Impact of Item Drift on Candidate Ability Estimation

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Background

- Computerized adaptive testing
  - Item response theory (IRT)
  - Item pools
  - Ability estimates
- Drift of item parameters can occur over time
  - Security breaches
  - Shifts in instruction or changes in practice
- Accuracy of candidate ability estimates depends on accurate item parameter estimates

Overview of Relevant Literature

- Fixed Forms
  - Impact of item parameter drift on ability estimates is small, even with unidirectional drift (Wells, Subkoviak, & Serlin, 2002)
  - Ability estimates are robust to drift, even when abilities and item difficulties are not normally distributed (Stahl, Bergstrom, & Shneyderman, 2002; Witt, Stahl, Bergstrom, & Muckle, 2003)
  - Although results were mixed, longitudinally, item parameter drift may negatively impact the linking process and resulting candidate ability estimates (Wollack, Sung, & Kang, 2006)
- A real data and simulation study of a CAT program found minimal impact to score stability, though scale drift was also minimal (Guo & Wang, 2003)

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Purpose and Research Questions

- To investigate the impact of item difficulty drift on candidate ability estimates for variable-length CAT. Specifically,
  1. How robust are candidate ability estimates when item difficulty drift is present to varying degrees in a CAT item pool?
  2. To what extent are pass/fail decisions impacted when item difficulty drift occurs in a CAT item pool?

Data

- Two large-scale licensure examinations
- Variable-length computerized adaptive tests (CAT) scored using the Rasch model
- Exam 1: 18,004 candidates
- Exam 2: 52,765 candidates

Investigation Conditions

- Only item difficulty parameter drift (Rasch model)
- Conditions
  - Percentage of items with drift
    - 5%, 10%, 20%
  - Magnitude of drift
    - 0.50, 0.75, 1.00 logits
  - Direction of drift
    - All items easier, all items harder, half and half
- Conditions fully crossed resulting in 27 conditions for each exam

Analysis

- Item drift randomly introduced into the operational item pool
- 20% of items in the operational pool were randomly selected to exhibit item drift
  - Items for the 10% condition were randomly selected from the 20%
  - Items for the 5% condition were randomly selected from the 10%

Analysis (cont.)

- The magnitude and direction of drift were applied to all items
  - For example,
    - Percentage: 20%
    - Magnitude: 0.50
    - Direction: All easier
    - Drift of -0.50 was applied to all 20% of the items
- Candidate ability estimates were re-estimated by anchoring items using the drifted item difficulty estimates

