Tablets, Tabletops, and Smartphones: Cross-Platform Comparisons of Children's Touchscreen Interactions

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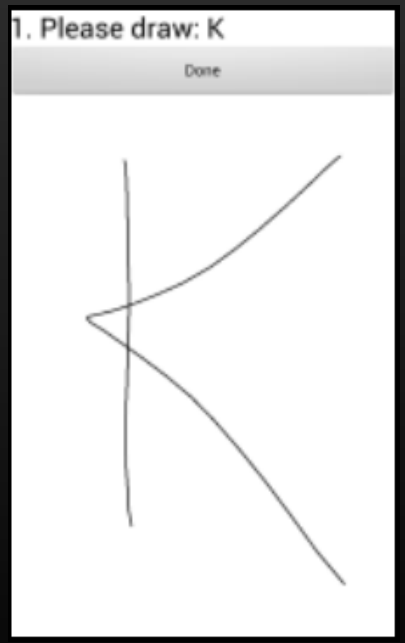
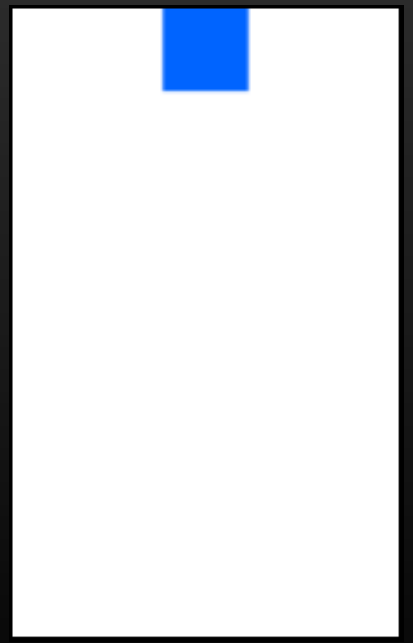
Motivation and Impact

- Anthony et al. (ITS 2012)
  - Study of children's touch and gesture interaction on smartphones

Please draw the specified gesture





Please touch the blue square


Icecream Screen ...
threshold3_...
test1
threshold10...
x_target_tas...
TIDESS_Pro...
threshold9_...
threshold8_...
Environment Lighting O...
threshold4_...
Enter Surface Mode
threshold5_...
DuOS
GA
Virtual Earth
Acrobat Reader DC
test123_tar...
Surface Shell
Recycle Bin
TA
Surface Config Editor
TC Logs
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Our Work

- We examined children's target and gesture interactions on a tablet and tabletop
- Compared results with previous work on smartphones

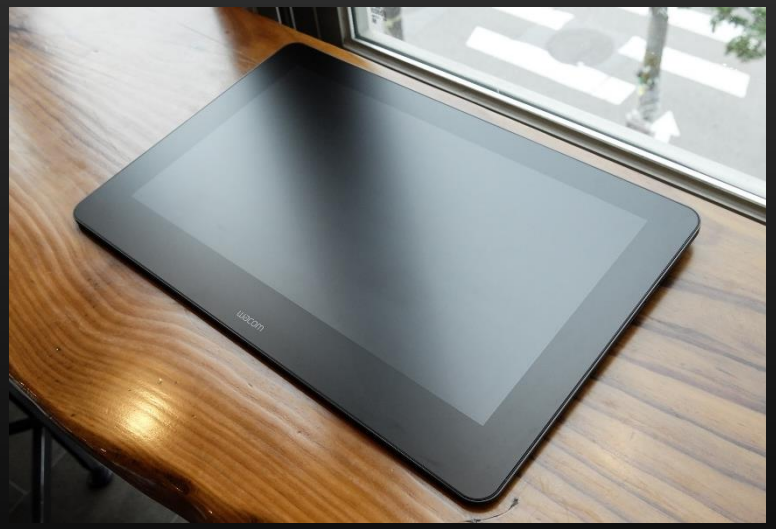
"student_ipad_school-129" by Brad Flickinger under CC 2.0

Comparison Between Devices

- Differences in touch interactions between devices
- Gesture recognition rates were consistent across devices

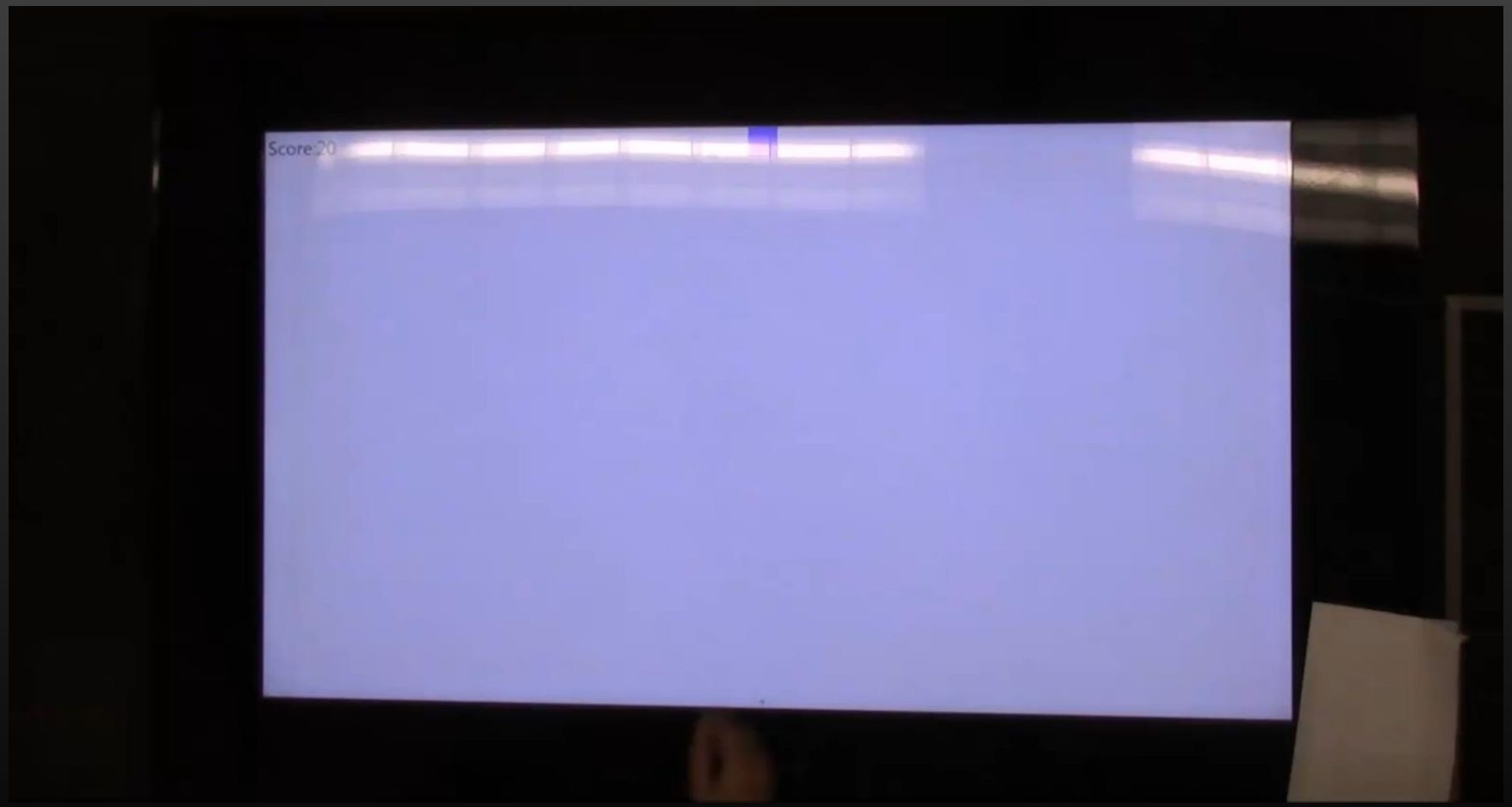
"Microsoft Surface" by Vanguard Visions CC 2.0

