Undirected learning styles and academic risk:
Analysis of the impact of stress, strain and coping

Abstract

**Background** Learning style inventories used in conjunction with a measure of academic achievement consistently show an association of meaning directed learning patterns with academic success, but have failed to show a clear association of undirected learning styles with academic failure. Using survey methods with anesthesia residents, this study questioned whether additional assessment of factors related to stress, strain, and coping help to better define the association between undirected learning styles and academic risk.

**Methods**
Pearson chi squared tests. 296 subjects were enrolled from eight institutions with 142 (48%) completing the study. American Board of Anesthesiologists In Training Examinations (ITE) percentiles (ITE%) were used as a measure of academic achievement. The Vermunt Inventory of Learning Styles (ILS) was used to identify four learning patterns and 20 strategies, and the Osipow Stress Inventory-Revised (OSI-R) was used as a measure of six scales of occupational stress, four of personal strain, and four coping resources.

**Results** Two learning patterns had significant relationship with ITE scores. As seen in previous studies, Meaning Directed Learning was beneficial for academic achievement while Undirected Learning was the least beneficial. Higher scores on Meaning Directed Learning correlated positively with higher ITE scores while higher Undirected and lower Meaning Directed patterns related negatively to ITE%. OSI-R measures of stress, strain and coping indicated that residents with Undirected learning patterns had higher scores on three scales related to stress, and 4 related to strain, while displaying lower scores on two scales related to coping. Residents with higher Meaning Directed patterns scored lower on two scales of stress and two scales of strain, with higher scores on two scales for coping resources.

**Conclusions** Low Meaning Directed and high Undirected learning patterns correlated with lower ITE percentiles, higher scores for stress and strain, and lower coping resources. This association suggests that successful remediation of at-risk residents must address stress, strain and coping if long term academic improvement is expected. Further research to identify the value of stress, strain, and coping screening and education is warranted.
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Introduction

All programs deal with residents with educational deficiencies and struggle to find ways to identify and remediate deficits.1-7 The most common resident deficit cited is insufficient medical knowledge with 7-12% of residents identified as being at "academic risk".7-10

In this study, the American Board of Anesthesiology In Service Training Exam (ITE) was the certifying body. The American Board of Anesthesiology is a member of the American Board of Medical Subspecialties and the national accrediting body for Anesthesiology. At the time of this study the ITE was given annually to all anesthesiology residents training in programs accredited by the Accreditation Council for Graduate Medical Education. The ITE is a nationally standardized and validated tool for assessment of resident knowledge.11

Early identification of residents with learning deficiencies12,13 is central to providing sufficient time for targeted assistance to correct deficiencies. Intervention with residents during the first year is more likely to succeed due to lighter patient loads and expectations for more feedback and guidance.14 Responses to enhance resident performance range from informal learning plans, such as advice to “study more and attend journal club,” to specific, written remediation programs with measurable goals and objectives.9,12,13 While these may address the observed symptoms of poor academic performance, the key goal of primary prevention should be to expand learning patterns, guide teaching, and set a basis for long term success in future learning environments. The added benefit of successful, long term, remediation is decreased department resource utilization and faculty time demands.14 If learning problems are not identified and addressed, learning strategies do not change. Suboptimal learning results from ineffective study patterns leads to increasing resident frustration, affecting both clinical and academic outcomes.15

Given the process of gaining admission to medical school, residents are considered “high achievers;” making the identification of academic risk something that is not consistent with their self-image. Successful remediation requires helping with resident denial, identifying specific areas of challenge, targeting unique issues, and establishing goals for mentoring or remediation plans.13 The challenge is finding the optimal blend of cognitive/metacognitive skills that facilitate meaning directed learning patterns and develop a deep approach to learning.16-18