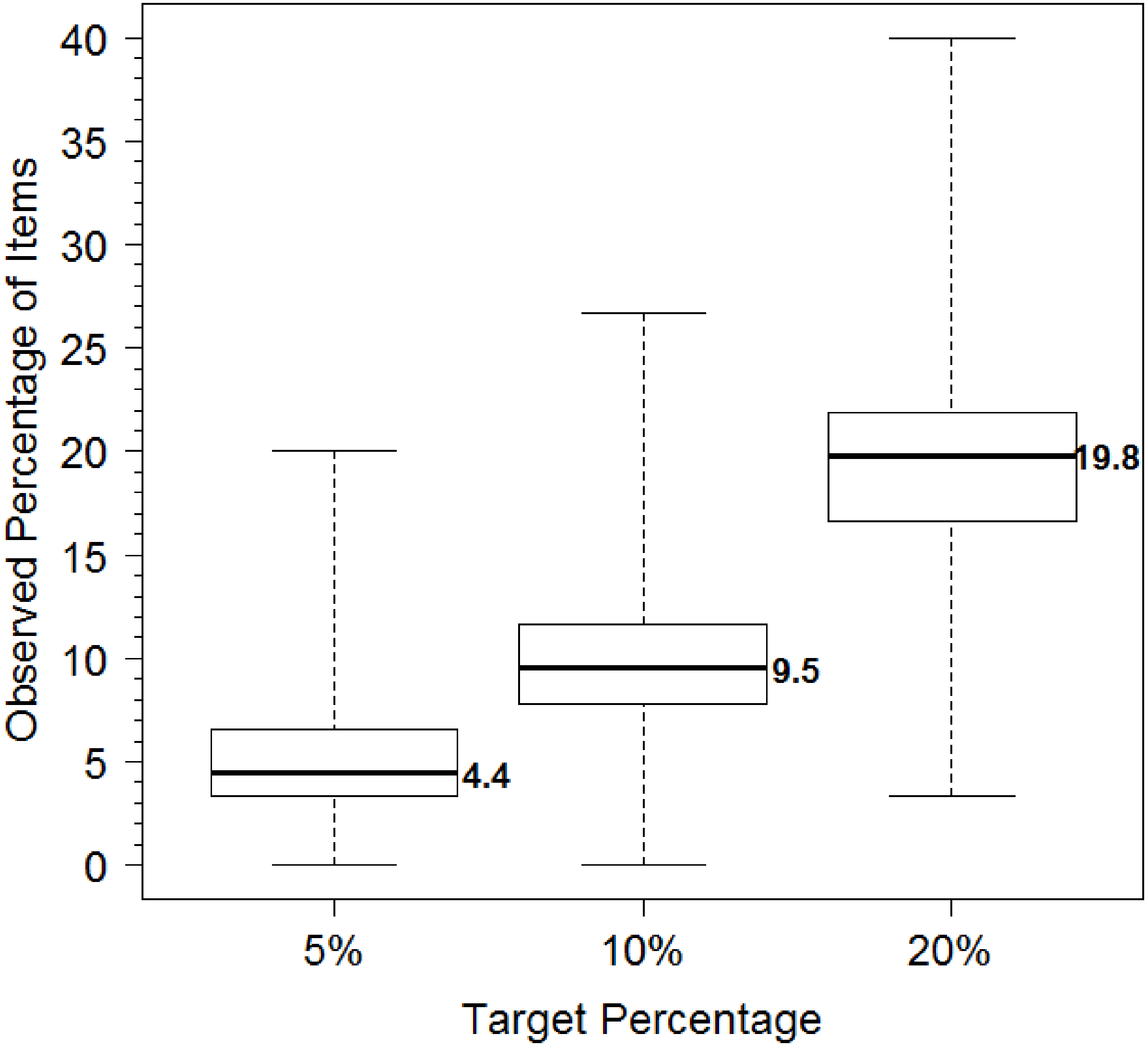
Evaluation

- Difference between re-calibrated candidate ability estimates and original candidate ability estimates
  - Re-calibrated candidate ability estimate minus original candidate ability estimate
  - Minimum, maximum, mean and standard deviation of differences
- Pass/fail decision consistency