"Nexus S" by Isriya Paireepairit under CC 2.0

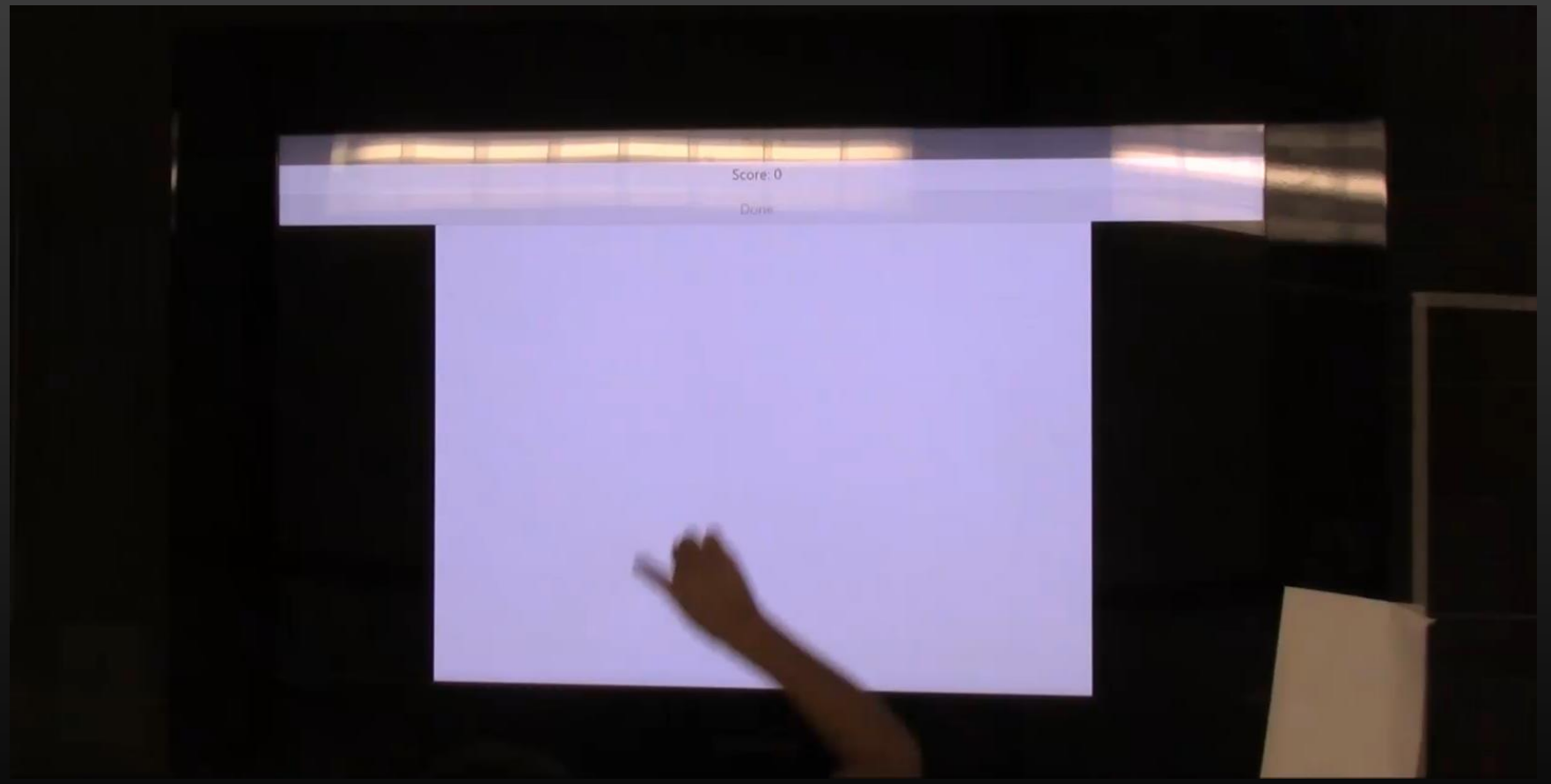


"Lr43_L1000181" by Aaron Yoo under CC 2.0

Target Touching Task



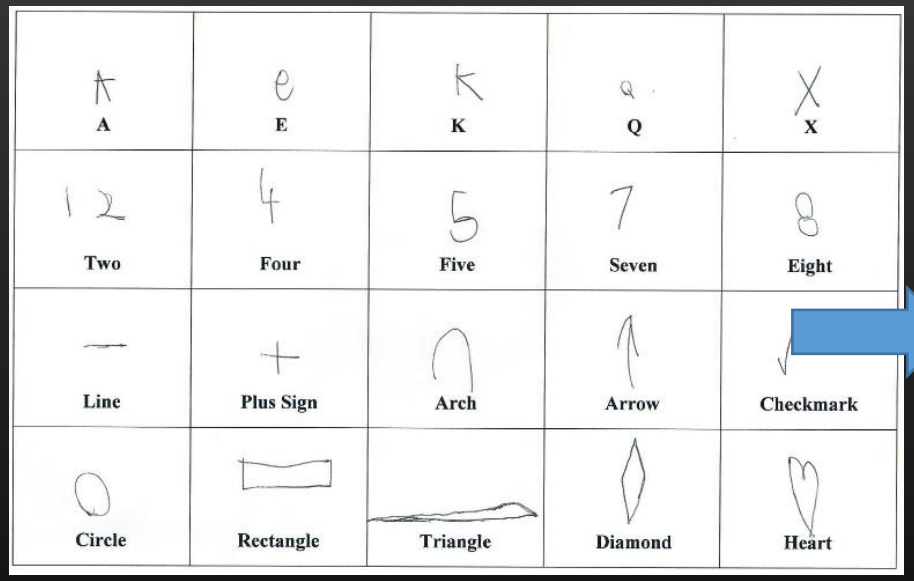
Gesture Drawing Task



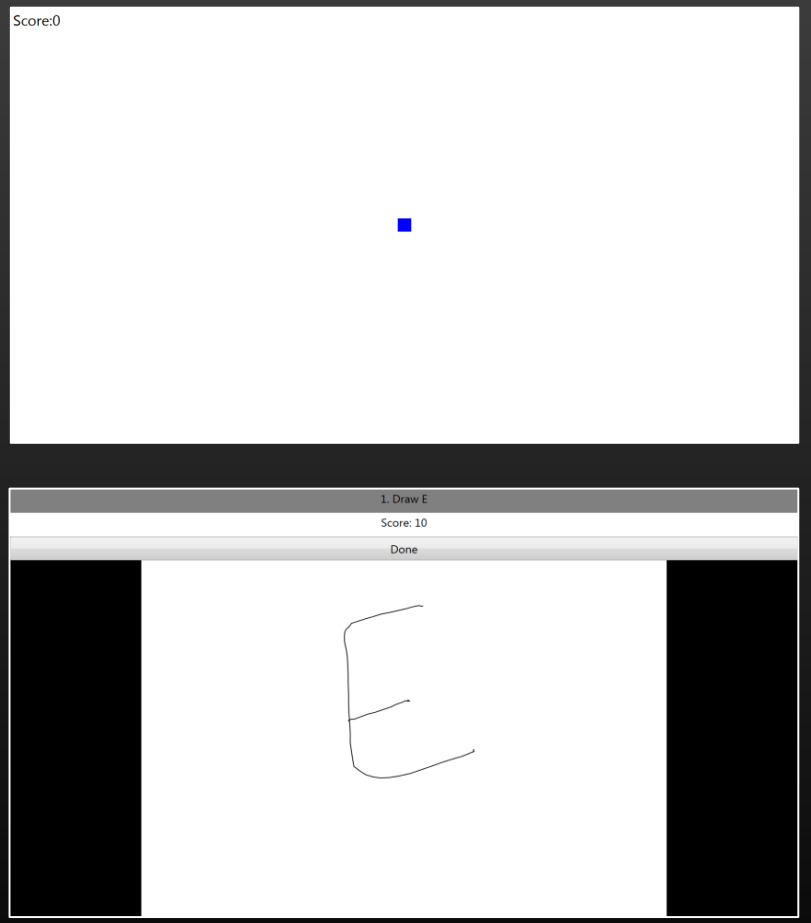
Participants

Experiment	Number of Participants	Male	Female	Age Range	Age Mean
Tablet	13	7	6	5 to 10 years	7.3 years
Tabletop	18	8	10	6 to 10 years	7.8 years

Experiment Procedure



Gesture Sheet



Target and Gesture Tasks

Prizes

Brewer et al. (IDC 2013)

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Target Interaction

Touch Metrics Overview

Touch Metrics	Smartphone	Tablet	Tabletop
Holdovers	3.9%		
Target Misses *(Target Size)*	Sig.		
