A COMPARISON OF THE PERFORMANCE OF WEBCAM VS. INFRARED EYE TRACKING TECHNOLOGY

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Motivation for the study

- Web-based eye-tracking may have the potential to:
  - Bring eye tracking studies within reach of a much broader range of practitioners
  - Greatly reduce recruiting difficulties (geographic, scheduling, etc.)
  - Allow larger sample sizes
- Very little research was found that directly compares web-based and infrared eye tracking technologies, and none within the context of usability or marketing

Existing Research

- Primarily looks at the use of web-based systems as alternate input option (i.e., for users with severe disabilities) (see, e.g., Jacob, 1990)
- Most common evaluation method looks at the angle between actual and estimated eye gaze (see, e.g., Bohme et al., 2006; Morimoto et al., 1999; Sewell & Komogortsev, 2010)
- Only two studies found that explicitly compare the two technologies (San Augustin & Skovsgaard, 2009; Skovsgaard et al., 2011)

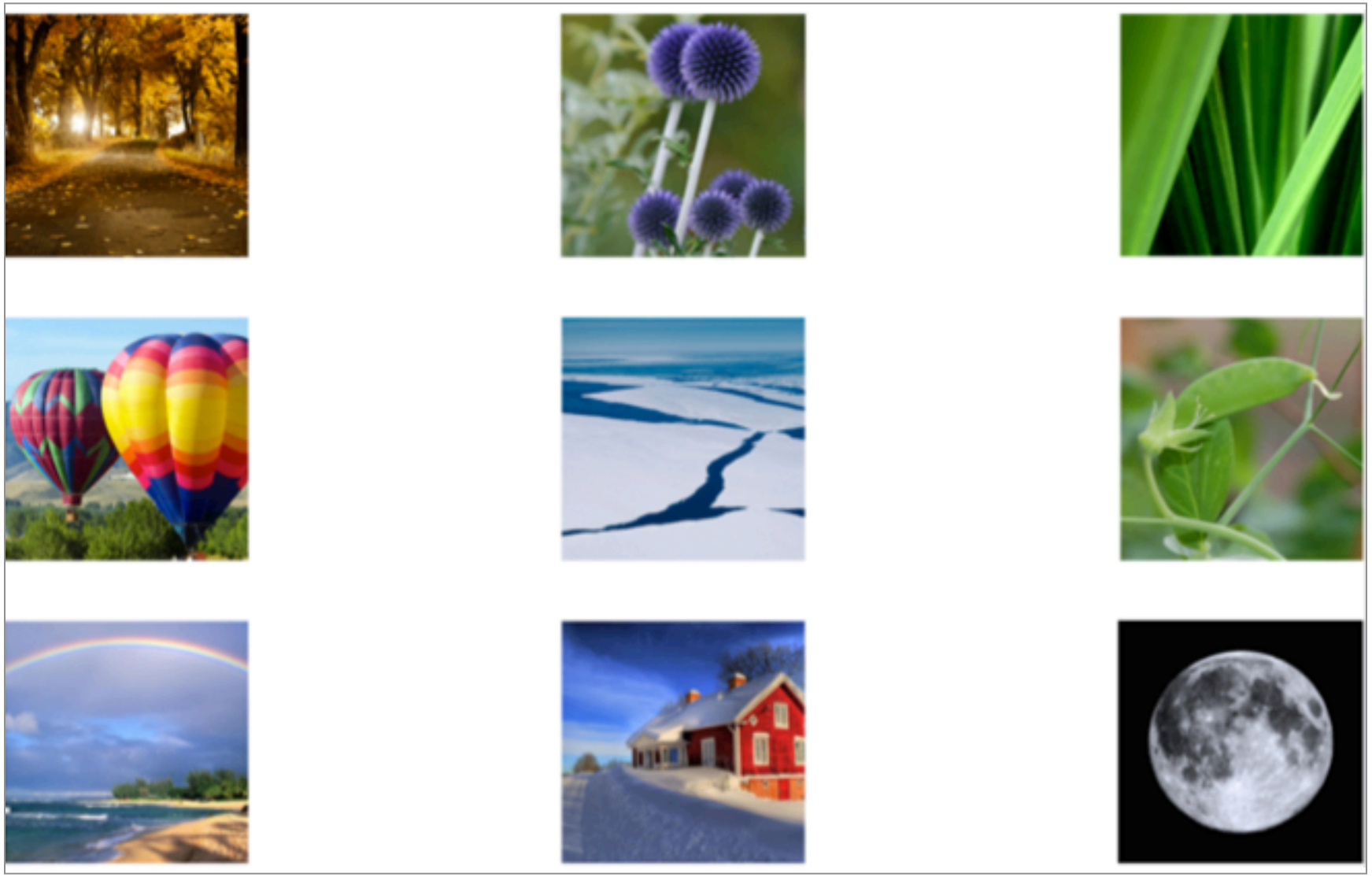
Research Question