Diagnostic assessments tied to established relationships measuring academic achievement are an essential, but currently elusive, component of successful remediation.1,19 The Vermunt Inventory of Learning Styles (ILS) measures four different categories of strategies: cognitive processing (thinking activities to process learning contents), metacognitive regulation activities (regulating the cognitive activities), mental models of learning (integration of learning conceptions including the role of self, teachers and others), and learning orientations (personal goals, motives, doubts and concerns).20 Four Learning Styles emerged from these strategies: the Meaning Directed Learning Style (MDLS), the Reproduction Learning Style, (RDLS), the Application Directed Styles (ADLS) and the Undirected Learning Style (UDLS) . The Meaning Directed Learning Style includes student patterns of self-regulation of learning and processing that integrate applications of learning and develop of independent thinking. The Reproduction Directed Learning Style identifies students who look to teachers to tell them what to learn with a focus on memorizing and rehearsing information. The Application Directed Style identifies students focused on learning focused on meeting the requirements for certification of accreditation. Lastly,
students with Undirected Learning Styles often display difficulty in determining between primary and secondary points, struggling with the amount of materials to study, and concerns about ability to process materials. The ILS is validated in students seeking advanced professional degrees in law, medicine and psychology and may play a diagnostic role in the earlier detection of learners potentially at risk academically.\textsuperscript{19-21}

In order to make optimal use of limited resources, clarity in identifying deficits helps to focus remediation plans on specific areas of deficiency and set clear goals aimed at measurable improvements.\textsuperscript{6,9,22} Lacking structured processes, struggling residents tend to spend more time using unsuccessful learning strategies when simply urged to increase study. Without specialized intervention on how to improve efficiency, they become increasingly frustrated and are more likely to experience negative outcomes.\textsuperscript{1,13,22}

In a previous pilot study, the authors explored anesthesiology residents’ learning patterns using the Vermunt Inventory of Learning Styles (ILS). The pilot study confirmed the finding of previous studies of learning pattern inventories that showed a positive relationship between Meaning Directed Learning Patterns and higher ITE\% and a negative relationship between ITE\% and Undirected patterns. However, the relationship between UDL\% and performance was bimodal with some student performing well on the ITE despite having an UDL\%. This confounding finding was also noted by Vermunt, who’s later work focused on patterns rather than styles to more clearly indicate periods of change, growth, and acclimation.\textsuperscript{20,21,24}

Based on coaching with residents struggling to increase their ITE\%, the role of stress and strain as factors in examinations measuring academic knowledge emerged. It was hypothesized that measuring occupational stress, personal strain, and coping resources, as assessed using the Osipow Stress Inventory-Revised,\textsuperscript{25} might reveal relationships between non-academic factors and measures of medical knowledge and help explain how students with UDL\% might, with a robust support system, succeed despite an inefficient method of study.

The general questions of this study were: (1) Do relationships exist between measures of Medical Knowledge, as assessed by the American Board of Anesthesiology In-Training Examination and learning patterns and strategies as identified by the Vermunt Inventory of Learning Styles? (2) What relationships exist between non-academic factors of stress, strain and coping, as measured by the Osipow Stress Inventory-Revised, and significant learning patterns? (3) Do learning strategies and factors of stress strain and coping correlate with academic performance?

Methods

Context of the study

The authors conducted survey research offered to all residents enrolled in eight ACGME accredited anesthesiology residency programs: George Washington University, Johns Hopkins University, University of Kansas Medical Center—Kansas City, University of Kansas Medical Center—Wichita, Ochsner Medical Center, Penn State Milton S. Hershey Medical Center, University of Rochester, and University of Washington.

Institutional Review Board Approval was received from each institution, and residents were recruited to volunteer to participate in the study. To avoid any perception of coercion, to protect resident identity, and to ensure that the results of the study would not be used in resident evaluations, program directors designated a study coordinator to recruit the residents and administer the survey instruments. Program directors did not know the identity of residents who participated and received only aggregate data for their department. Residents who wanted access to individual results could request direct communication from the Principal Investigator and an individualized coaching session at no cost.

The study was completed during the first four months of 2009 such that all surveys were completed before the residents took that year’s American Board of Anesthesiology In-Training Examination (ITE). After study
coordinators obtained approved consent from each participant, the resident received a numbered study packet with the Vermunt Inventory of Learning Styles (ILS), Osipow Occupational Stress Inventory-Revised (OSI-R), and an Educational Demographic Survey to determine age, gender, postgraduate year (PGY), family status, ethnicity, and relationship to faculty mentor and fellow residents. Following survey completion, the packets were sent to the principal investigator for scoring. The program coordinator maintained a spreadsheet of resident participants and packet identification numbers. After receiving ITE results, the program coordinators added the ITE scores and post graduate year to the spreadsheet and forwarded the results to the primary investigator. Personalized results were sent to their programs in sealed envelopes by identification numbers, assuring confidentiality of results.