Edge Padding *(Target Misses)*	Sig.		
Location *(Target Misses)*	Sig.		
Response Time *(Target Size, Age Group)*	Sig.		
Input Drag *(Target Size)*	NA		

Sig. = Significance

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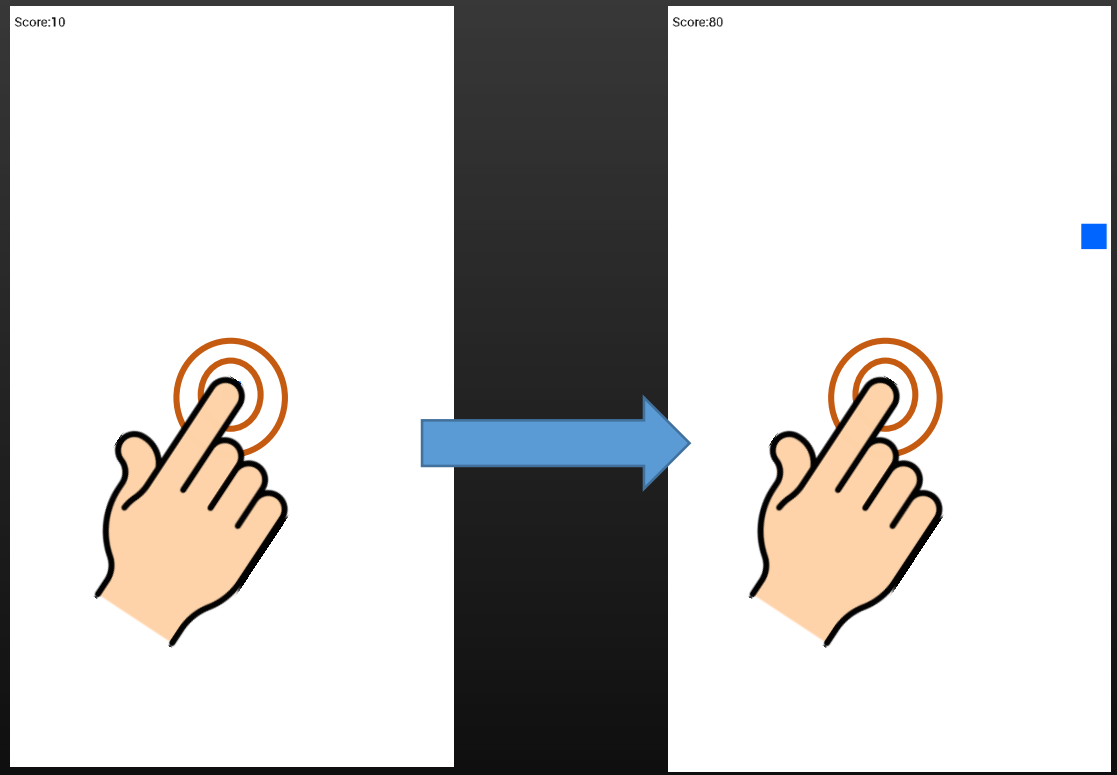
Holdovers

- **Tablet (Touch)**: 9.9%
- **Tablet (Pen)**: 5.8%
- **Tabletop**: 2.9%
- **Smartphone**: 3.9%



Touch Metrics Overview

Touch Metrics	Smartphone	Tablet	Tabletop
Holdovers	3.9%	Touch: 9.9% Pen: 5.8%	2.9%
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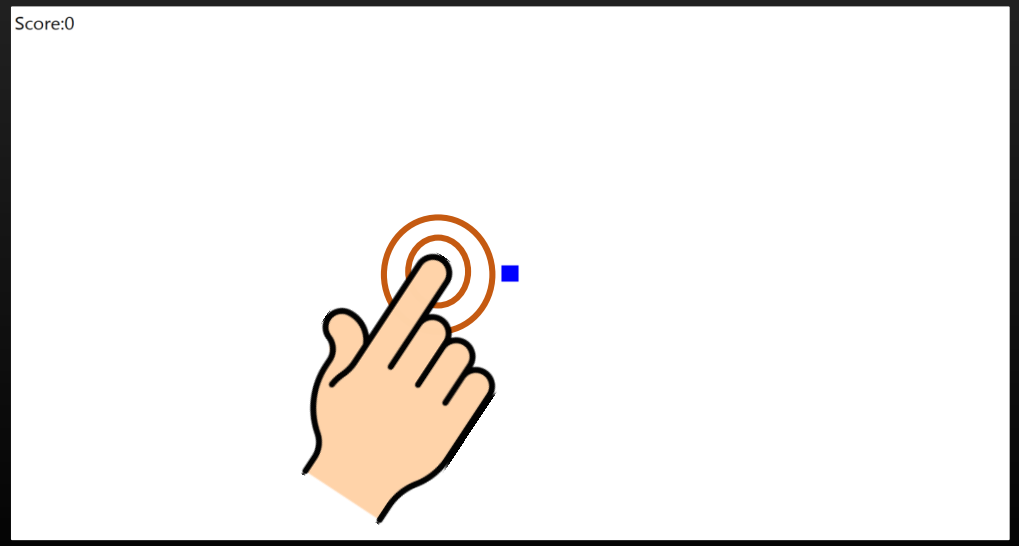
Edge Padding *(Target Misses)*	Sig.		
Location *(Target Misses)*	Sig.		
Response Time *(Target Size, Age Group)*	Sig.		
Input Drag *(Target Size)*	NA		