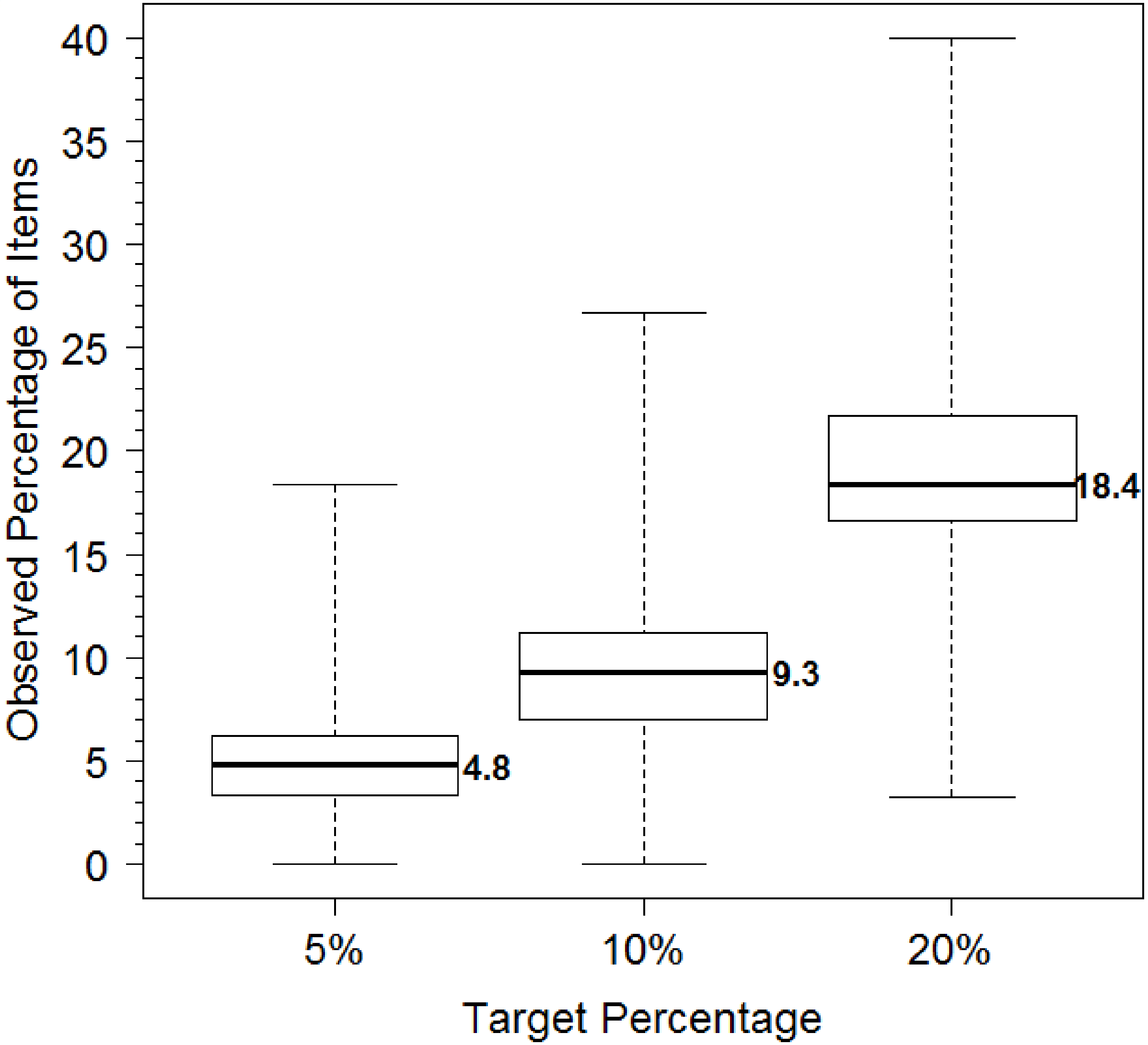
Results

- Percentage of drifted items on individual exams
- Theta differences
- Pass/fail decision consistency

