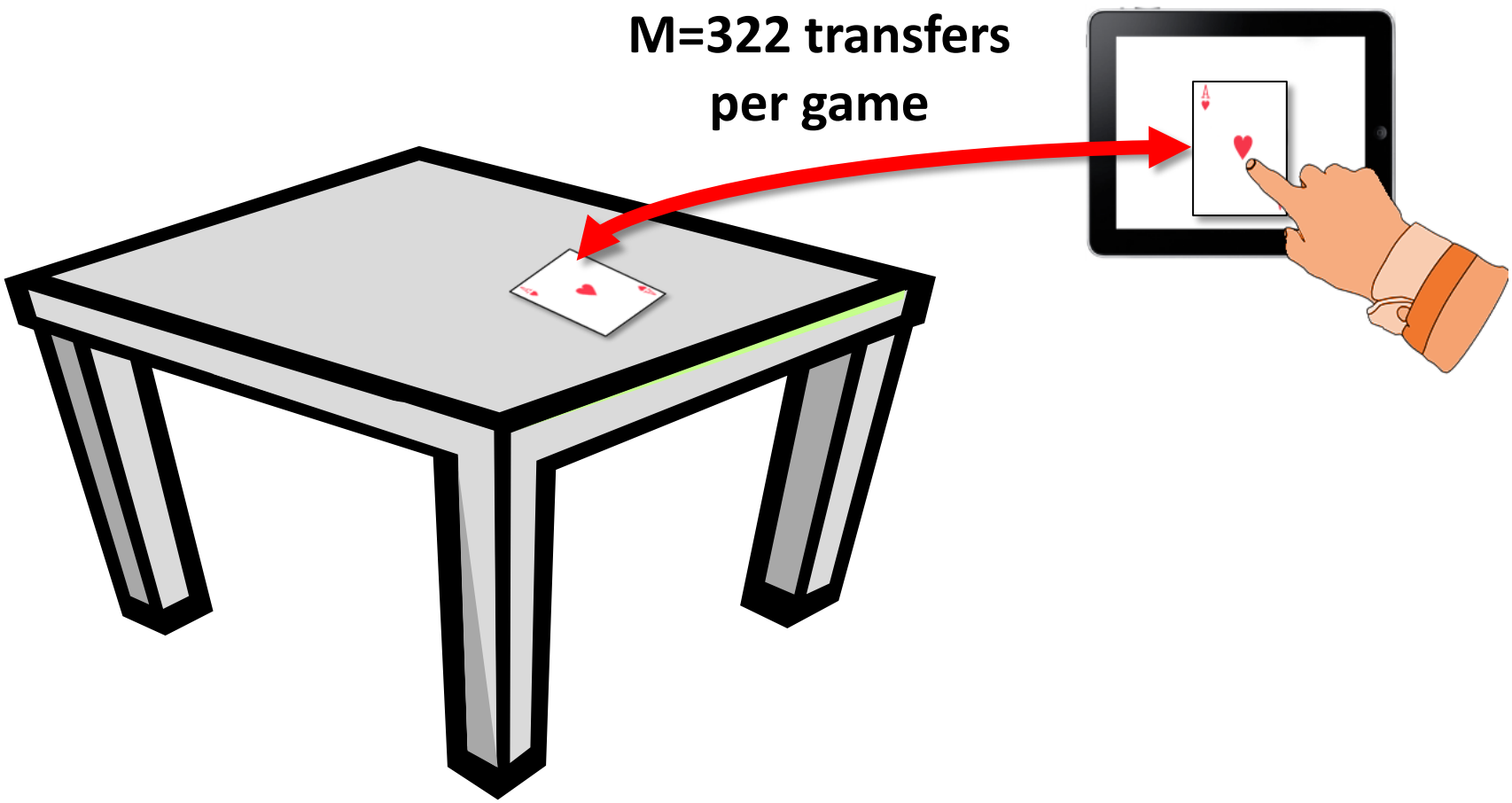
A-PND Implicit



Post-condition questionnaires

Results and Discussion

Frequent Card Transfers in All Conditions



Player Preferences Split Across Transfer Techniques

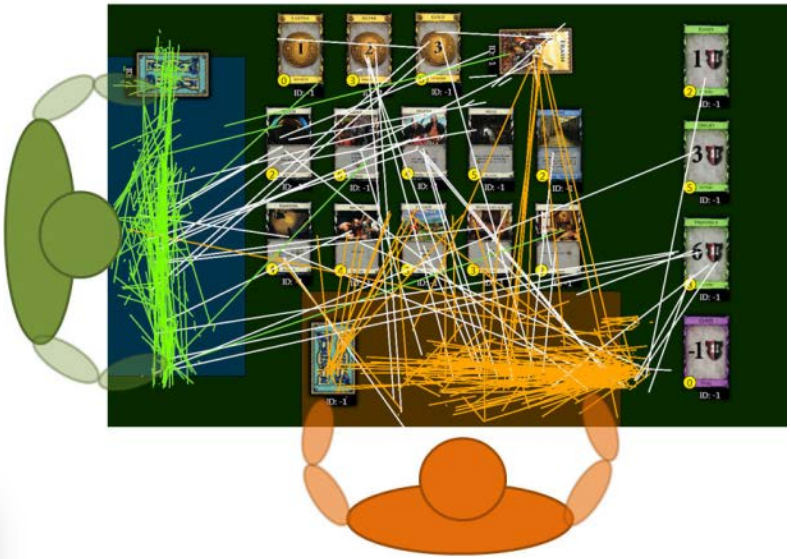
- Statistical analysis revealed:
  - **No significant difference in preference ratings** across transfer techniques
  - **No significant difference in subjective study measures** (game enjoyment, awareness, and level of effort) across transfer techniques

- Participants equally divided in their preferences between Bridges and A-PND transfer techniques

Qualitative Analysis Comparing Bridges and A-PND

- In-depth qualitative analysis of video data, observer notes, participant comments, and computer log data

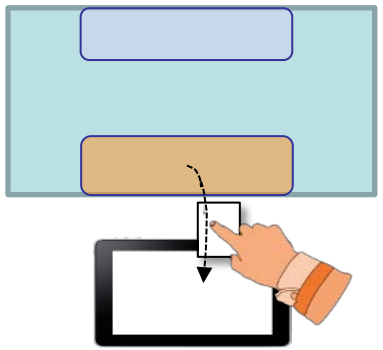
Video data



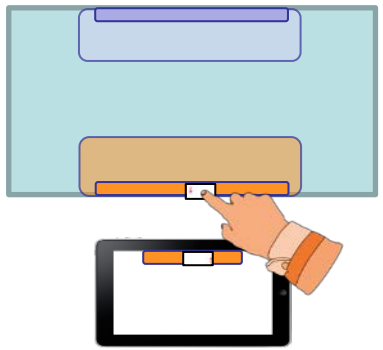
Sample activity plot from computer log data (A-PND Implicit session)

