

Measuring Vigilance Abilities to Enhance Combat Identification Performance

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Introduction

- Vigilance: The ability to
 - Maintain one's focus of attention
 - Remain alert for prolonged periods of time
- Vigilance is:
 - Essential to Combat Identification (CID) performance
 - An ability that varies among Warfighters
 - An ability that can be enhanced by training
- Vigilance Decrement:
 - Decline in target or hazard detection over time
 - Can occur within first 10 minutes of a vigilance task

Background

- Early Vigilance Research
 - Stimulated by British airborne radar observer performance
 - Patrolling for enemy submarines
 - Failed with increasing frequency to detect critical signals over time
 - Failed in spite of intensive training and motivation
- Clock Test Procedure (Mackworth, 1948)
 - Simulated radar display
 - Confirmed that the quality of sustained attention wanes over time
- Subsequent Research Confirmed Vigilance Decrement
 - Performance decline complete 20-35 min. after initiation of vigil
 - Half of observed decline occurs within first 15 minutes
 - In high demand situations, decrement appears in first 5 minutes of watch

Background (Cont.)

- Summary of Research on Vigilance Ability
 - Individuals vary widely in vigilance task performance
 - Important to assign individuals selectively to tasks requiring sustained attention (vigilance)
 - Only limited success in predicting individual vigilance capability using traditional selection tests
 - An alternative, non-traditional approach is needed
- Potential Vigilance Predictors
 - Personality variables (Introversion/Extroversion, Locus of Control, Field Independence/Dependence, etc.)
 - Short Vigilance Tasks (SVT) may predict performance on tasks requiring sustained attention for long periods
 - Differential response to vigilance task demands may predict performance on tasks requiring sustained attention for long periods

Vigilance Selection Test Battery Model

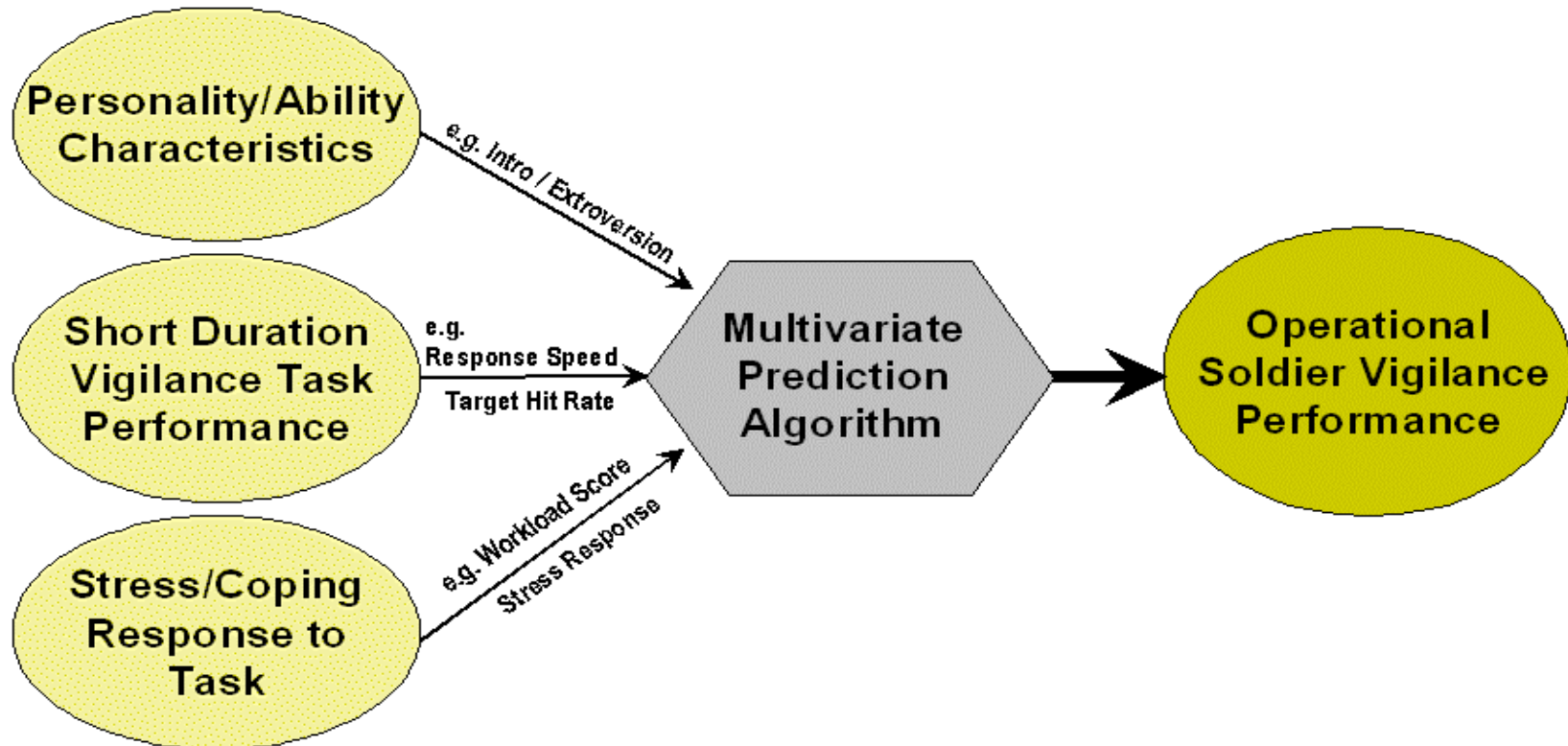


Figure 1. VIGILANT WARRIOR: An Approach to Developing a Personnel-Selection Tool for Sustained-Attention Ability (Vigilance)

Preliminary Research

- Created a Modified Short Vigilance Task (SVT)
 - All possible letter pair combinations of “O,” “D,” & “Q”
 - Twelve minute duration (Six 2-minute blocks)
 - Twenty percent signal rate
 - Two SVT Options
 - Simultaneous (SIM): Signal is identical letters in letter pair
 - Successive (SUC): Signal is two O’s in letter pair
 - Letter pair presented every second for 50 msec.
- Verified Vigilance Decrement in SVT

Preliminary Research (Cont.)

Personality Constructs and Measures

- NEO-FFI
- Other Personality Tests
 - Cognitive Failures
 - O-LIFE Cog. Disorganization
 - Mind Wandering
 - Daydreaming
 - Fatigue
 - ADHD
 - Boredom – External
 - Epworth Sleepiness Scale
 - Boredom – Internal
 - O-LIFE Unusual Experiences
- Other Personality Tests (Cont.)
 - UPPS Sensation-seeking
 - Pittsburgh Sleep Quality 1
 - Pittsburgh Sleep Quality 2
 - Pittsburgh Sleep Quality 3
 - Impulsivity
 - UPPS Premeditation
 - O-LIFE Impulsivity
- Measures of Fluid and Crystallized Intelligence
 - ETS Letter Sets
 - ETS Advanced Vocabulary

Preliminary Research (Cont.)

