Cyber knowledge is here, but not evenly distributed

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ABSTRACT
Current selection systems in cybersecurity tend to pick candidates based on existing knowledge of cybersecurity concepts and procedures. As part of a larger study designed to create an aptitude test for cyber operations, we surveyed a sample of students and community members to determine their cybersecurity knowledge, cognitive abilities, and demographic characteristics. We found that the best prediction for cybersecurity knowledge came from a background in computer science, identifying as a gamer, and general academic ability. The top 25% of candidates on cybersecurity knowledge were not as diverse as the top 25% of candidates on ability measures, however. This finding shows that selection based only on cybersecurity knowledge may systematically overlook talented candidates.

CCS Concepts
• **Social and professional topics~Employment issues** • *Social and professional topics~Adult education* • *Social and professional topics~Testing, certification and licensing*

Keywords
Aptitude testing; cybersecurity workforce; selection.

1. INTRODUCTION
The usual way of selecting people for entry-level cybersecurity jobs is to assess cybersecurity knowledge. Such knowledge is unevenly distributed in the population, possibly due to uneven distribution of access to cybersecurity information in educational contexts. Using aptitude tests designed to assess abilities that have been demonstrated to predict cybersecurity success may provide an opportunity to identify candidates among people with less cybersecurity knowledge.

2. METHODS
The initial sample data were collected as part of a psychometric study to determine task characteristics for a set of cybersecurity aptitude measures. A total of 290 individuals, mostly university students (94%), participated: 129 in wave 1 and 161 in wave 2. A demographic questionnaire asked participants to report information like race, gender, education, gaming background, and whether they had formal training in computer science. In addition, a cyber knowledge assessment (CKA) required participants to answer cyber knowledge questions in four categories: *general*, *forensics*, *operations*, and *development*. We also administered several cognitive and personality measures found to predict cybersecurity performance, including need for cognition (NFC) [1], anomaly detection (AD), paper folding (PF; adapted from [3]), remote associates (RA; adapted from [2]), and statistical learning (SL).

3. RESULTS AND DISCUSSION
A combination of computer science (CS) background and gamer status accounted for 32% of the variance in CKA, and no demographic factors increased that value significantly. Gamers were more likely to be white or Asian and more likely to be male, while people with CS background were more likely to be black or Asian and more likely to be male. AD, PF, and NFC were significantly related to CKA.

A *selection ratio* is the proportion of candidates selected from a particular group divided by the proportion selected from a reference group, and any number less than 0.8 may be considered adverse impact. We simulated selection of the top 25% of participants in each wave on particular measures. Selection on CKA, performed separately for the two cohorts, resulted in a selection ratios of 0.35 and 0.13 for black participants (vs. white), and 0.4 and 0.7 for women (vs. men). Selection on ability measures resulted in selection ratios of 0.45-1.08 for black participants (vs. white), and 0.42-1.46 for women (vs. men).

4. CONCLUSIONS
Selection based on cybersecurity knowledge is an important part of choosing candidates, but the addition of aptitude measures can increase fairness.

5. DISCLAIMER
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6. REFERENCES
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