Bridges vs. A-PND: Key Themes (More in Paper)

- Cognitive Effort
- Physical Effort
- Privacy & secrecy



A-PND



Bridges

✘ Cognitive demanding to track cards during transfer:

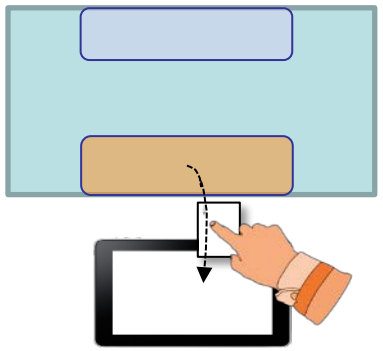
*"Not seeing the cards that are **'in the ether'** while picking up **confused** me a couple of times"*

✓ State of cards always visible:

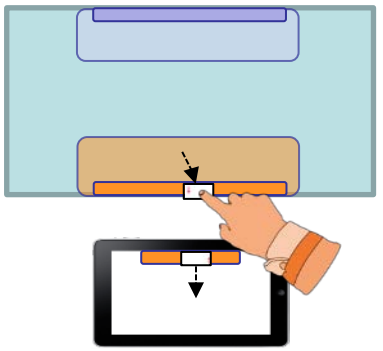
*"**Easier** to keep track of cards" ; "More **intuitive**"*

Bridges vs. A-PND: Key Themes

- Cognitive Effort
- Physical Effort
- Privacy & secrecy



A-PND



Bridges

✓ More direct, efficient transfer

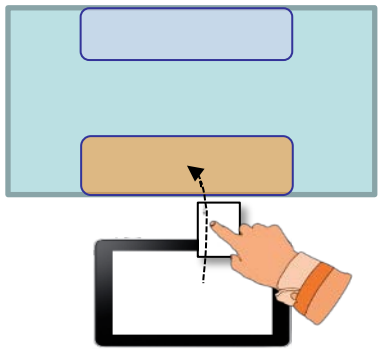
✓ Multi-card transfer also improved efficiency

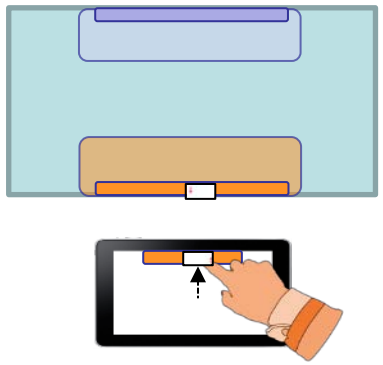
✗ Dragging cards to/from Bridge on each device created interaction bottleneck:

"[Bridges] was super annoying... It just added more clicks to the game."