Measures of Reaction to Task Demands

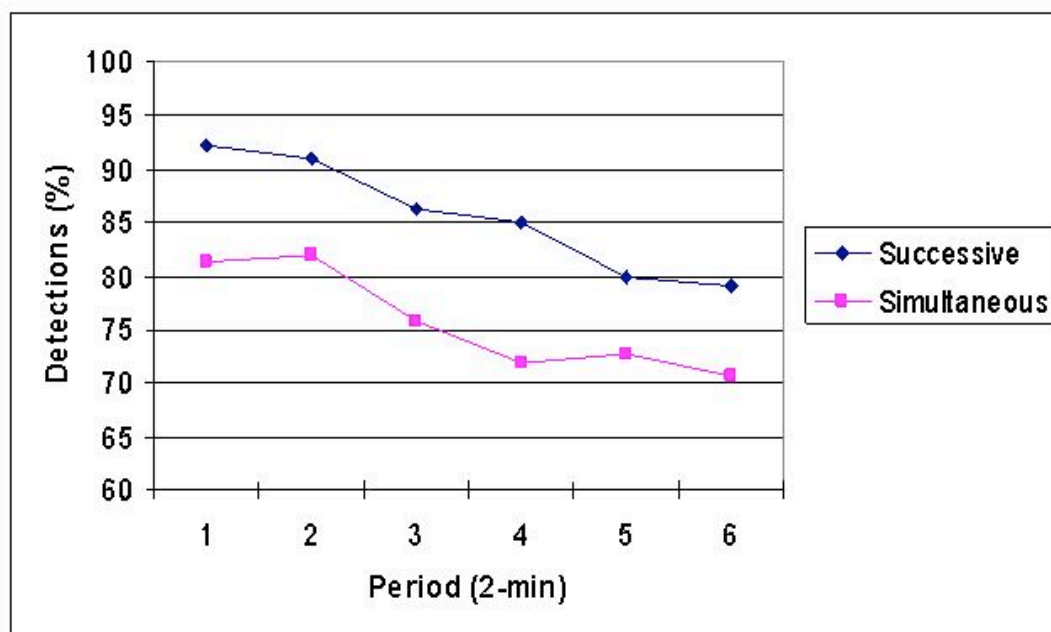
- Dundee Stress State Questionnaire (DSSQ)
 - Task engagement including Subjective energy, concentration, and task motivation
 - Task-related stress including tension, negative mood, and lack of confidence
 - Task-related worry including self-focused attention, low self-esteem, and cognitive interference
- Coping Inventory for Task Situations (CITS)
 - Coping by task focusing (trying to maintain performance)
 - Coping by emotional focusing (self-criticism & wishful thinking)
 - Coping by task avoidance (withdrawing from the task)
- NASA-TLX (six scales)
 - Mental, physical, and temporal demands of the task
 - Performance, effort, and frustration ratings with respect to the task

Preliminary Research (Cont.)

- Created Vigilance Criterion Task
 - Simulates a real-world, electronic-display-monitoring environment
 - High vigilance requirements
 - Similar to tasks to which Army operators might be exposed in operational settings
- Criterion Task Characteristics
 - Twelve-minute and 60-minute versions
 - Three tank columns moving across a topographical map display
 - Operator monitors front tank in middle column for change in gun length, indicating threat
 - Display changes every second, as tank columns move back and forth across screen
 - Tank guns displayed for 500 msec. in each display update
- Vigilance Decrement Validated for Criterion Task

Preliminary Research Findings

- Both simultaneous and successive task versions show vigilance decrement.



N.B. Main effects of task version and period sig. at $p < .01$; interaction NS

Short Vigilance Task (SVT) Conditions x Period

Preliminary Research Findings

- NEO-FFI very weakly related to SVT
 - Introversion/Extroversion correlated 0.17 ($p < 0.05$, $N = 200$) with percent hits
 - Other factors unrelated to SVT
- Other personality constructs resolved into four principal factors not related to SVT performance
 - Factor 1: Cognitive Disorganization (Cognitive Failures, O-LIFE Cog. Disorganization, Mind Wandering, Daydreaming, Fatigue, ADHD, Boredom – External and Epworth Sleepiness Scale)
 - Factor 2: Heightened Experience (Boredom – Internal, O-LIFE Unusual Experiences, and UPPS Sensation-seeking)
 - Factor 3: Sleep Quality (the three Pittsburgh indices)
 - Factor 4: Impulsivity (I7 Impulsivity, UPPS Premeditation, and O-LIFE Impulsivity)

Preliminary Research Findings

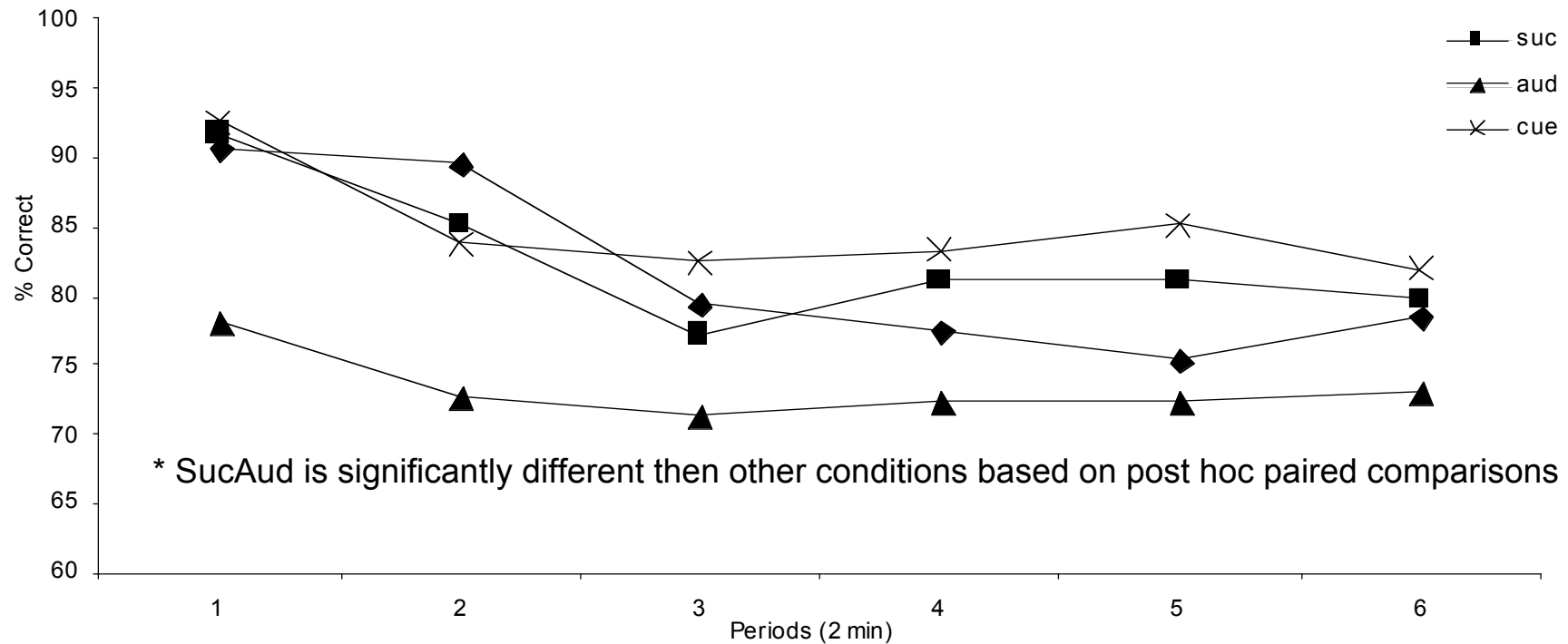
| Stress Type | Stress Dimension | Intelligence | Stressors |
|---------------|-----------------------|--------------|-----------|
| Intelligence | Attention Monitoring | .000 | .000** |
| | Other Data | .000** | .000** |
| Anxiety | Negative Organization | -.000 | -.000 |
| | Impulsivity | -.100 | -.100 |
| | High-level attention | .000 | .000 |
| | Strong quality | -.000 | .000 |
| Stress (low) | Engagement | .000** | .100 |
| | Stress | -.100 | -.000 |
| | Stress | -.100 | -.100 |
| Stress (high) | Engagement | .000** | .000** |
| | Stress | -.100* | -.100 |
| | Stress | -.100 | -.100 |
| Coping | Self-Interest | .000** | .000** |
| | Positive Interest | -.000* | -.100 |
| | Self-Interest | -.000** | -.000** |

*Correlation is significant at the .05 level.

