Input for People with Motor Impairments

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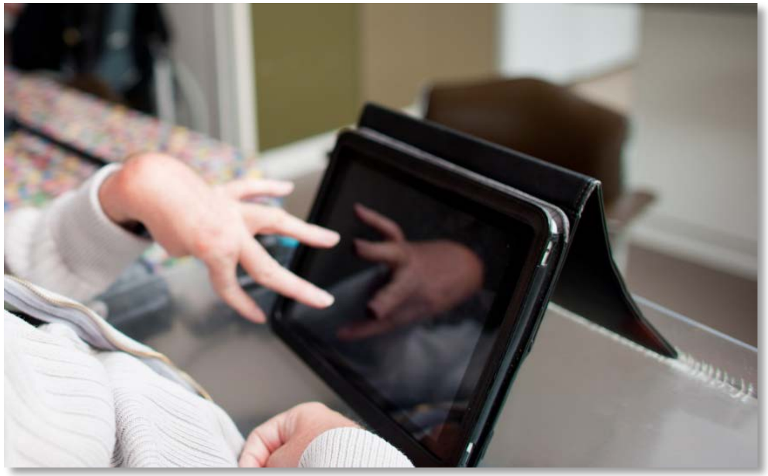
Motor Impairments

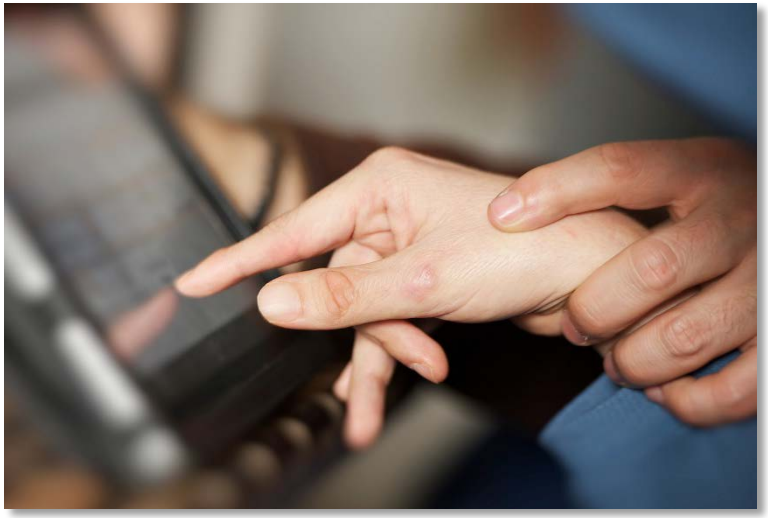
Affect **35.2 million adult Americans** (15% of the adult population).

Cerebral palsy, muscular dystrophy, spinal cord injury, peripheral neuropathy, ALS, Parkinson's disease, multiple sclerosis, Friedreich's ataxia, stroke, loss or damage of limbs, and arthritis.

Potential Challenges

Rapid fatigue
Poor coordination
Low strength
Slow movements
Tremor
Spasm
Stiffness
Numbness
Pain
Difficulty gripping
" lifting
" holding
" holding still
" forming hand postures
" controlling movement direction
" controlling movement distance





Two Main Strategies for Input

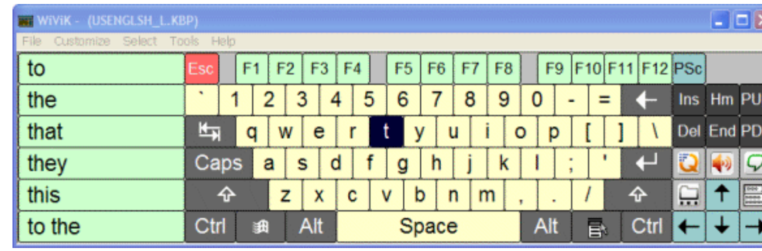
Assistive Technology

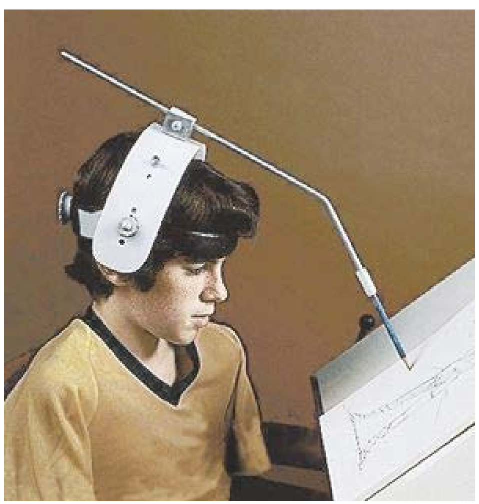
Make **specialized input technologies** designed specifically for people with motor impairments.