- How does the accuracy of the two platforms compare when the purpose of the eye tracking study is to measure where on the screen a user focuses his/her attention?

Study Design

- Conducted in November/December 2012
- 15 minute sessions
- Within-subjects design:
  - Participants viewed 2 sets of nine images twice, once using SMI, once using Sticky
- Participants were instructed to maintain their eye gaze within the border of each image while it remained on the screen (3 seconds)

Large Images: 300 x 300 Pixels



Small Images: 150 x 150 Pixels

Measures Used

- Percent Noted - the percent of participants who had at least one fixation within the stimulus during the three-second exposure.
- Dwell Time – the cumulative total fixation duration in milliseconds, averaged across participants.

Study Design

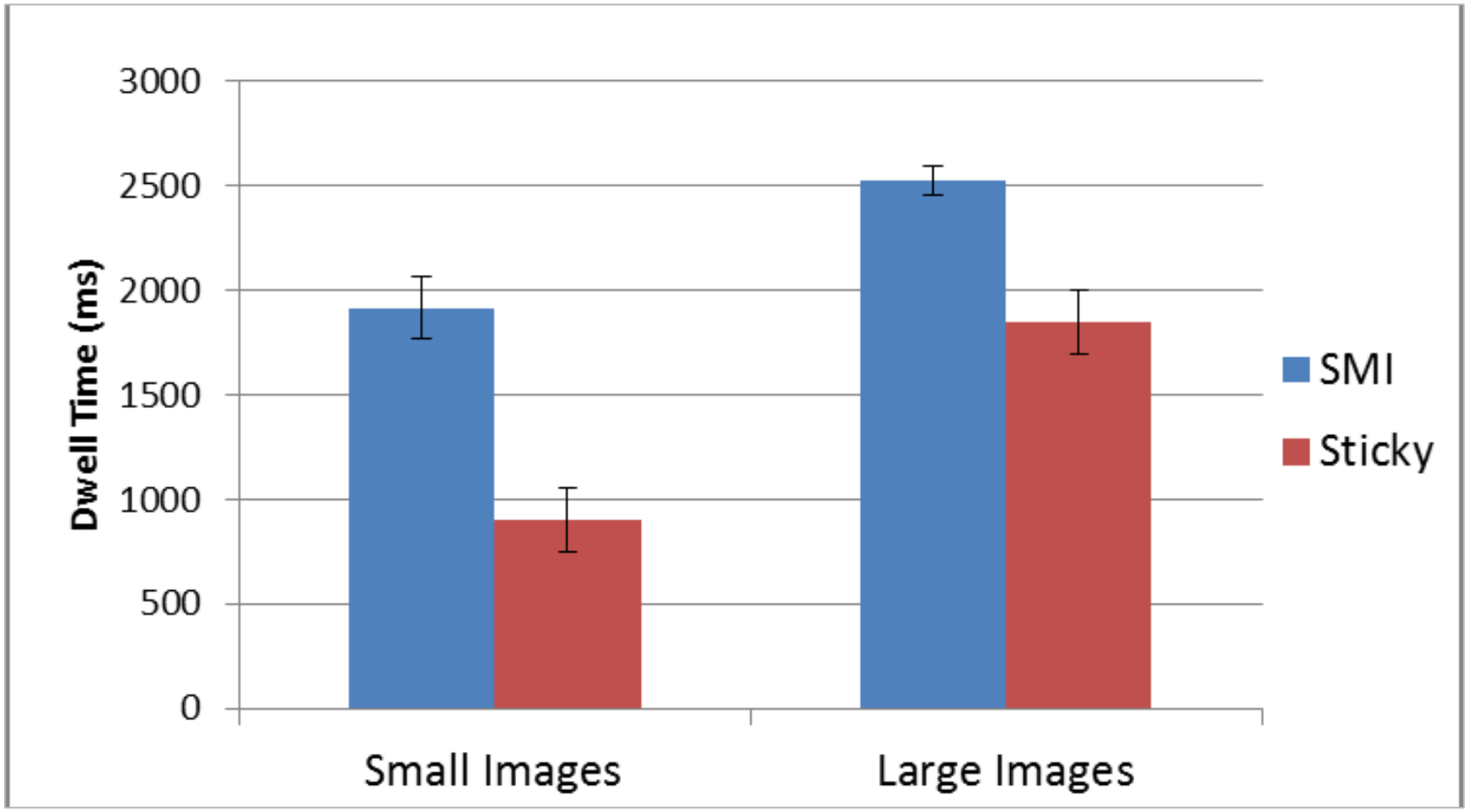
- Order of presentation of technology was *intended to be* counterbalanced
  - Technical difficulties
- Order of presentation of images was arbitrary
  - Participants could not predict where on the screen the next image would appear
- 77 total participants, but substantial attrition due to technical issues
  - Complete data obtained for 27 participants:
    - 70% men
    - 63% under age 35