**Correlation is significant at the .01 level.

Correlations of Intelligence and Stress Variables with SVT Performance

Preliminary Research Findings



Condition $F(3, 111) = 13.50, p < .001$

Periods $F(5, 185) = 9.50, p < .001$

Vigilance Criterion (Tank Task) Performance (% Correct)

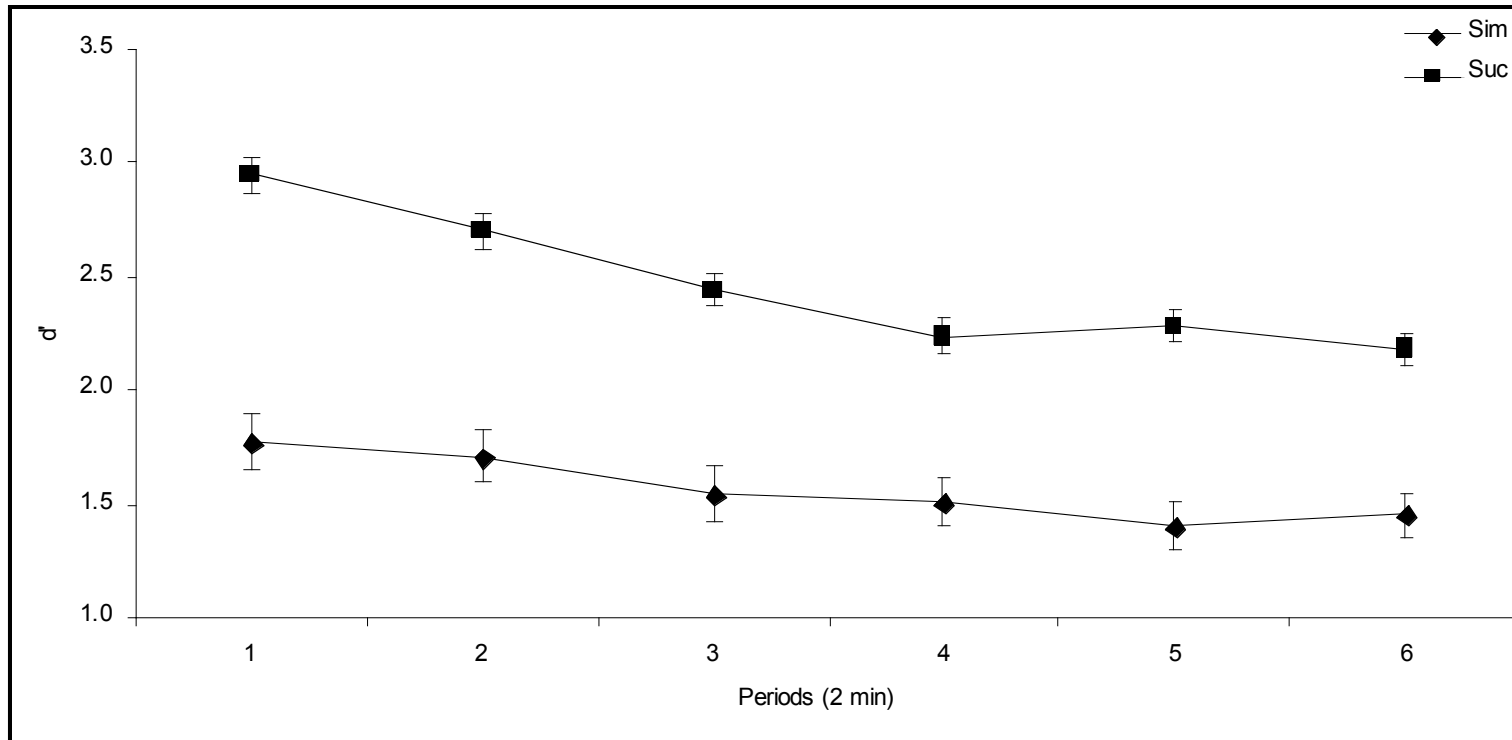
Validation Studies

- Two studies currently underway
- Study 1: Laboratory Investigation
 - Conducted at University of Cincinnati
 - 400 participants (Seven hours each)
 - Four Criterion Conditions:
 - Simultaneous (Sim)
 - Successive (Suc)
 - Successive with auditory secondary task (SucAud)
 - Successive with auditory cues (SucCue)
 - Personality measures administered as pretest
 - Task stress/coping and NASA-TLX measures administered pre-SVT, post-SVT, and post-Criterion
 - Both SVT and Criterion administered after 2-minute practice with auditory feedback (“hit,” “miss,” and “false”)
- Study 2: Three planned field data collections

Laboratory Study Preliminary Findings

- Verified vigilance decrement for all task versions
 - Decrement in d' indicates declining perceptual sensitivity
 - Increase in C indicates increasing response criterion
- Correlations between SVT and average d' for all criterion task versions
 - Computed within each condition
 - $N = 100$ for each condition
- Personality, stress state, and coping data are still to be analyzed

Performance Data: SVT (d')

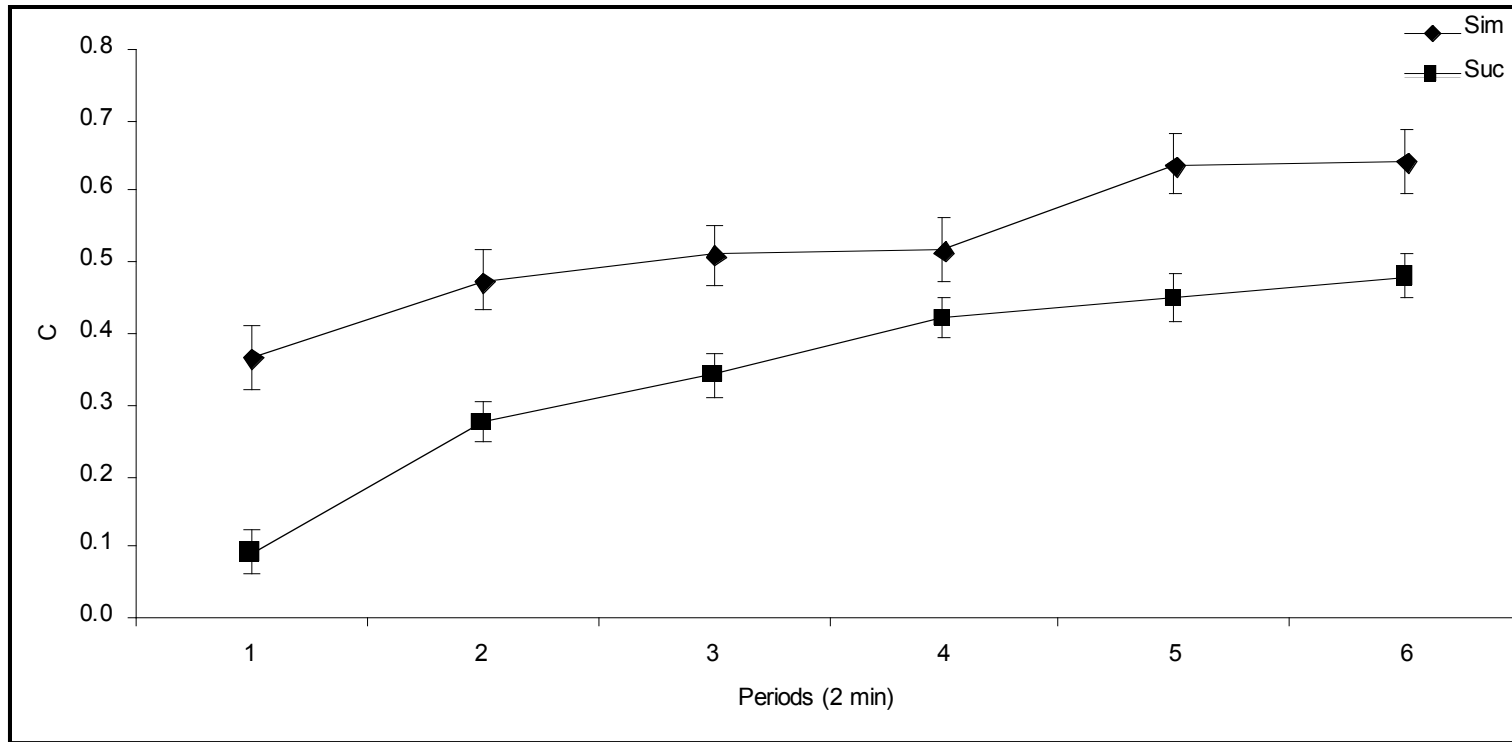


Condition: $F(1, 398) = 49.68, p < .001$

Periods: $F(3.94, 1569.13) = 39.17, p < .001$

Periods x Cond: $F(3.94, 1569.13) = 5.56, p < .001$

Performance Data: SVT (C)