Accessible Computing

Add **accessible input to mainstream systems** through adaptable and adaptive software.

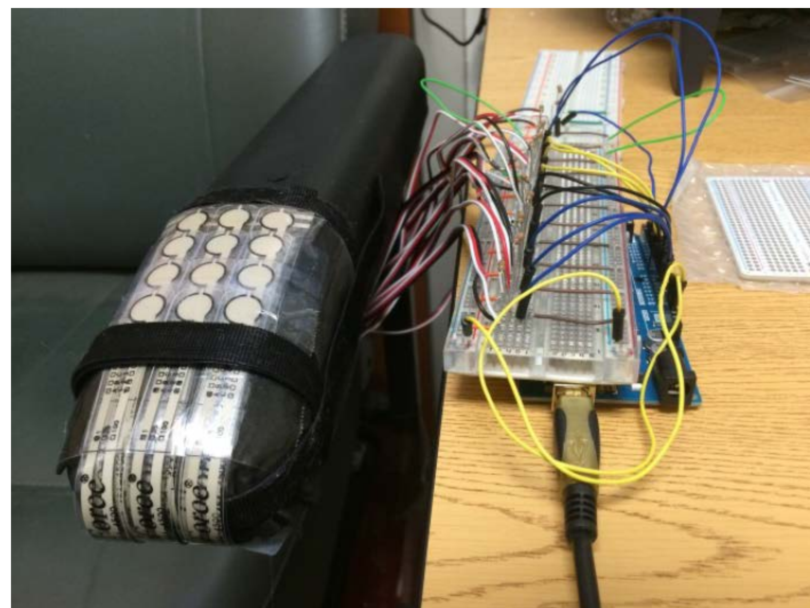
Specialized Input





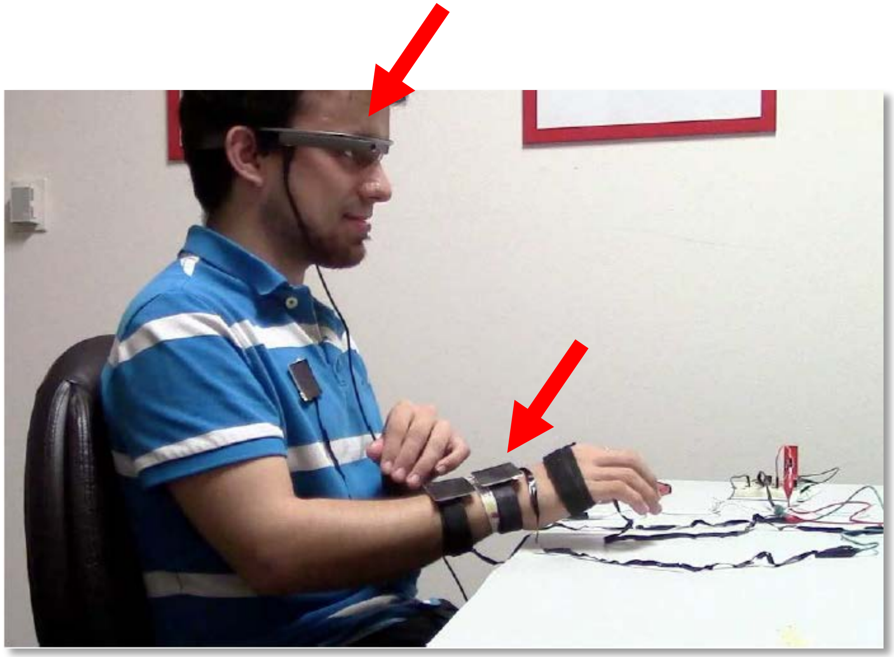
Gest-Rest (Carrington et al. 2014)

A pressure-sensitive flexible touchpad incorporated into wheelchair armrests enabling gestures for controlling computer applications.