Sig. = Significance

Target Misses

- **Tablet**: Missed more when using touch (41%) than pen (32%)
- **Tabletop**: Missed 62% of targets
- **All Devices**: Children had a harder time touching the smallest targets than the largest targets



Touch Metrics Overview

Touch Metrics	Smartphone	Tablet	Tabletop
Holdovers	3.9%	Touch: 9.9% Pen: 5.8%	2.9%
Target Misses *(Target Size)*	Sig.	Sig. †	Sig.
Edge Padding *(Target Misses)*	Sig.		
Location *(Target Misses)*	Sig.		
Response Time *(Target Size, Age Group)*	Sig.		
Input Drag *(Target Size)*	NA		

Sig. = Significance

†Significant effect of Input Modality

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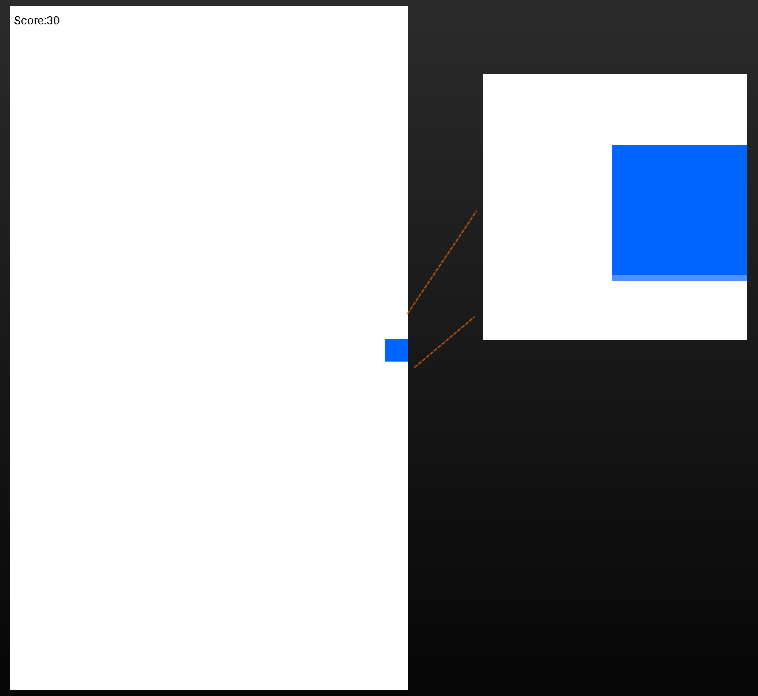
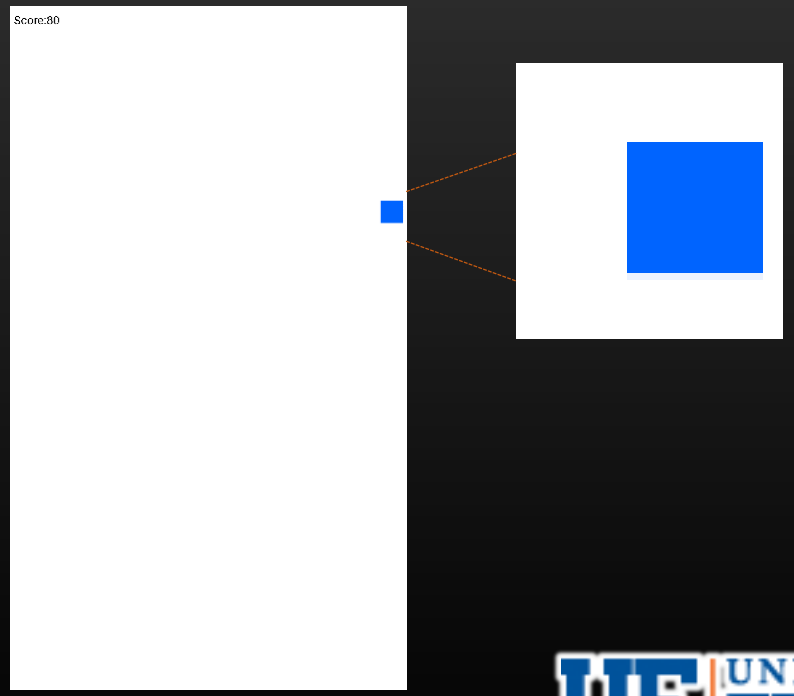
Edge Padding

- **Tablet**, **Tabletop**: No difference in miss rate for targets with and without edge padding



Without Edge Padding



With Edge Padding

Touch Metrics Overview

Touch Metrics	Smartphone	Tablet	Tabletop
Holdovers	3.9%	Touch: 9.9% Pen: 5.8%	2.9%
Target Misses *(Target Size)*	Sig.	Sig. †	Sig.
Edge Padding *(Target Misses)*	Sig.	NS	NS
Location *(Target Misses)*	Sig.		
Response Time *(Target Size, Age Group)*	Sig.		
Input Drag *(Target Size)*	NA		