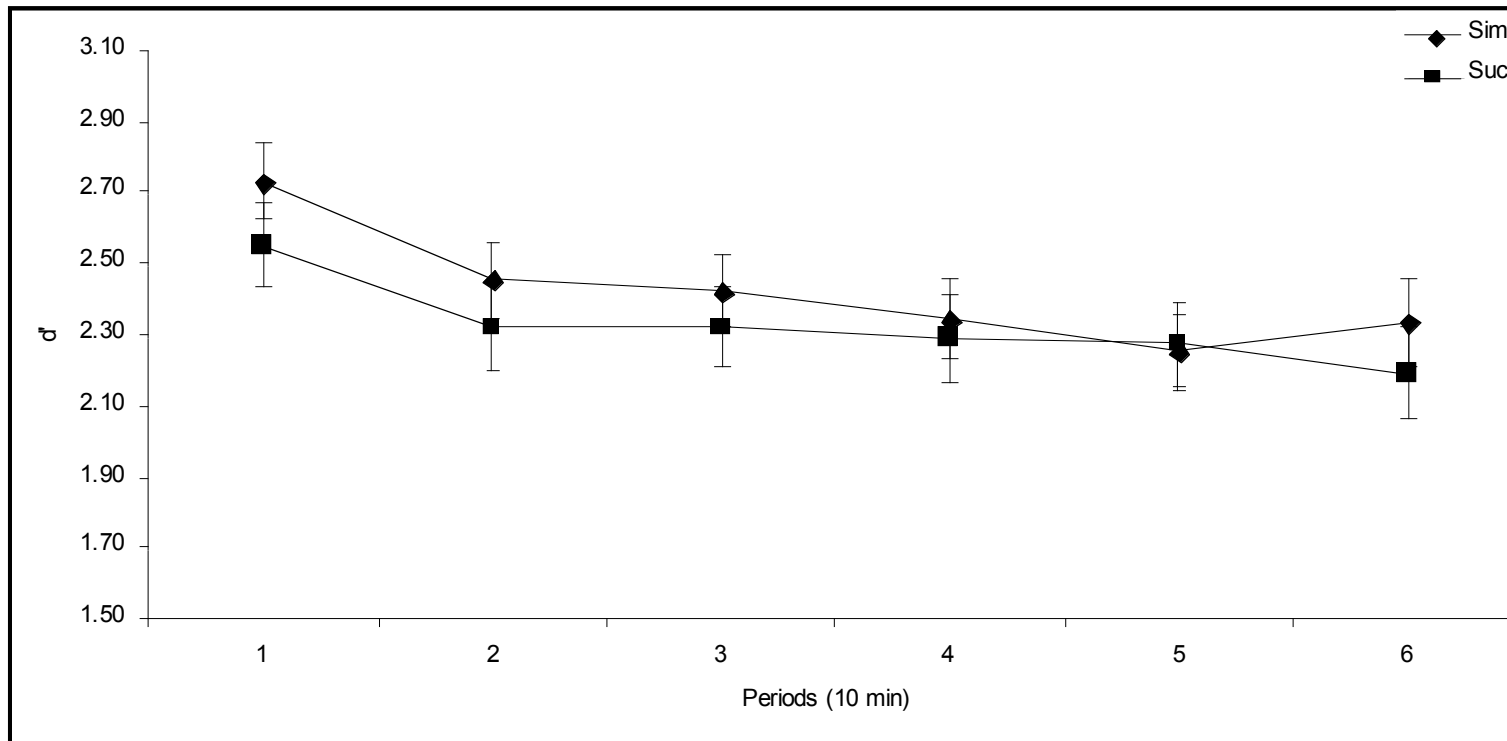


Condition: $F(1, 398) = 14.21, p < .001$

Periods: $F(4.01, 1596.34) = 59.47, p < .001$

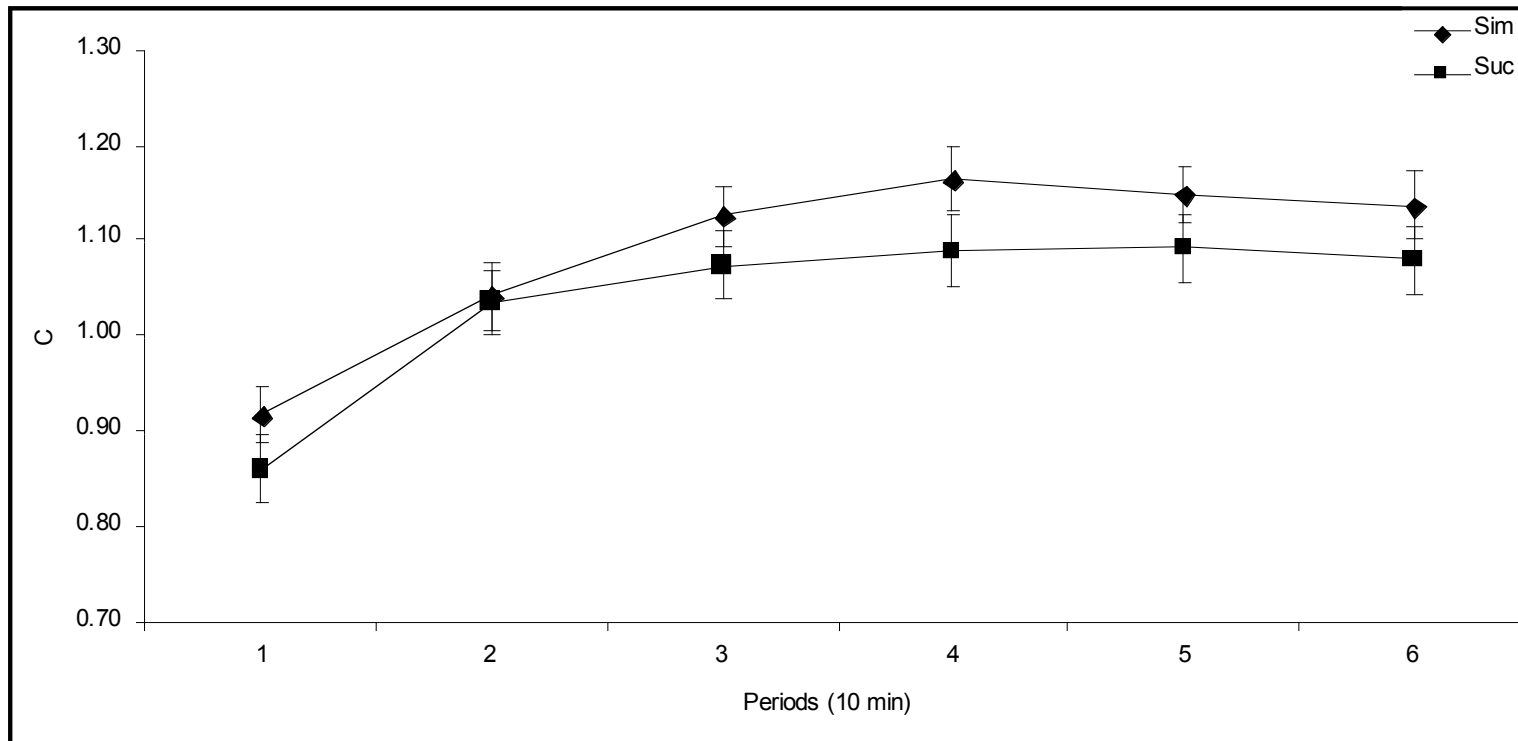
Periods x Cond: $F(4.01, 1596.34) = 3.41, p < .01$