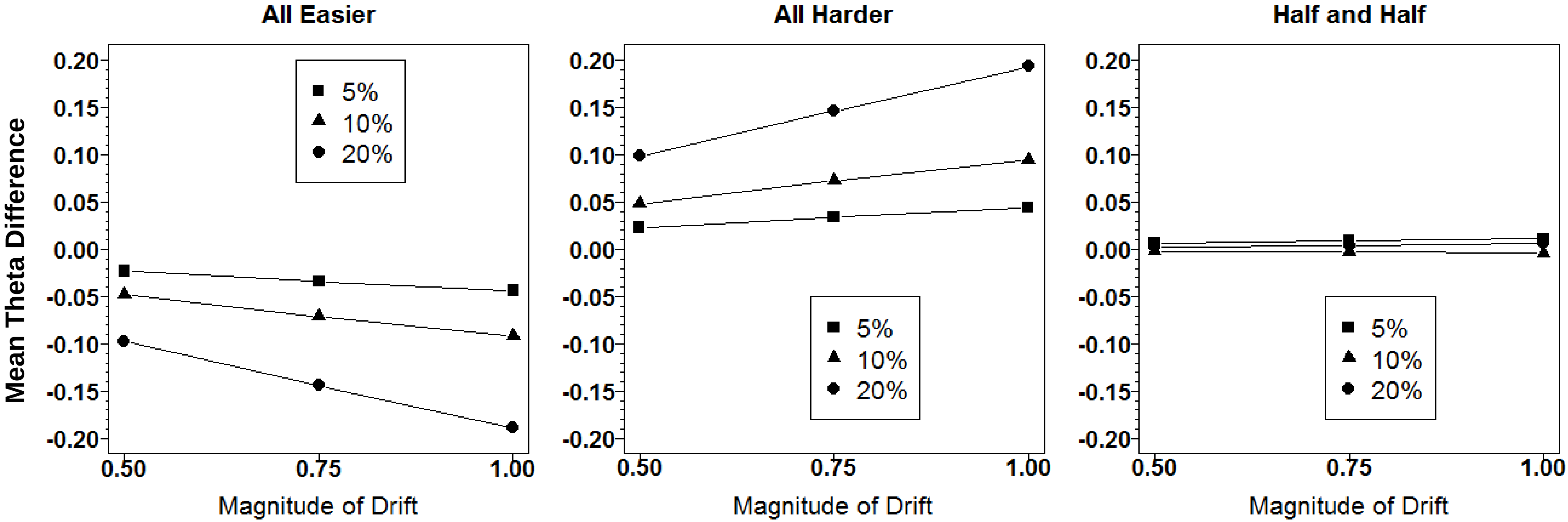
Percentage of Drifted Items on Individual Exams for Exam 1



Percentage of Drifted Items on Individual Exams for Exam 2



Mean Theta Differences: Exam 1



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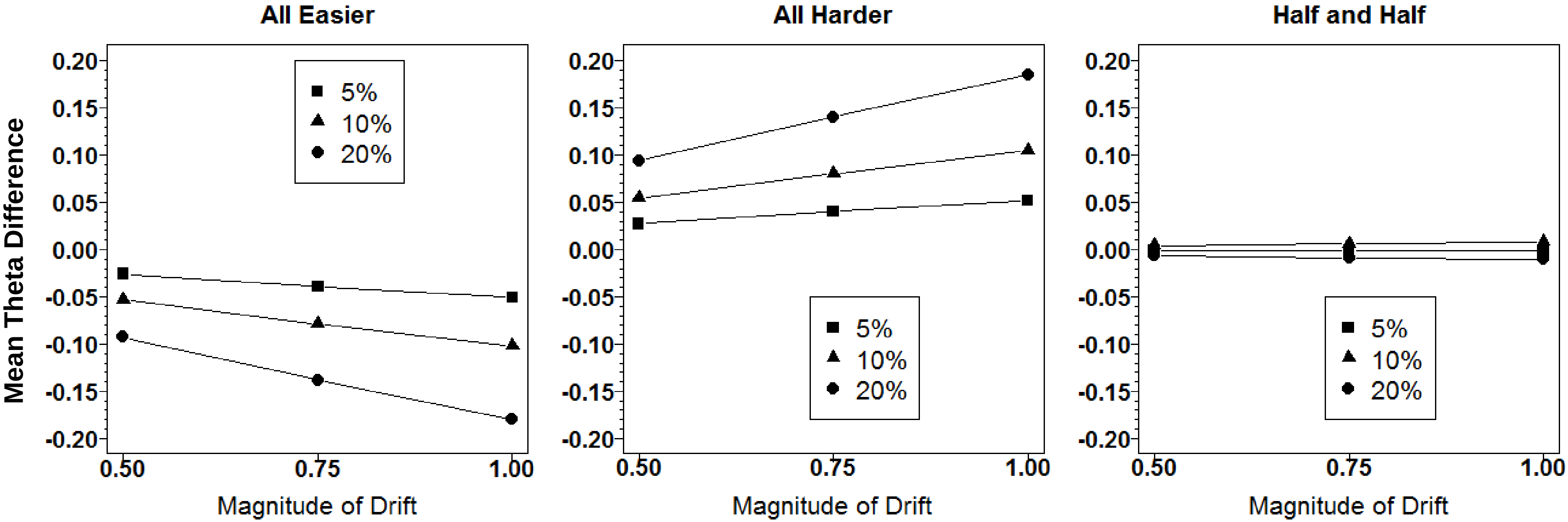
Mean Theta Differences: Exam 2