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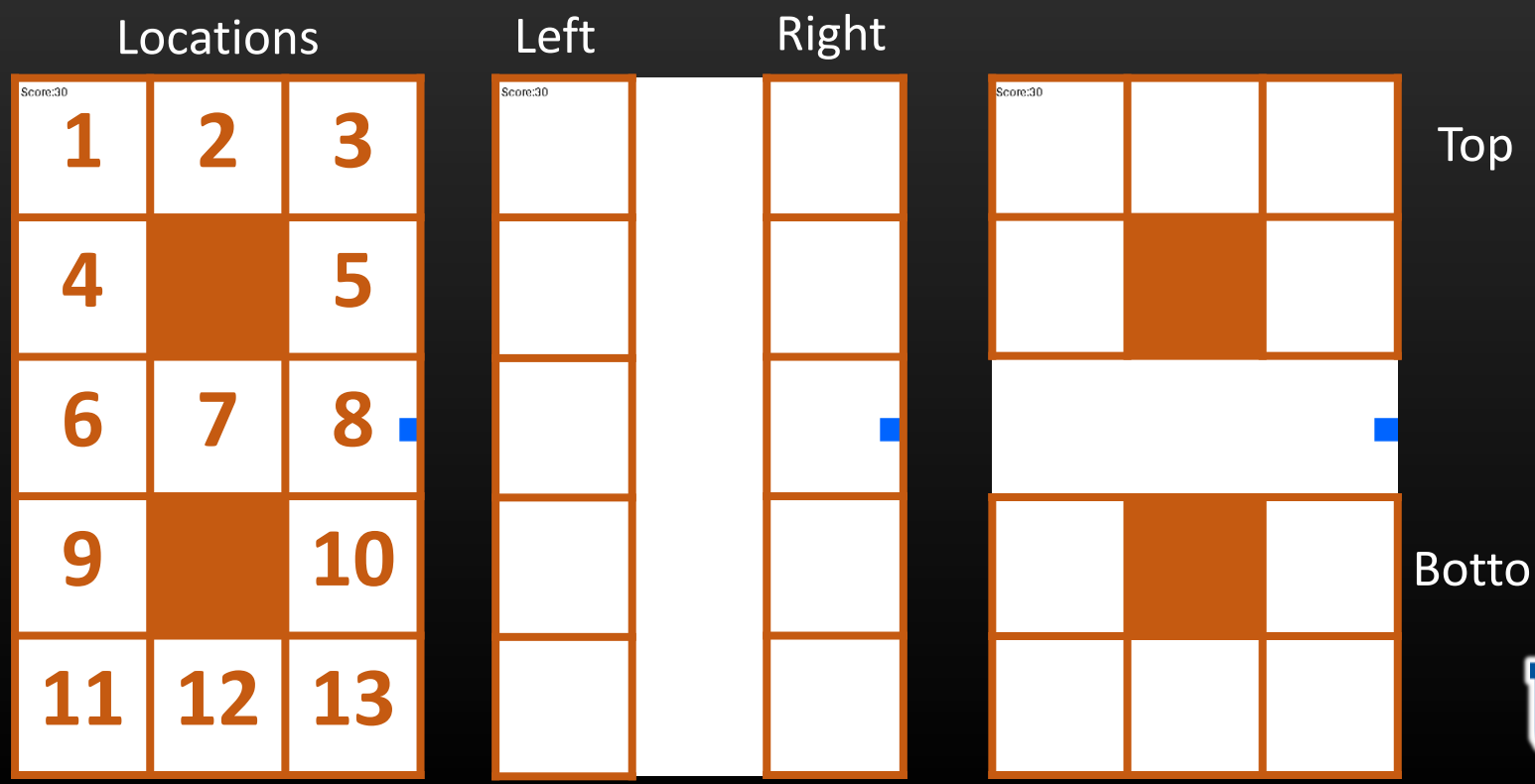
Location

- **Tablet**: Missed more on the left side and the top
- **Tabletop**: No effect of location



Touch Metrics Overview

Touch Metrics	Smartphone	Tablet	Tabletop
Holdovers	3.9%	Touch: 9.9% Pen: 5.8%	2.9%
Target Misses *(Target Size)*	Sig.	Sig. †	Sig.
Edge Padding *(Target Misses)*	Sig.	NS	NS
Location *(Target Misses)*	Sig.	Sig.	NS
Response Time *(Target Size, Age Group)*	Sig.		
Input Drag *(Target Size)*	NA		

Sig. = Significance

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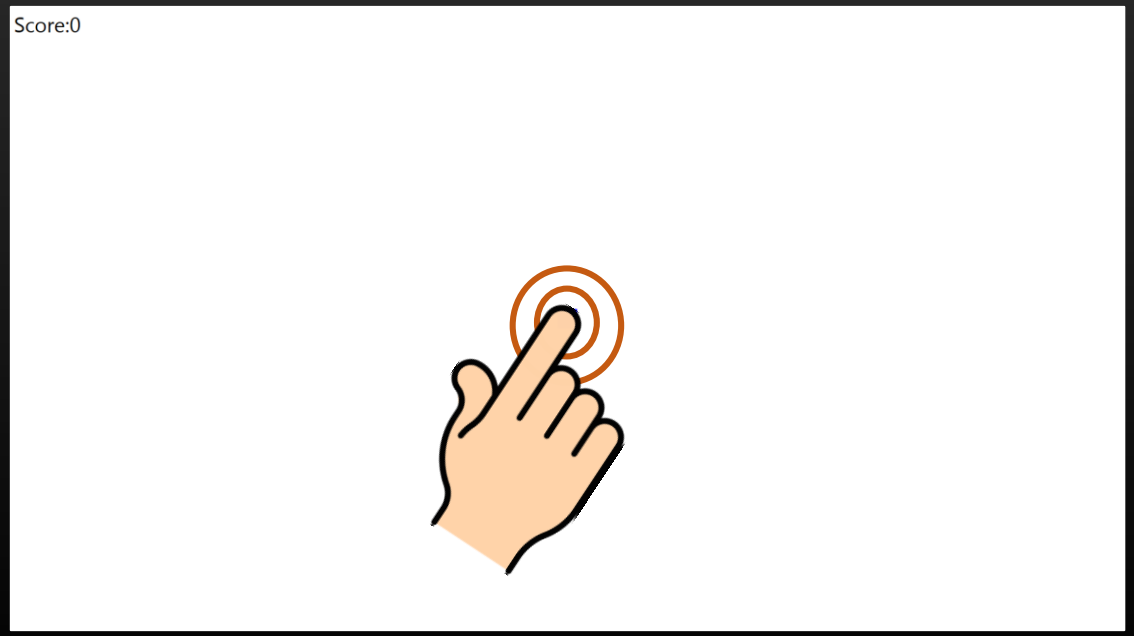
Response Time

- **Tablet**: Faster response time with touch than pen
- **All Devices**: Younger children had slower response times and children had slower response times on smaller targets



Touch Metrics Overview

Touch Metrics	Smartphone	Tablet	Tabletop
Holdovers	3.9%	Touch: 9.9% Pen: 5.8%	2.9%
Target Misses *(Target Size)*	Sig.	Sig. †	Sig.
Edge Padding *(Target Misses)*	Sig.	NS	NS
Location *(Target Misses)*	Sig.	Sig	NS
Response Time *(Target Size, Age Group)*	Sig.	Sig. †	Sig.
Input Drag *(Target Size)*	NA		