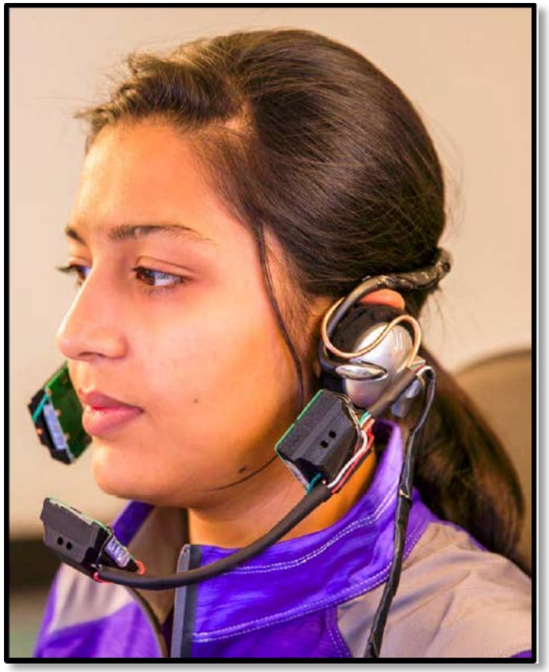
Wearable Touchpads (Malu & Findlater 2015)

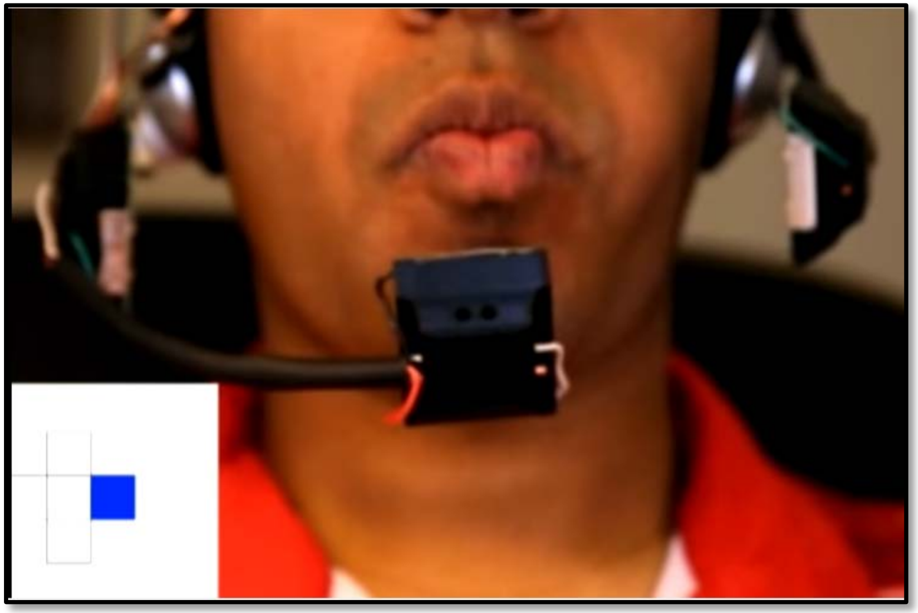
Small worn touchpads allow people with motor impairments to control Google Glass with minimal reaching or straining.



Tongue-in-Cheek (Goel et al. 2015)

Non-invasive Doppler radar sensing of the movement of the cheeks to detect 8 different facial gestures.





Pros and Cons

Pros	Cons
Recognizes unique access needs of people with motor impairments	Specialized technologies can be expensive or difficult to procure
Develops highly tailored solutions	Specialized devices may "mark" people as having a disability
Specialized technologies often spur mainstream breakthroughs	

Mainstreaming Accessible Input

Make the keyboard easier to use

When you select these tools, they will automatically start each time you sign in.

Control the mouse with the keyboard

☐ Turn on Mouse Keys

Use the numeric keypad to move the mouse around the screen.

Set up Mouse Keys

Make it easier to type

☐ Turn on Sticky Keys

Press keyboard shortcuts (such as CTRL+ALT+DEL) one key at a time.

Set up Sticky Keys

☐ Turn on Toggle Keys

Hear a tone when you press CAPS LOCK, NUM LOCK, or SCROLL LOCK.