**Data Analysis:** Vermunt’s Inventory of Learning Styles is a diagnostic assessment focused on tertiary learning. The 120 question self-report survey utilizes a 1-5 Likert Scale. The 20 learning strategies comprised four domains: Processing Strategies, Regulation Strategies (metacognition), Mental Models of Learning, and Learning Orientations. A factor analysis identified four learning styles, later referred to as learning patterns: Meaning Directed, Reproduction Directed, Undirected, and Application Directed. Definitions of each learning pattern and scale can be found in the glossary.

The Osipow Stress Inventory-Revised is a 140 question self-report diagnostic assessment with a Likert scale ranging from 1-5. The three domains measured are: Occupational Stress, Personal Strain, and Coping Resources. Occupational Stress is measured by six scales: Role Overload, Role Insufficiency, Role Ambiguity, Role Boundary, Responsibility and Physical Environment. Personal Strain has four scales: Vocational Strain, Psychological Strain, Interpersonal Strain, and Physical Strain. Coping Resources measure Recreation, Self-care, Social Support, and Rational Cognitive Coping.

Descriptive statistics of measures of ITE% are reported in Table 1. The descriptive statistics for the four learning patterns and twenty strategies, and six scales of occupational stress, four scales of personal strain and four coping resources were also calculated, including means and standard deviations. Correlations were analyzed to determine a relationship of learning patterns and strategies with ITE%, Table 2. A dependent t-test was conducted to determine if there was a significant difference in mean learning patterns, specifically between Meaning Directed and Undirected learning patterns, between those who scored lower on ITE% (less than or equal to the 35%tile) compared to those who scored higher (above the 35%tile). The Meaning Directed and Undirected learning pattern scores were divided between low and high based on the means for the respective variables. Factorial ANOVA was then used to determine the individual effects and interaction effect of Meaning Directed and Undirected learning patterns on ITE%. A correlation analysis of occupational stress, personal strain, and coping resources variables with Meaning Directed and Undirected Learning patterns was also conducted. A p-value less than 0.05 was considered significant.

**Results**

Of the 296 enrolled students in the eight ACGME accredited anesthesiology post graduate education programs, 160 (54%) responded, of which 142 (48%) had complete data, see Figure 1. The ITE% mean for all programs is 50.7 with a standard deviation of 28.89.

A dependent t-test revealed that on average the mean of the Meaning Directed learning patterns was lower for those scoring at the 35th percentile or below (M=3.0, SE=.05) than to those scoring above the 35th percentile (M=3.4, SE=.08, t(140)=3.879, p<.01, r=.31). There was not a significant difference in the means of the Undirected learning pattern scores between low scorers and high scorers.

**Interaction Effect of Meaning Directed and Undirected Learning Patterns on ITE%**

Both the Meaning Directed and Undirected learning pattern scores were approximately bell-shaped with means of 3.25 and 2.79, respectively. A participant was considered to have
a low Meaning Directed learning pattern if their score was below 3.25 and high if it was greater than or equal to 3.25. Similarly, a participant was considered to have a low Undirected learning pattern if the score was less than 2.79 and high if it was greater than or equal to 2.79. Analysis using factorial ANOVA further defined any individual and interaction effects of Meaning Directed and Undirected learning patterns on ITE%. Meaning Directed learning pattern had a significant main effect on ITE% ($F(1,138)=10.741, p<.01$). When Meaning Directed was ignored, Undirected did not have an effect on ITE%. However, the interaction effect was significant ($F(1,138)=4.430, p<.05$). The effect of Meaning Directed learning pattern on ITE% is different for participants with low Undirected learning pattern compared to participants with high Undirected learning pattern. Specifically, for those participants with low Meaning Directed learning pattern, ITE% was significantly lower for those with high Undirected learning pattern (M=36.0, SD=28.1) compared to those with low Undirected learning pattern (M=50.5, SD=30.1). For those participants with high Meaning Directed learning pattern, the ITE% was similar between low (M=56.0, SD=25.7) and high (M=61.0, SD=26.2) Undirected learning patterns. See Figure 2.