Analyses

- For dwell time:
  - Repeated Measures ANOVA
  - Pairwise t-tests for each image size and position
- For percent noted:
  - McNemar pairwise tests for each image size and position
- Analysis of the amount of bleed outside the borders of the images

ANOVA Results (Dwell time)

- Significant main effects:
  - Image size ($p<.001$)
  - Image location ($p<.001$)
  - Technology ($p<.001$)
- Significant interaction effects:
  - Image size and technology ($p<.001$)
  - Image location and technology ($p<.001$)



Dwell Time by Image Size and Technology

(including 95% CI)

Pairwise Tests: Large Images

	Sticky	SMI	*p*
Percent Noted	93%	100%	0.5
Dwell time (msec)	2063	2259	0.4

	Sticky	SMI	*p*
Percent Noted	100%	100%	--
Dwell time (msec)	2115	2555	0.006

	Sticky	SMI	*p*
Percent Noted	93%	100%	0.5
Dwell time (msec)	1889	2249	0.09

	Sticky	SMI	*p*
Percent Noted	81%	100%	0.06
Dwell time (msec)	1533	2561	<0.001

	Sticky	SMI	*p*
Percent Noted	100%	100%	--
Dwell time (msec)	2007	2865	<0.001

	Sticky	SMI	*p*
Percent Noted	93%	100%	0.5
Dwell time (msec)	1815	2497	<0.001

	Sticky	SMI	*p*
Percent Noted	96%	100%	--
Dwell time (msec)	1796	2532	<0.001