☐ Turn on Toggle Keys by holding down the NUM LOCK key for 5 seconds

☐ Turn on Filter Keys

Ignore or slow down brief or repeated keystrokes and adjust keyboard repeat rates.

Set up Filter Keys

Double-click speed

Double-click the folder to test your setting. If the folder does not open or close, try using a slower setting.

Speed: Slow Fast

ClickLock

☐ Turn on ClickLock Settings...

Enables you to highlight or drag without holding down the mouse button. To set, briefly press the mouse button. To release, click the mouse button again.

Snap To

☐ Automatically move pointer to the default button in a dialog box

Character repeat

Repeat delay:

Long Short

Repeat rate:

Slow Fast

Steady Clicks (Trewin et al. 2006)

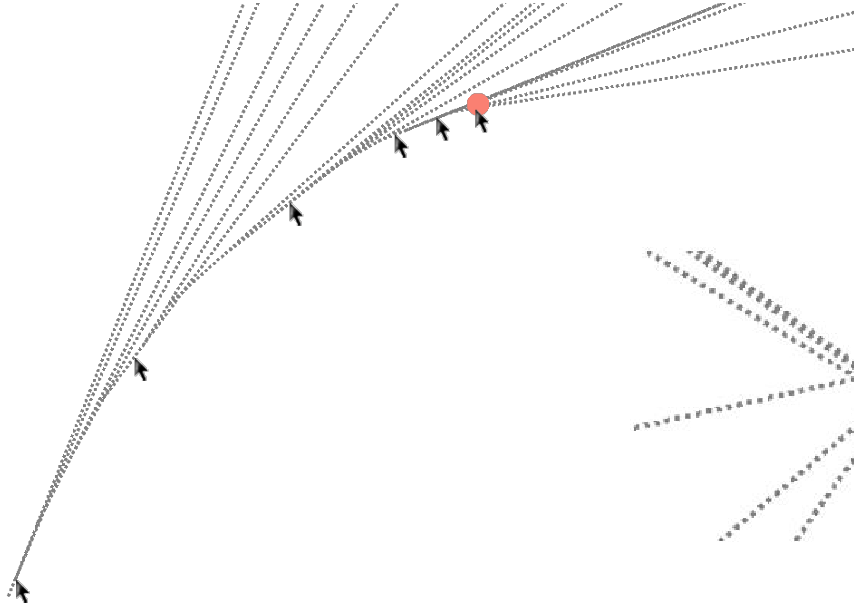
Freezes the mouse cursor when the mouse button is down to prevent slips while clicking, and disallows accidental clicks when the mouse is moving quickly.

Reduced misses by about 74%.

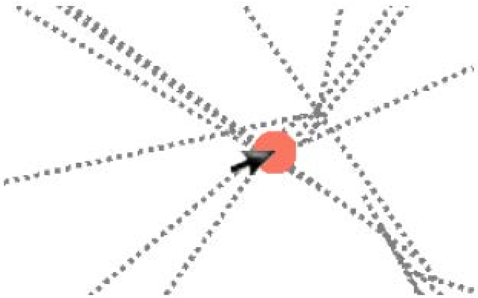
Photo: Gajos et al. 2008

Angle Mouse (Wobbrock et al. 2009)

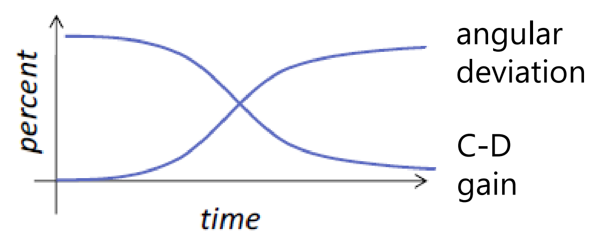
Adapts the mouse C-D gain to make targets bigger in motor-space based on the spread of movement angles.