Performance Data: Criterion (Sim vs Suc – d')



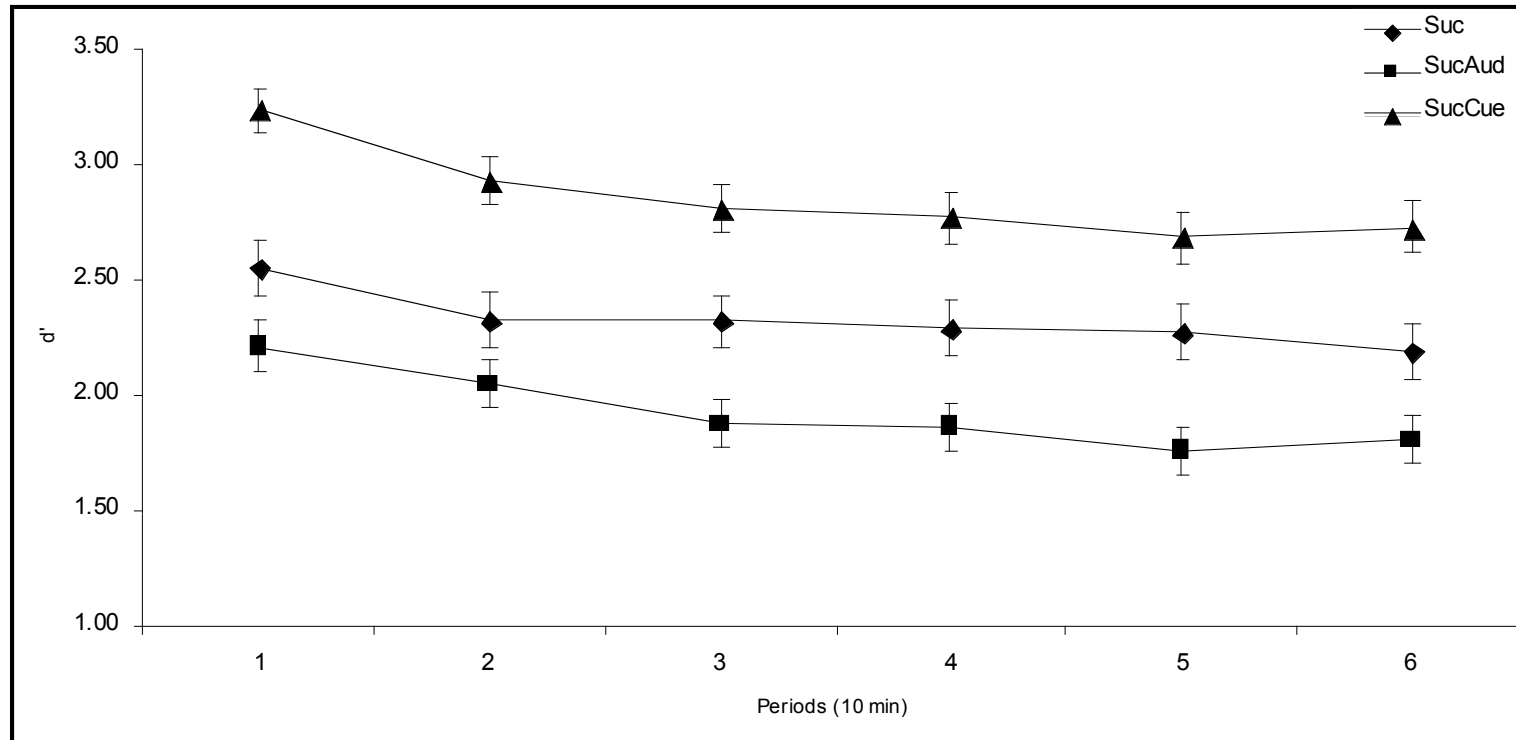
Periods: $F(3.51, 695.71) = 14.89, p < .001$

Performance Data: Criterion (Sim vs Suc - C)



Periods: $F(3.88, 767.64) = 35.90, p < .001$

Performance Data: Criterion (Suc conditions – d')



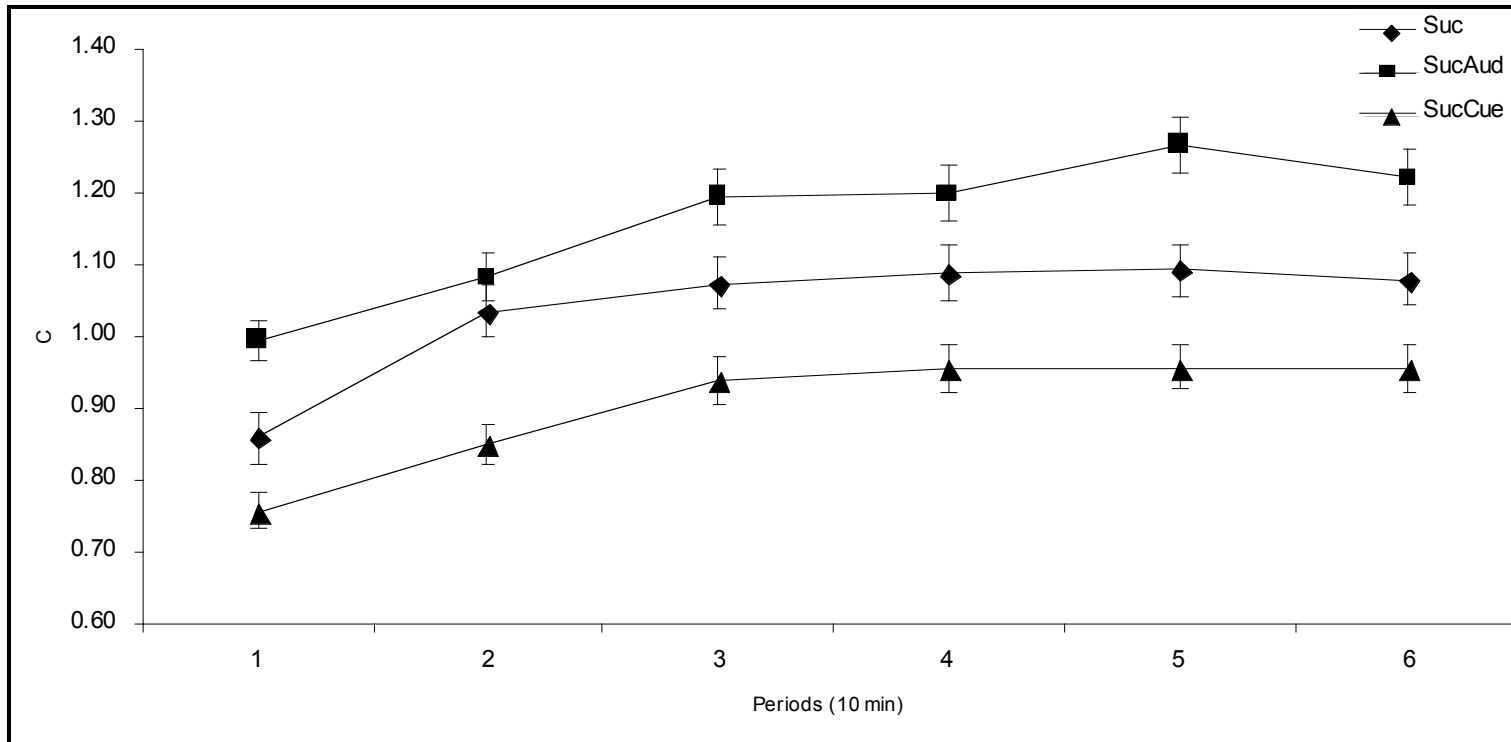
Condition:

$$F(2, 297) = 21.62, p < .001$$

Periods:

$$F(3.64, 1081.72) = 28.60, p < .001$$

Performance Data: Tank (Suc conditions- C)