Theta Differences: Exam 1

Direction of Drift	Magnitude (Logits)	All Easier		All Harder		Half and Half	
		Min	Max	Min	Max	Min	Max
5%	**0.50**	-0.10	0.00	0.00	0.09	-0.08	0.06
	0.75	-0.15	0.00	0.00	0.14	-0.13	0.15
	1.00	-0.20	0.00	0.00	0.18	-0.16	0.12
10%	**0.50**	-0.13	0.00	0.00	0.14	-0.07	0.08
	0.75	-0.20	0.00	0.00	0.21	-0.10	0.11
	1.00	-0.26	0.00	0.00	0.28	-0.14	0.15
20%	**0.50**	-0.20	-0.02	0.02	0.20	-0.10	0.12
	0.75	-0.29	-0.02	0.03	0.30	-0.16	0.18
	1.00	-0.39	-0.03	0.03	0.40	-0.22	0.24

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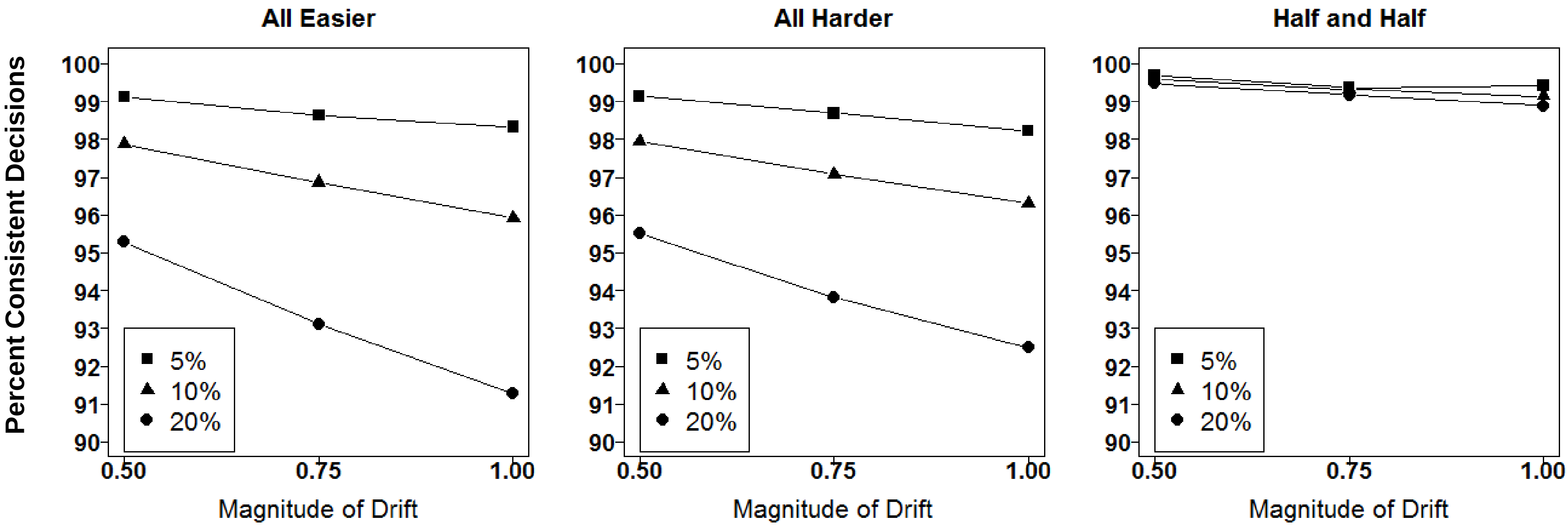
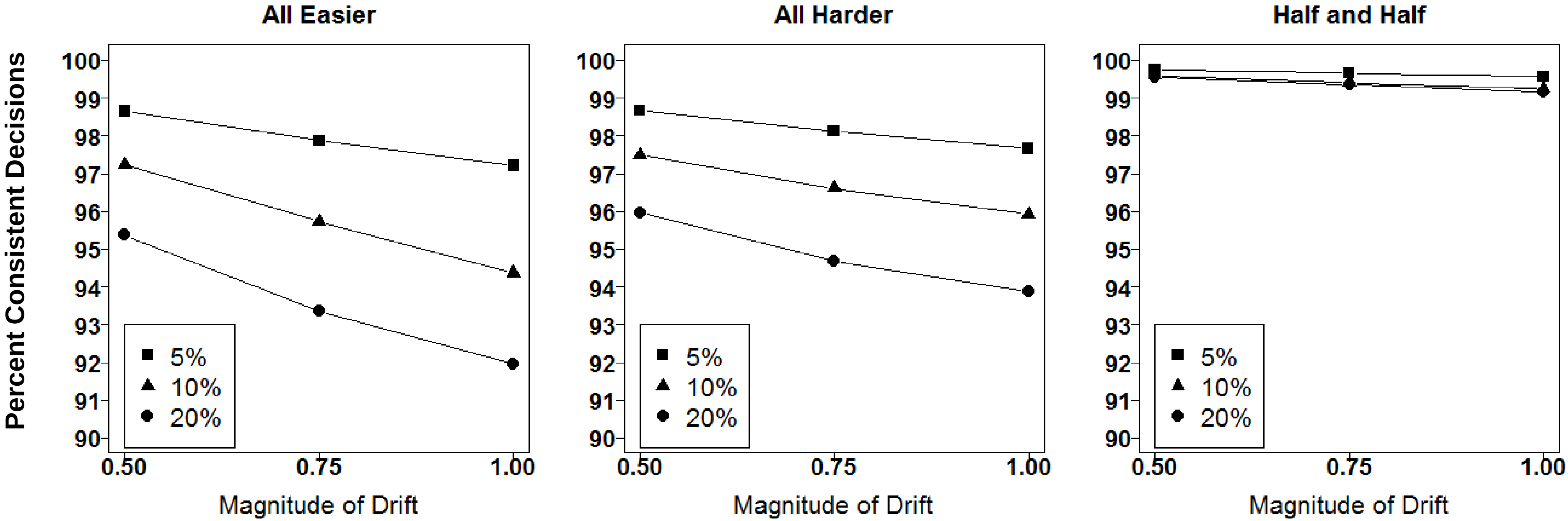
Decision Consistency: Exam 1



Decision Consistency: Exam 2



Summary

- As the percentage of items increased or the magnitude of drift increased, differences in theta estimates also increased
- The largest difference in theta estimates was 0.40 logits for 20% with drift of 1.00 logits
- Decision consistency was greater than 95% for all conditions except 20% with drift of 0.75 or 1.00 logits

Discussion

- For large operational pools, candidate ability estimates appear robust to item drift, especially under conditions that may represent ‘normal’ amounts of drift
- Even with ‘extreme’ conditions of drift (e.g., 20% of items drifting 1.00 logits), decision consistency was still high

Limitations and Future Research

- Limitations
  - Recalibration study
  - Current study conducted on only variable-length CAT exams
- Future Research
  - Comparison with paper-and-pencil based tests
  - Simulation study
    - Replicate simulations of candidate response strings based on various drift conditions
    - Vary size of operational CAT item pool