Continuously observe the spread of angles during movement



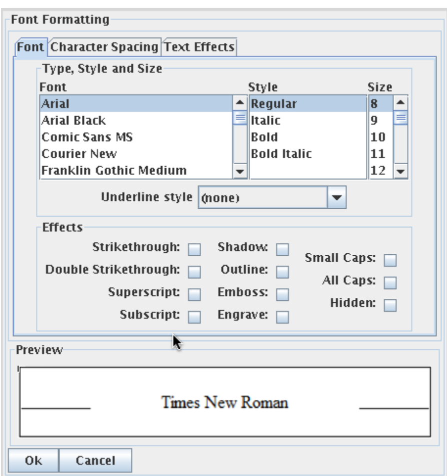
Angles diverge when acquiring targets



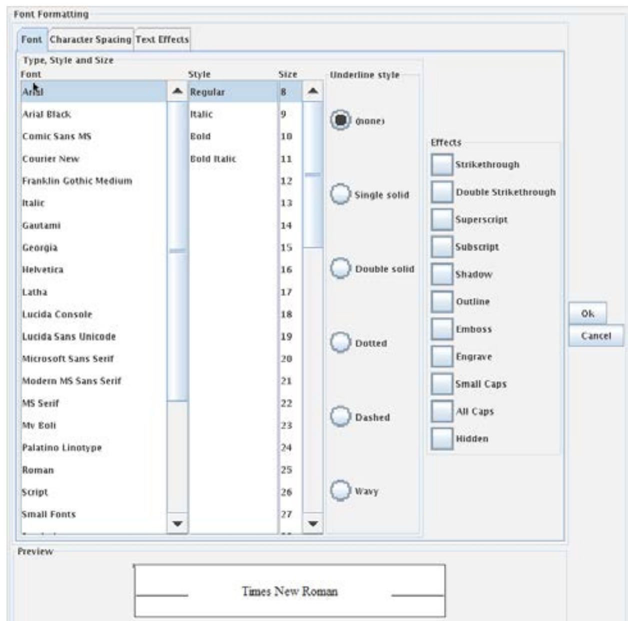
Adapt mouse C-D gain to make targets bigger in motor-space

SUPPLE (Gajos et al. 2007, 2008, 2010)

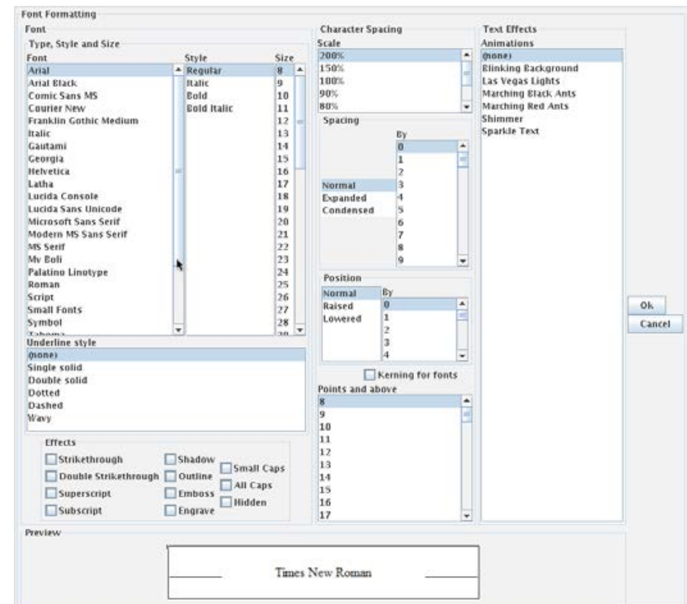
Adapt UI designs to a user's measured mouse pointing performance.