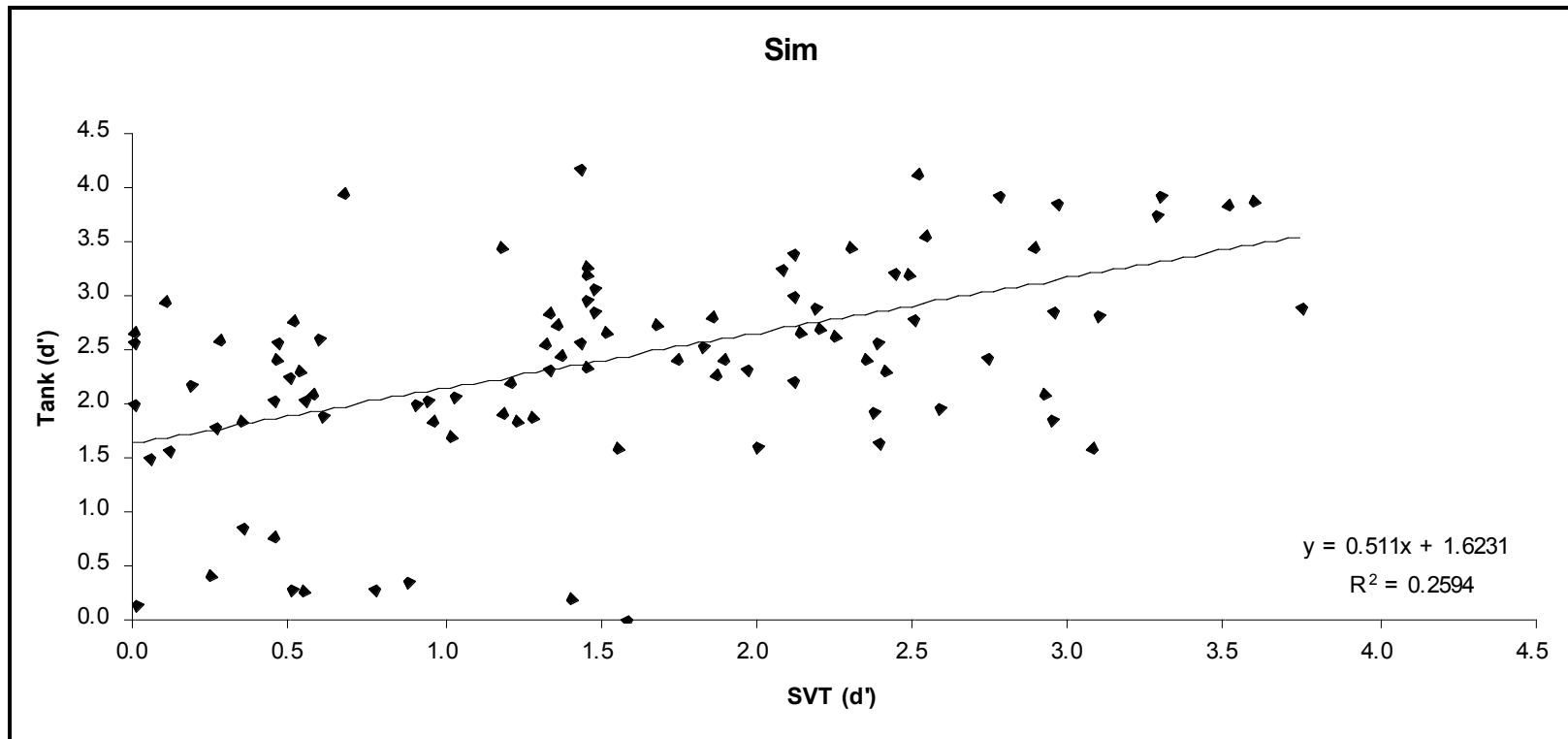
Condition:

$$F(2, 297) = 20.62, p < .001$$

Periods:

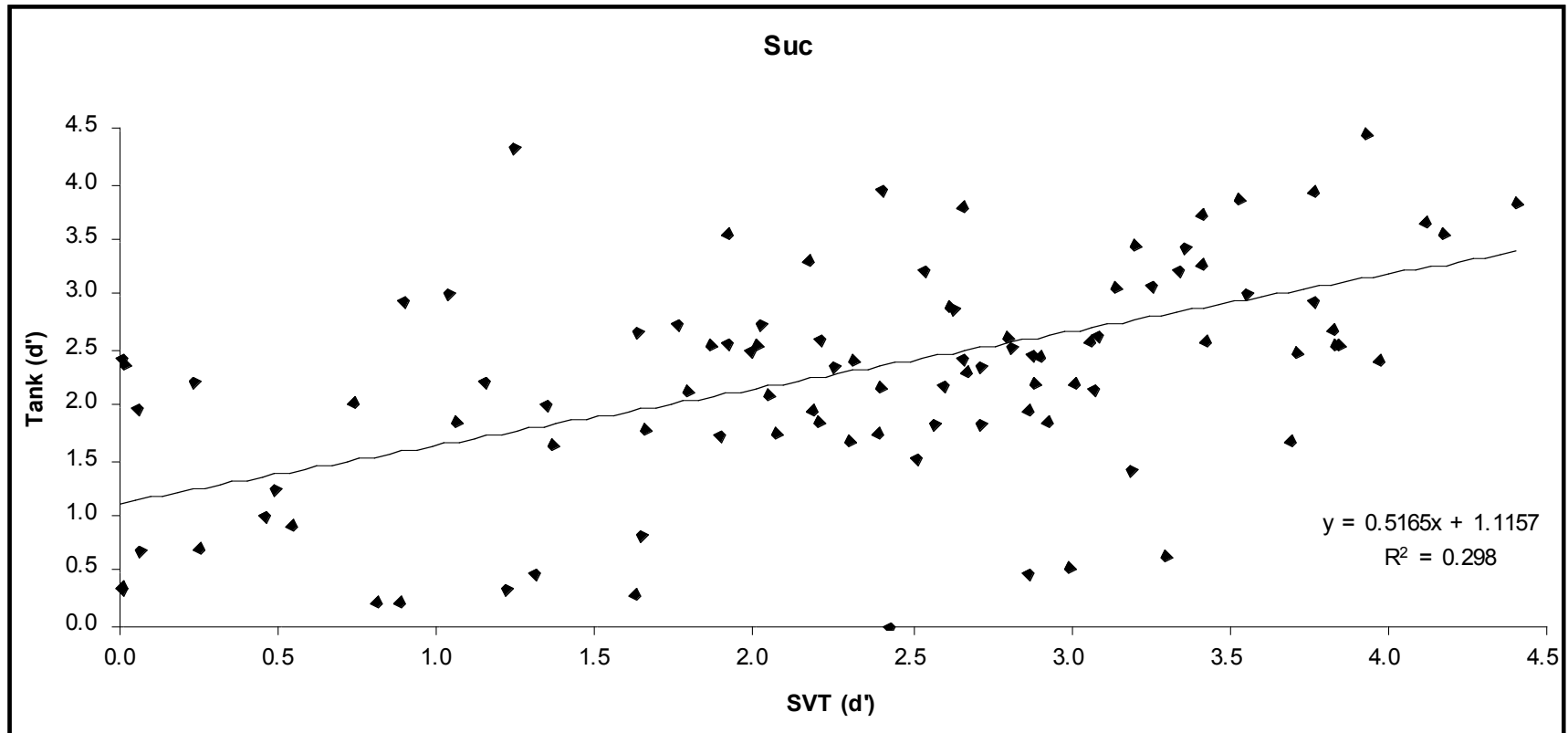
$$F(4.29, 1273.79) = 51.82, p < .001$$

Performance Data Correlation



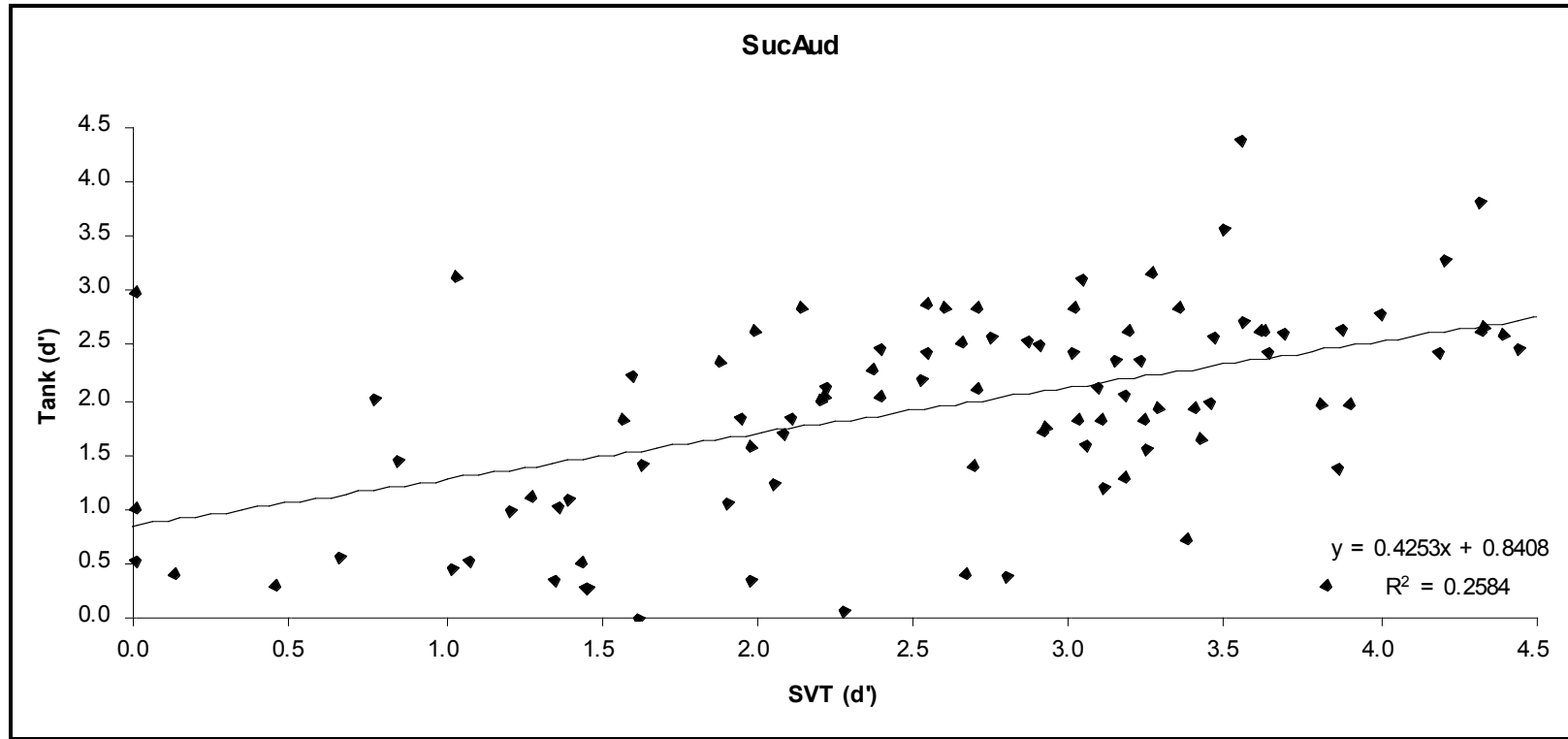
N = 100

Performance Data Correlation



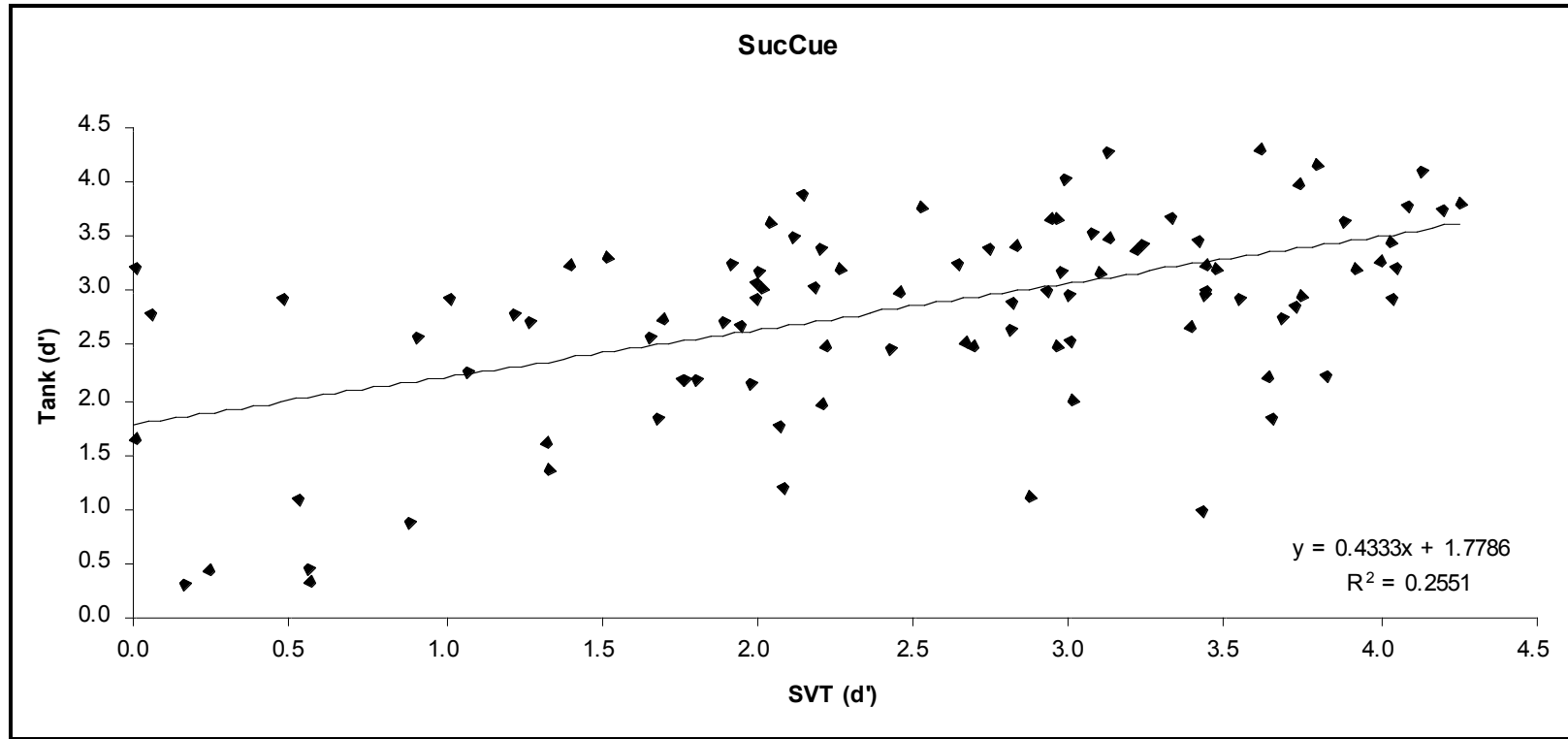
N = 100

Performance Data Correlation



N = 100

Performance Data Correlation



N = 100

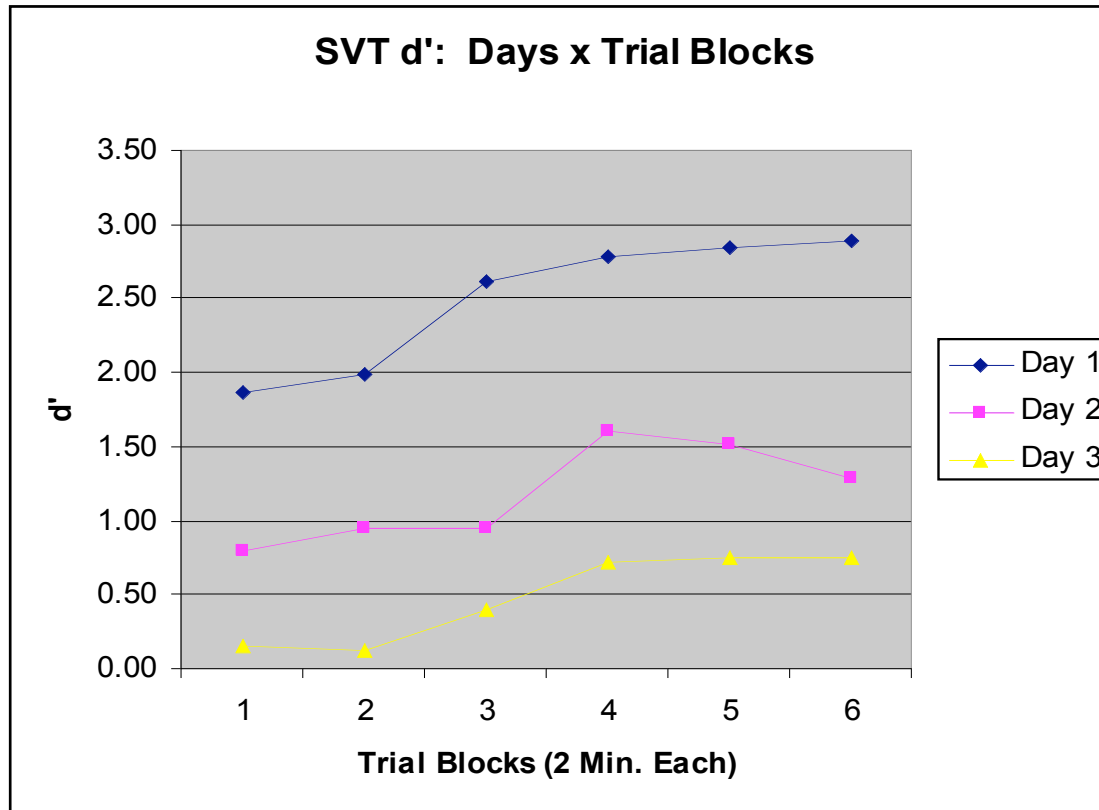
Field Validation Studies

- Abbreviated Automated Test Battery (ATB) Constructed Consisting of:
 - SVT plus 2-minute practice with auditory feedback
 - Abbreviated DSSQ and CITS
 - NASA-TLX
- Abbreviated ATB administered to military personnel
 - Criterion measure is score on two “performance lanes”
 - Mounted IED detection
 - Dismounted IED detection
- Pilot Study with 47 Participants 13-15 March 2008
- First “Real” Data Collection 12-16 May 2008

Pilot Study Conditions

- Testing Room Extremely Bright (Unexpected)
 - Estimated ambient luminance exceeded 400 candles/m²
 - Significant impact on SVT letter-pair visibility
- Abbreviated ATB Presented on Panasonic ToughBook C-74
 - Screen objects visible even in broad daylight
 - Results in very bright screen
 - Tilt of laptop screen caused significant perceived change of screen brightness
- Interaction of above factors complicated testing
 - Significantly impacted SVT vigilance scores
 - Nevertheless, data collected produced interpretable and potentially significant results
- Testing Differences: Day 1 vs. Days 2 & 3
 - Day 1 participants allowed to shift position and tilt screen to see
 - Day 2 and 3 participants: Fixed screen position and minimal body movement

Field Pilot Study Performance Data: SVT (d')



Days x Trial Blocks Interaction: $F_{(10,125)} = 4.02, p < .001$

Comment on SVT d' Data

- Visibility of Letter-Pairs in SVT
 - Data confirms that visibility was a severe problem
 - Day 1 conditions allowed participants to partially compensate for visibility problem
 - Day 1 data are artificial and complicated all other data analyses
 - Day 1 data were dropped from further analysis
- All Other Analyses Used Sample Size of 30

Correlations Between SVT d', Predictors, & Criterion Variables

| Situation/Coping Variables | d prime (ave.) | beta (ave.) | MOUNTED | DISMOUNT |