Sig. = Significance

†Significant effect of Input Modality

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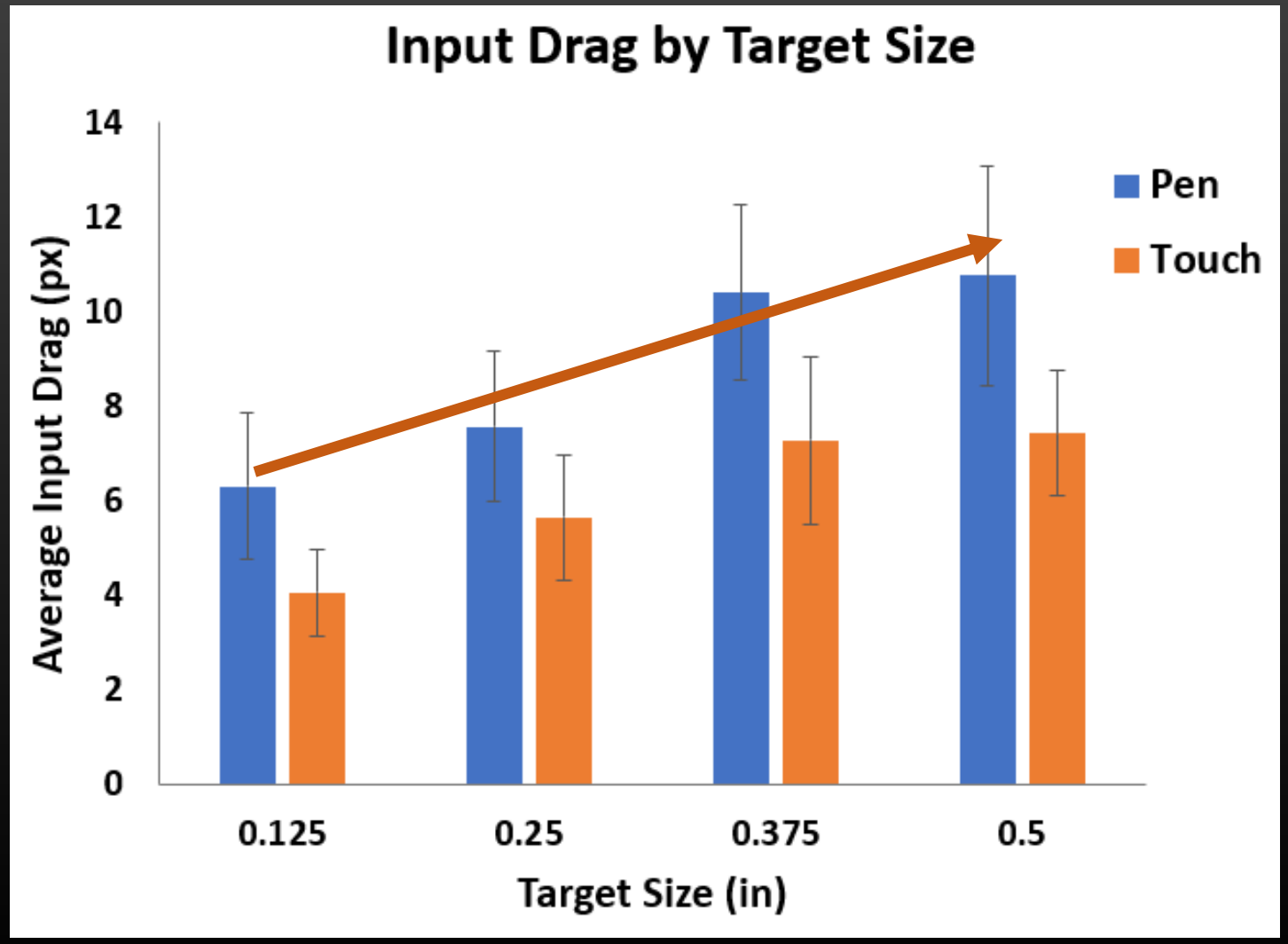
Input Drag (Tablet)



Touch Metrics Overview

Touch Metrics	Smartphone	Tablet	Tabletop
Holdovers	3.9%	Touch: 9.9% Pen: 5.8%	2.9%
Target Misses *(Target Size)*	Sig. 23%	Sig. † 41% (Touch)	Sig. 62%
Edge Padding *(Target Misses)*	Sig.	NS	NS
Location *(Target Misses)*	Sig.	Sig.	NS
Response Time *(Target Size, Age Group)*	Sig.	Sig. †	Sig.
Input Drag *(Target Size)*	NA	Sig. †	NA

Sig. = Significance

†Significant effect of Input Modality

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Limitation of Tabletop Platform

- Determine if child specific behavior
  - Pilot study with 8 adults (M = 26.38)
- Asked 10 (new) adults (M = 24) to touch the tabletop as fast as possible
  - Filtered out unintentional touches
  - Threshold: 57 ms

Impact of Tabletop Limitation

- 40% of children's data and 37% of adult's pilot data below threshold
- Removed children's touch events below threshold:
  - Holdover rate changed from 2.9% to 3.5% [Smartphone: 3.9%]
  - Average miss rate decreased from 62% to 55%

Gesture Interaction

Gesture Set

- **Tablet**:
  - 6 reps * 20 gestures * 2 modalities * 13 participants =

    <u>3,120</u> total gestures
- **Tabletop**:
  - 6 reps * 20 gestures * 18 participants =

    <u>2,160</u> total gestures

Anthony et. al (ITS 2012)