Microsoft Word font dialog



For someone with Cerebral Palsy

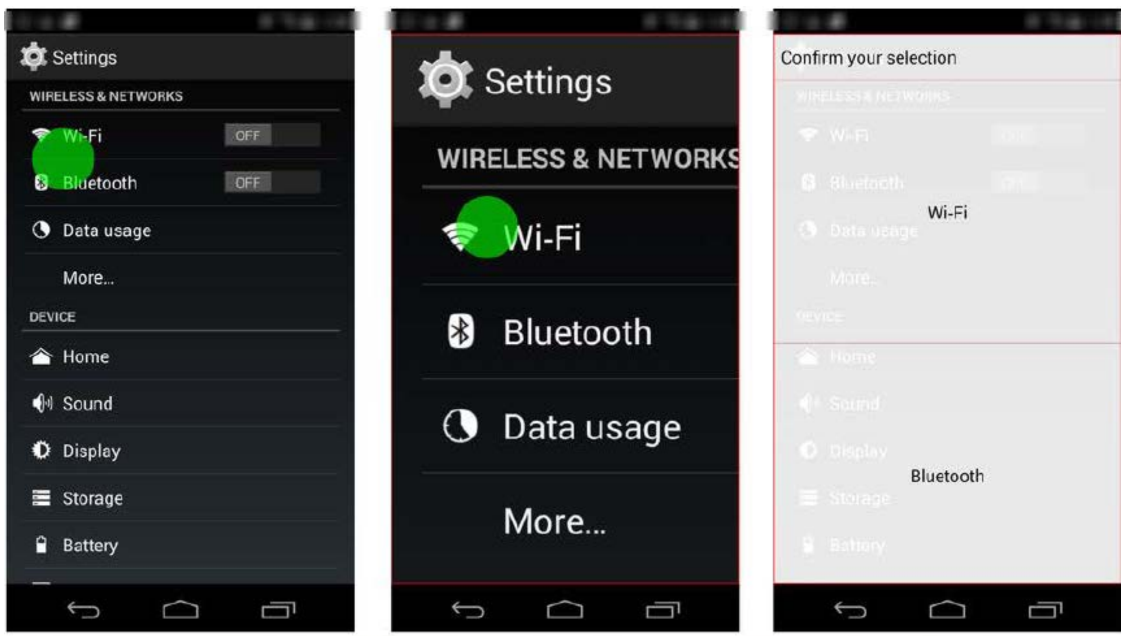


For someone with Muscular Dystrophy

Touch Guard (Zhong et al. 2015)

When a finger taps on multiple targets at once, a magnified view or a disambiguation list is shown.

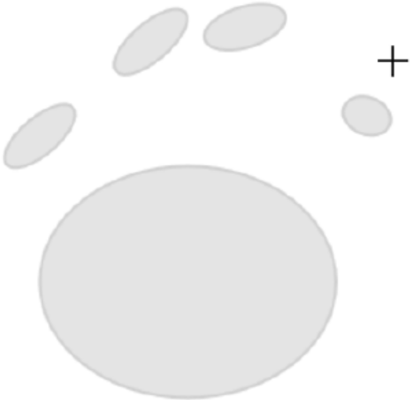
Results in a 65% reduction in tapping errors.



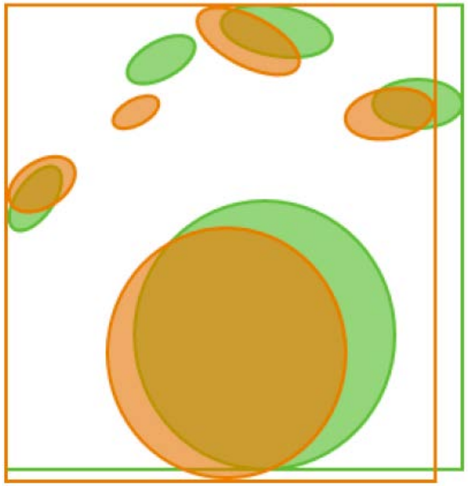
Smart Touch (Mott et al. 2016)

Model however people with motor impairments touch, and disambiguate that touch at runtime to infer intended targets.

Collect samples of touch however the user wants



Create and store a model of that touch



Resolve ambiguity at runtime via pattern matching

Pros and Cons

Pros	Cons
Commodity input devices are ubiquitous and cheap	May not be powerful enough to address severe disabilities
Built-in options are available to everyone	Insurance often does not cover multi-purpose technologies
Technologies may become more usable to everyone	
Software-only solutions can be downloaded	

Promising Developments

Gesture recognition is now widespread.

Eye-tracking is becoming mainstream.

Speech recognition has dramatically improved.

User modeling and **adaptation** have made big strides.

3-D printing is enabling custom assistive devices.

How can we capitalize?

How can we…

Create **self-optimizing input systems** that adapt to their users' abilities from everyday use?

Increase the availability of new or alternative **hardware input devices**?

Enable **cross-platform accessibility** for people with motor impairments with minimal reconfiguration?

Enable people with motor impairments to **easily share their solutions**?

Renewed Focus on ~~Dis-~~Ability

What a person <u>CAN</u> do

Sensing, measuring, and modeling a user's abilities

Ability-based user interfaces (Gajos et al. 2007, 2008, 2010)

Ability profiles in the cloud (Vanderheiden et al. 2013, 2014)

Ability-Based Design (Wobbrock et al. 2011, 2014)

Thank You

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