Bridges vs. A-PND: Key Themes

- Cognitive Effort
- Physical Effort
- Privacy & secrecy





A-PND

Bridges

✓ Drops on table were **context-aware**:

- ✓ Cards dropped on deck took **face-up/face-down value of deck**
- ✓ Enabled competitive players to keep **discarded cards secret**

✗ All cards transferred to table were **displayed face-up** on table Bridge

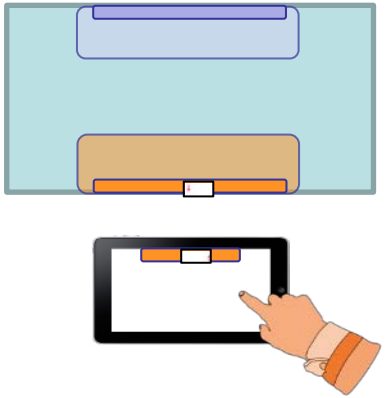
✓ Non-competitive players appreciated this openness:

"[Bridges] allowed you to show what you were doing more easily."

Emergent Strategy: Bridges Partial-Transfer

- To address limitations of Bridges some players adopted **"partial-transfer" strategy:**

  Cards half on table Bridge,
  half on tablet Bridge



- ✓ Reduces physical effort
- ✓ Resolves "disclosure issue"

- ✗ Hard to see card details

Summary

No "clear winner", each technique had pros and cons, varying across different player play styles

- Bridges was **easier** to use, but A-PND was more **efficient**
- Lack of feedback during A-PND transfer introduced **confusion**
- A-PND preserved **private information** better than Bridges
  - Bridges **"partial-transfer"** strategy resolved this issue

Conclusion

- Study successfully applied existing transfer techniques to multi-user tabletop without user identification
  - Dedicated Personal Play Areas enabled multi-user ***physical proxy transfer (A-PND)***
  - Dedicated Bridges on tabletop and tablets enabled multi-user ***virtual portals transfer***

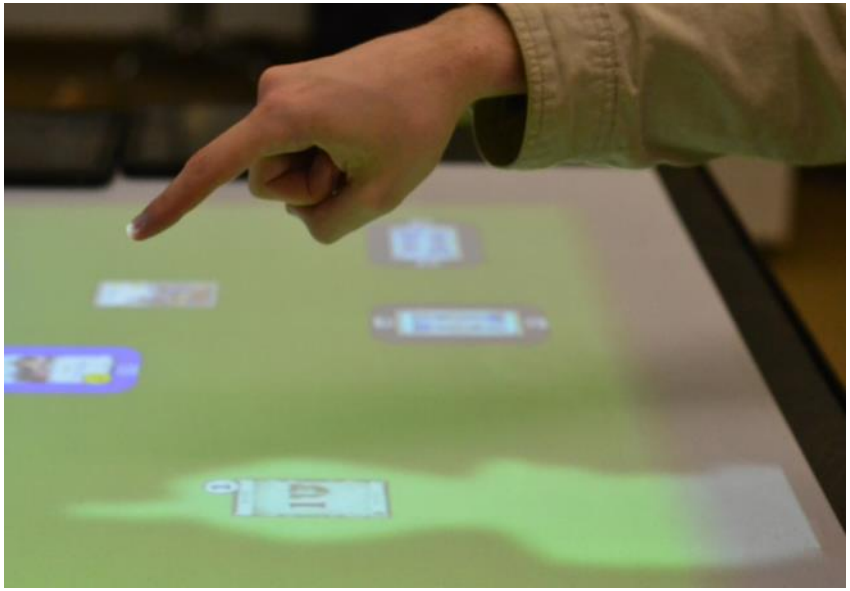
- Study revealed Bridges and A-PND technique **each provided unique advantages**, which aligned better or worse with different participants personal tasks goals

Ongoing / Future Work

- Address lack of feedback during A-PND transfer

Object-plus-Arm Shadow Design Concept

Object-plus-Arm Shadow Implementation



(Presented as a Interactivity Demo at ACM CHI 2014)

[Besacier et al. (2014). Object and Arm Shadows: Visual Feedback for Cross-Device Transfer. CHI 2014]

Thank You!

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