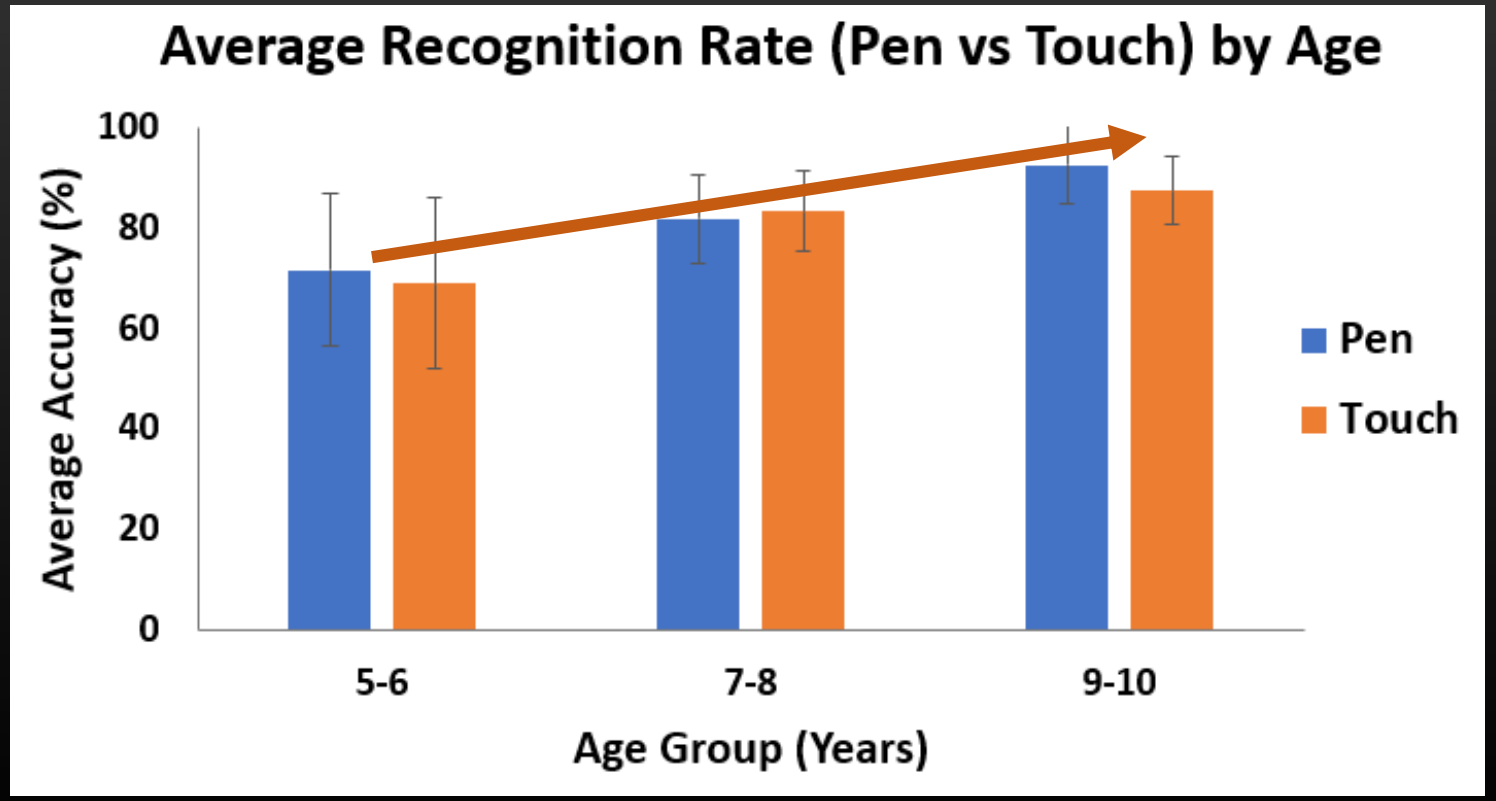
Gesture Recognition Experiments

- User Dependent
  - *within* user
- User Independent
  - *between* users

- $P Recognizer (Vatavu et al, ICMI 2012)

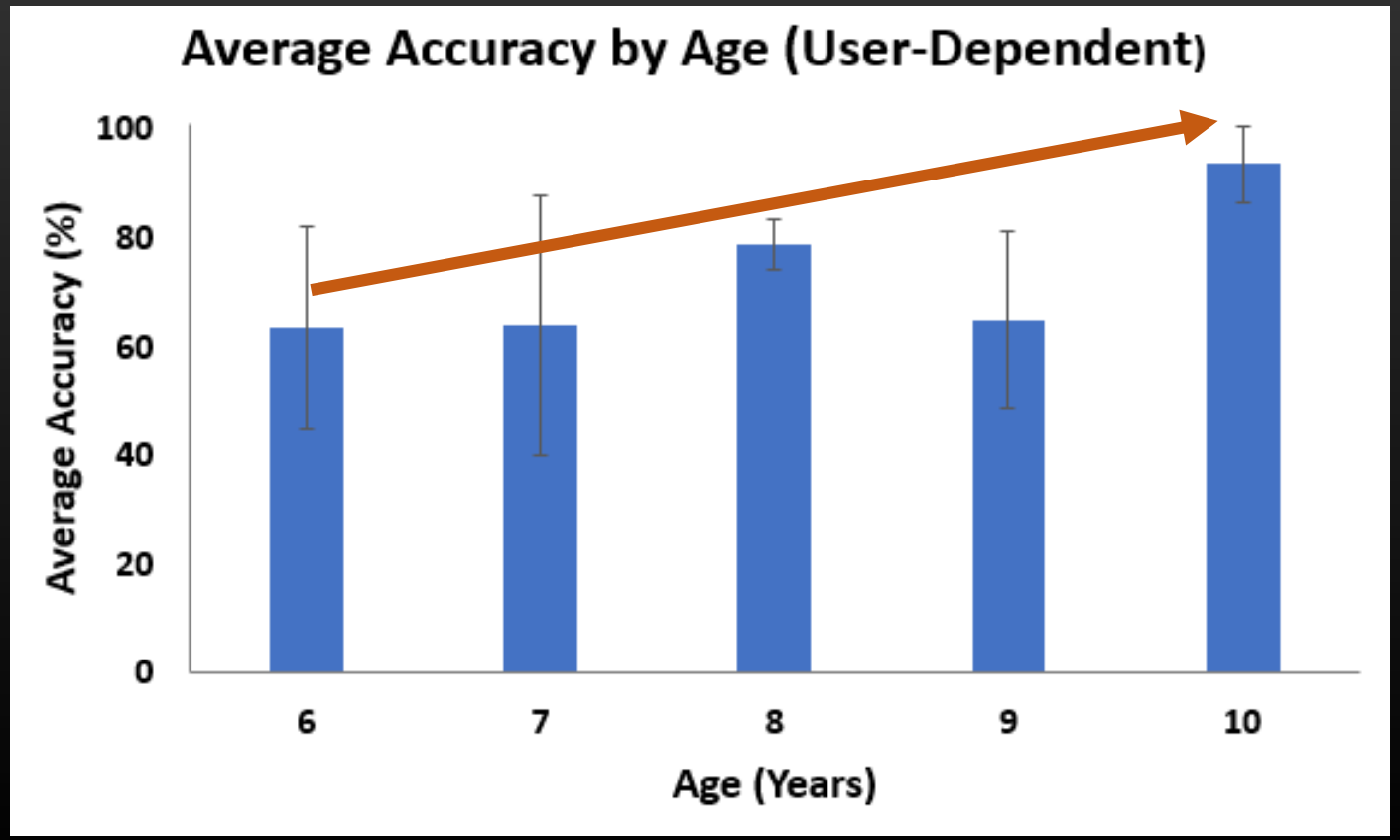
User Dependent and User Independent

- **Tablet**: Accuracy worse for younger children



User Dependent and User Independent

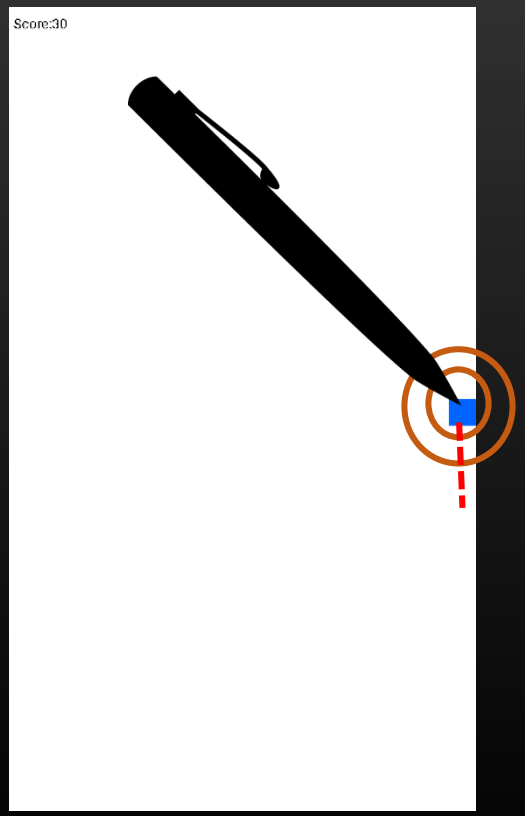
- **Tabletop**: Similar pattern for age but not significant