	Sticky	SMI	*p*
Percent Noted	96%	100%	--
Dwell time (msec)	1996	2621	<0.001

	Sticky	SMI	*p*
Percent Noted	81%	100%	0.06
Dwell time (msec)	1433	2584	<0.001

$p<0.10$ $p<0.01$

Pairwise Tests: Small Images

	Sticky	SMI	p
Percent Noted	70%	96%	0.04
Dwell time (msec)	1270	1312	0.89

	Sticky	SMI	p
Percent Noted	74%	96%	0.07
Dwell time (msec)	1085	2293	<0.001

	Sticky	SMI	p
Percent Noted	59%	81%	0.11
Dwell time (msec)	956	960	0.98

	Sticky	SMI	p
Percent Noted	52%	93%	0.003
Dwell time (msec)	722	2165	<0.001

	Sticky	SMI	p
Percent Noted	63%	100%	0.002
Dwell time (msec)	793	2722	<0.001

	Sticky	SMI	p
Percent Noted	41%	93%	<0.001
Dwell time (msec)	707	1908	<0.001

	Sticky	SMI	p
Percent Noted	59%	100%	<0.001
Dwell time (msec)	885	1892	<0.001

	Sticky	SMI	p
Percent Noted	78%	100%	0.03
Dwell time (msec)	1137	2145	<0.001

	Sticky	SMI	p
Percent Noted	48%	93%	0.002
Dwell time (msec)	589	1847	<0.001

p<0.10 p<0.01

Image Bleed: Large Images

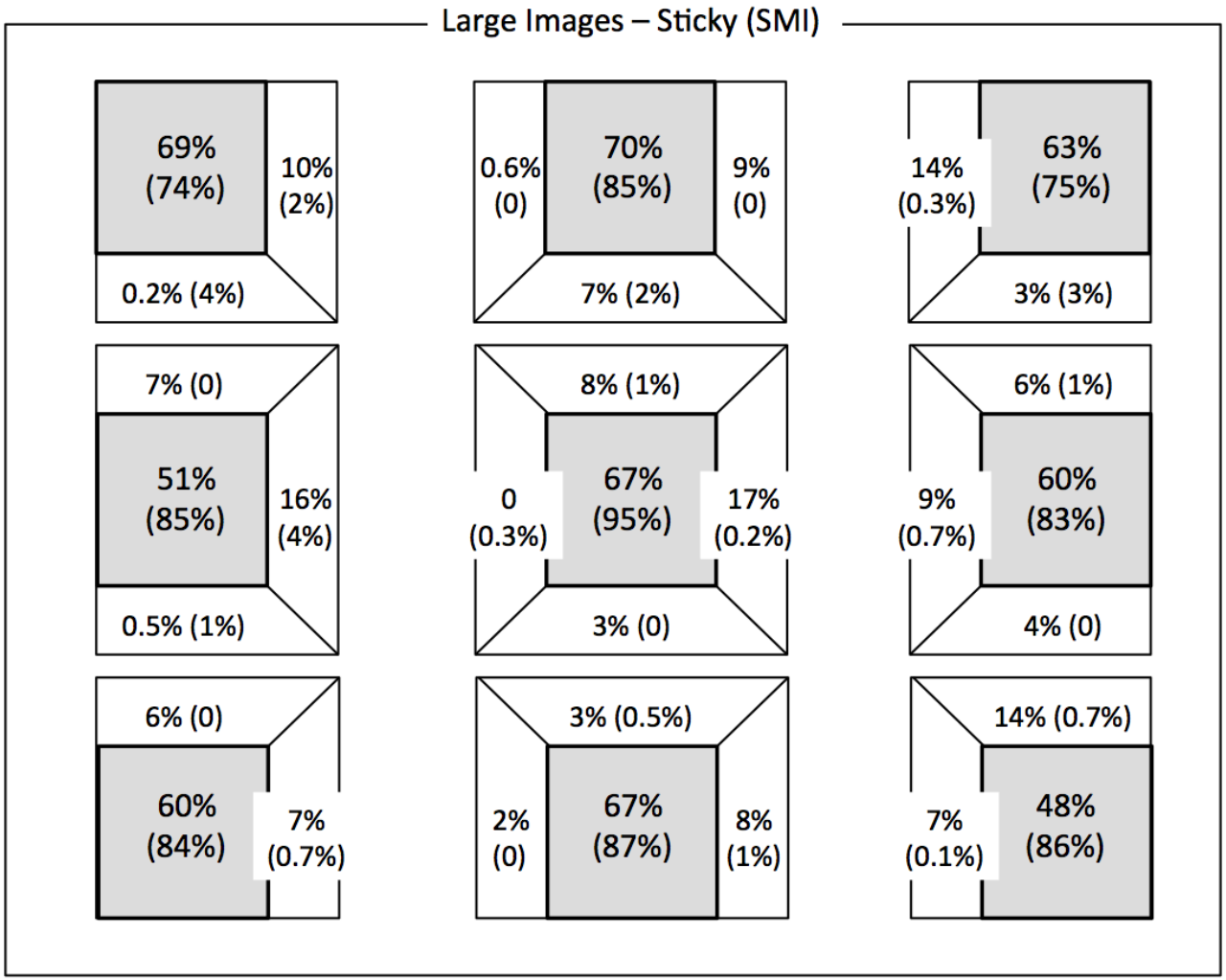
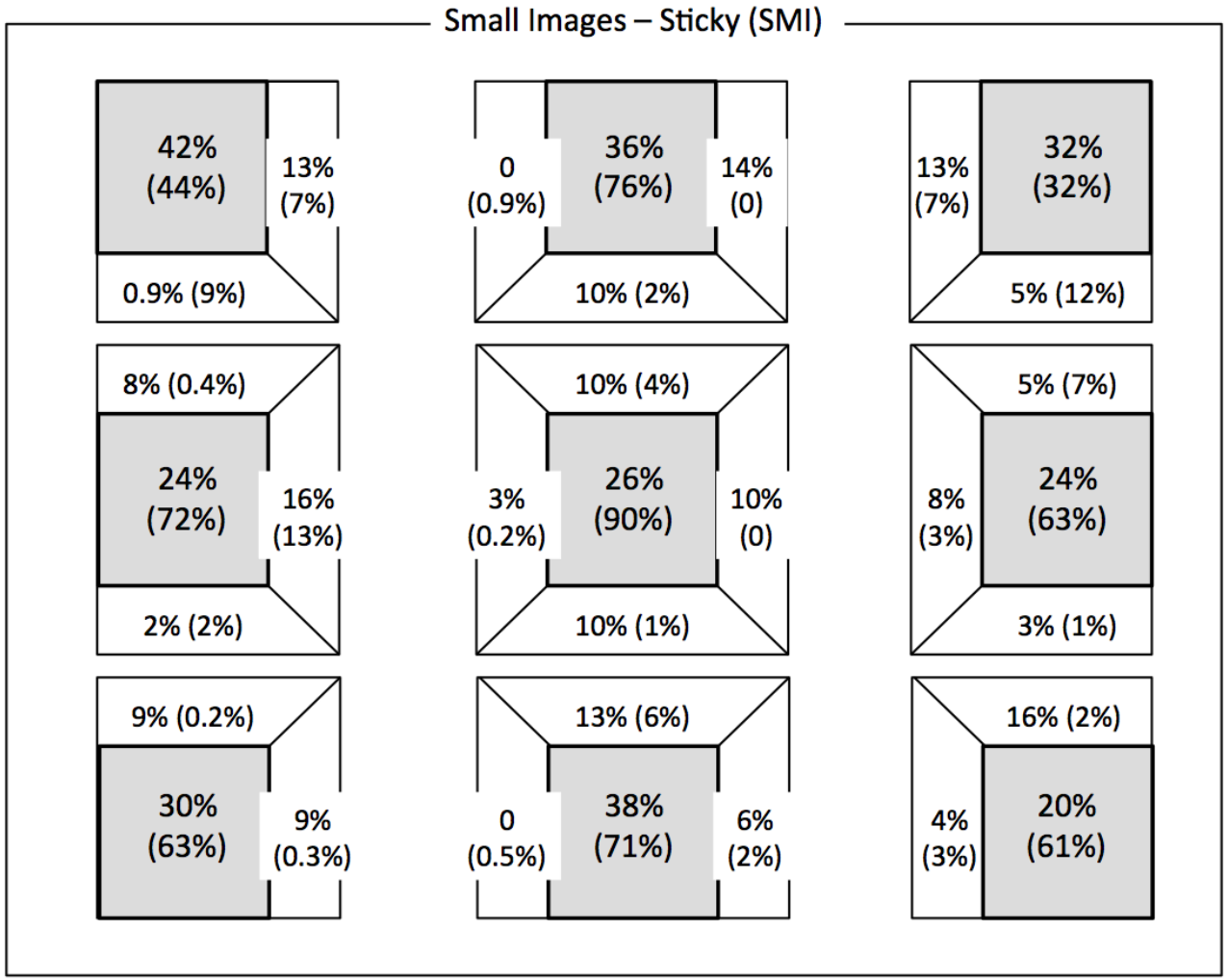


Image Bleed: Small Images



Findings

- For percent noted, no significant difference for 7 out of 9 large images
- Significant differences in most cases for small images and for dwell time
- Bleed varied substantially but generally bleed is greater:
  - For small images
  - For the Webcam technology
  - For images in the corner
  - In the direction of the center of the screen

Conclusions

- Unsurprisingly, the infrared technology generally outperformed the webcam system.
- The webcam technology may be a viable alternative when:
  - The stimulus is of reasonable size
  - The stimulus is not too close to the edges of the screen
  - It is not necessary to evaluate dwell time

Limitations/Further Study

- Only one infrared and one webcam system included in the study: can't necessarily generalize to other systems/ manufacturers
- Continual improvements to the webcam technology; these results represent performance at a given point in time
- Other variables:
  - Other sizes/shapes/locations/exposure times of images
  - Subjective feedback from participants
  - Other types of eye tracking technology, e.g., goggles
  - Effect of participant characteristics, e.g., age

References

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