|-------------------------------|----------------|------------------|-----------------|-----------------|
| Energy | 0.117 | 0.027 | 0.188 | 0.349 |
| Tension | 0.152 | 0.047 | 0.105 | .410(*) |
| Intrinsic Motivation | -0.082 | 0.142 | 0.082 | 0.232 |
| Self-consciousness | 0.178 | -0.267 | -0.238 | -0.165 |
| Concentration | 0.334 | -0.059 | 0.326 | 0.204 |
| Confidence | .398(*) | 0.019 | 0.072 | 0.238 |
| Non Task-Related Interference | -0.366 | 0.228 | -.412(*) | -0.269 |
| Situation Control | -0.011 | -0.164 | 0.206 | -0.12 |
| Task Focus | 0.368 | -0.216 | 0.257 | 0.1 |
| Emotion Focus | -0.219 | -0.111 | -0.093 | -.434(*) |
| Avoidance | -0.340 | 0.260 | -0.247 | -.494(*) |
| d prime (average) | 1.000 | -.656(**) | .401(*) | -0.115 |

* Correlation is significant at the 0.05 level (2-tailed).

Correlations Between SVT d', NASA-TLX & Criterion Variables

| Variables | Mental Demand | Physical Demand | Temporal Demand | Performance | Effort | Frustration |
|---|---------------|-----------------|-----------------|-----------------|----------------|--------------|
| d prime (ave.) | -0.115 | -0.229 | 0.264 | .495(**) | 0.11 | 0.121 |
| Beta (ave.) | 0.011 | 0.124 | -0.142 | -0.226 | -0.129 | -0.162 |
| Mounted | 0.047 | -0.117 | 0.236 | -0.011 | .391(*) | 0.364 |
| Dismounted | 0.226 | .442(*) | -0.143 | 0.098 | -0.029 | -0.105 |
| ** Correlation is significant at the 0.01 level (2-tailed). | | | | | | |
| * Correlation is significant at the 0.05 level (2-tailed). | | | | | | |

SVT Changes Resulting from Field Pilot Study

- Luminance Mini-Study undertaken
 - Measured ambient luminance of test room
 - Measured luminance of letter-pair grayscales used in SVT
 - Calculated contrast ratios on testing laptop
 - Modified SVT software as follows:
 - Mean grayscale 26 units darker than lab setting
 - Eight selectable grayscale options for letter pairs
 - Option selected based on ambient luminance of test room at field site
 - Selected option automatically loads letter pairs into SVT
 - Standardized room setup and testing procedure
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Questions

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