Design Implications

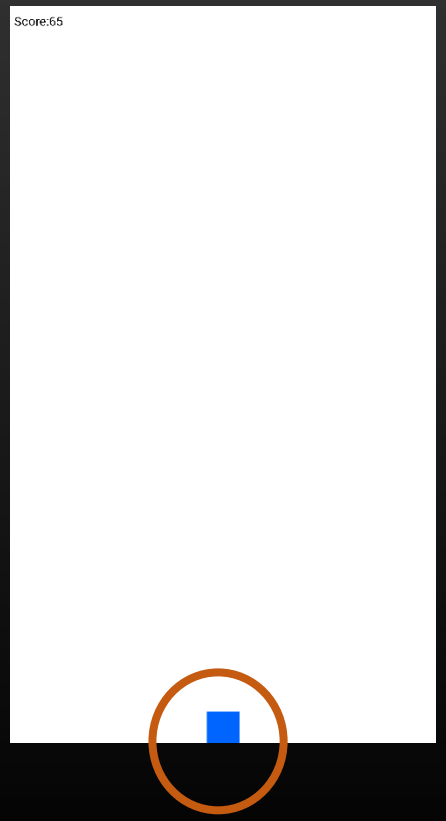
Design Implication

- Account for children's tendency to drag pens while touching targets



Design Implication

- For all devices, favor widgets toward the location of the child

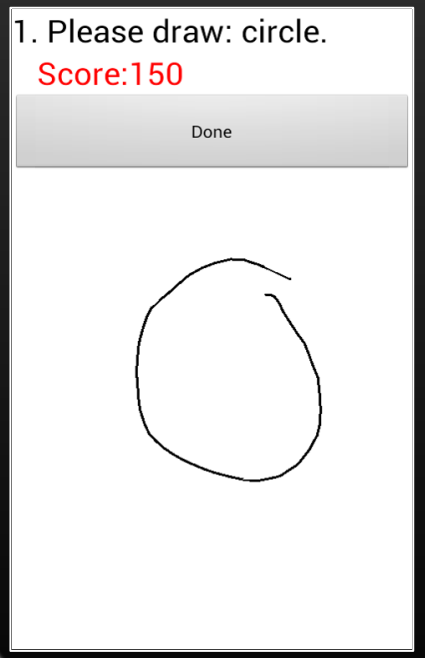


Design Implication

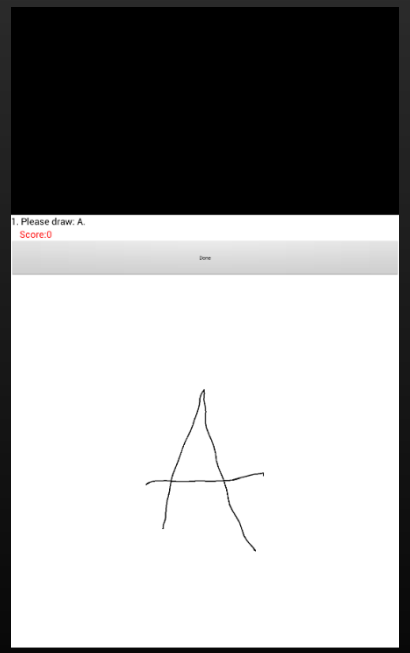
- For the tabletop, space widgets farther apart for both children and adults

Design Implication

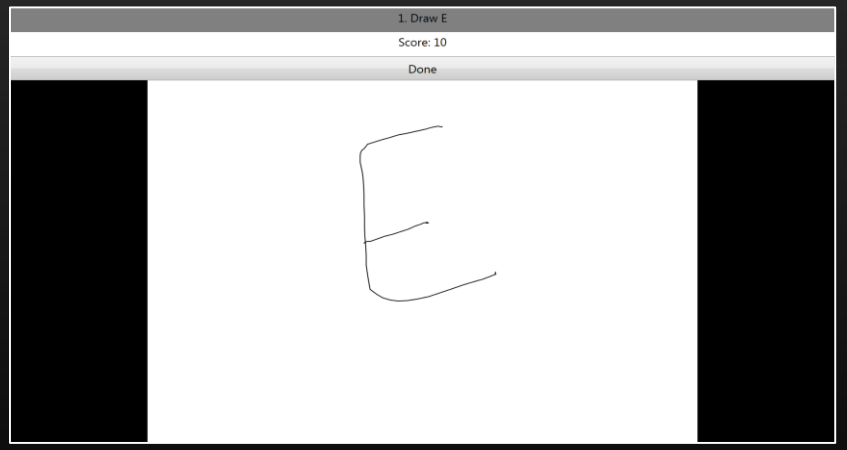
- Collect gesture data on whichever device is most convenient for the youngest children



Smartphone



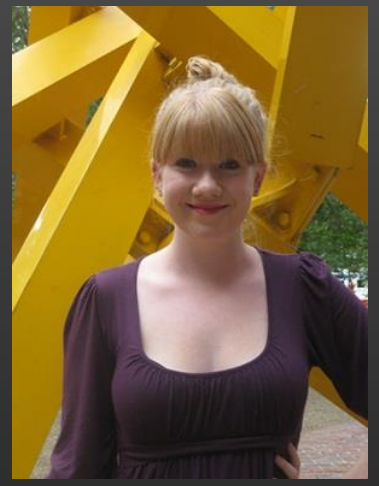
Tablet



Tabletop

Conclusion

- Differences in touch interactions between devices
- Gesture recognition rates were consistent across devices



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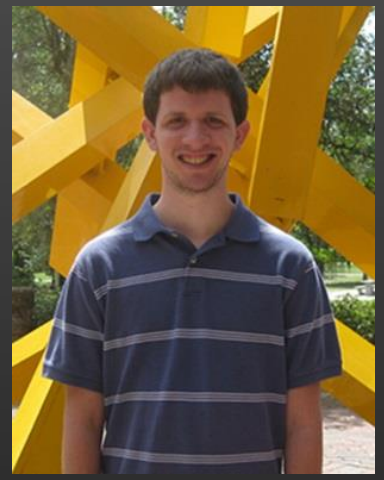

Alex Shaw

Thank you!

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Dr. Lisa Anthony

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Touch Metrics Overview

Touch Metrics	Smartphone	Tablet	Tabletop
Holdovers	3.9%	Touch: 9.9% Pen: 5.8%	2.9%
Target Misses *(Target Size)*	Size p<.0001	Size p<.0001 *Input p<.0001	Size p<.0001
Edge Padding *(Target Misses)*	p<.0001	NS	NS
Location *(Target Misses)*	Vertical p<.0001 Horizontal p<.05	Vertical p<.0001 Horizontal p<.01	NS
Response Time *(Target Size, Age Group)*	Size p<.0001 Age p<.0001	Size p<.0001 Age p<.05 *Input p<.0001	Size p<.01 Age p=.05
Input Drag *(Target Size)*	NA	Size p<.0001 *Input p<.001	NA

*Significant effect of Input Modality