Differentiated Performance of ILS Orientation and Strategies for those Participants with High Undirected Learning Patterns

A correlation analysis showed that those participants with higher scores of Undirected learning patterns tend to have higher scores on Ambivalent ($r=-.674, p<.01$) and Lack of Regulation ($r=-.660, p<.01$). There was also a correlation between Undirected learning patterns and low scores on Self-regulation of Learning Content ($r=-.189, p<.05$) as well as with Construction of Knowledge ($r=.181, p<.05$), however, the effect sizes are low. There is no indication that those with higher scores of Undirected learning pattern have lower scores on Self-regulation of Learning Process and Result ($r=.774, p<.01$), Self-regulation of Learning Content ($r=.777, p<.01$), Critical Processing ($r=.808, p<.01$), Analyzing ($r=.496, p<.01$), and Construction of Knowledge ($r=.496, p<.01$). For the most part, these are strong correlations with medium to high effect sizes.

Discussion

Positive and negative relationships exist between measures of medical knowledge and learning patterns. Confirming previous studies, as Meaning Directed scores increased, ITE percentiles tended to increase. Similarly, those with higher Undirected and lower Meaning patterns tended to have lower ITE percentiles. The pattern of low Meaning Directed and High Undirected identified those most at risk academically and the targeted group for remediation. The question remained, however, of why these residents, having had a very successful academic career up to this point, now found themselves at academic risk. The authors hypothesized that the transition to the work based “apprenticeship” of residency requires higher levels of metacognitive management, personal organization, and coping skills to facilitate the transition.

In this study, the addition of the OSI-R allowed for assessment of nonacademic factors such as stress, strain, and coping, to further understanding of the relationship between academic performance and learning styles. Residents with high Undirected scores show more stress and strain and report fewer coping resources while those with high Meaning Patterns demonstrated less strain and stress and more effective coping resources.

The combination of these two diagnostic assessments, ILS and OSI-R, provides focused academic and non-academic strategies to improve the educational experience for struggling residents. Anecdotal information from coaching using both of these tools suggest that the additional focus on nonacademic factors can play a significant role, not only in remediation from the acute signs of academic risk, but in
long term academic success and higher levels of personal satisfaction and personal accomplishment. This raises the need for further studies to determine if proactive assessment and identification of learning style coupled with stress, strain, and coping mechanisms, and personal coaching and mentorship can modify the risk of academic failure. Earlier identification of at-risk residents leads to specialized interventions for earlier adaptation of more effective learning and coping strategies, increasing learning opportunities. Specific strategies gleaned from diagnostic assessments provide clarity, specificity and structure for remediation plans and for goal development. Potential benefits include earlier identification of struggling residents, enhanced educational growth from formal or informal remediation plans, decreased faculty time determining concerns, and measured outcomes.

This study had several limitations. The ITE, while a standardized tool for measurement of medical knowledge, does not assess other areas of academic competency. As standardized tools for evaluation of other competencies become available, further research in these relationships would be merited. The study was limited to a single specialty and it is unknown if these relationships would extend to residents in other medical specialties, although the authors could not readily identify any reason why they would not apply more broadly in graduate medical education. Additional studies are needed to explore learning patterns and ITE results in other medical specialties to explore earlier identification of residents potentially at risk for academic and non-academic factors. While the authors were able to statistically identify the association between learning styles and stress strain and coping, causation is only implied. Causation would be better supported if subsequent work determines that interventions designed to address the associated issues of stress, strain and coping results in a shift toward Meaning Directed learning and improved academic performance.

References
1 Guerrasio, J. Remediation of the Struggling Medical Learner. LaVergne, TN: Association for Hospital Medical Education 2013.
10 Yao DC, Wright SM. The challenge of problem residents. JGIM;16:486-92.
### Table 1: Survey Information and Dropouts

<table>
<thead>
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<th>Total Residents All Programs</th>
<th>296</th>
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<tr>
<td>Total Residents Enrolled in Study</td>
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<td>Dropouts</td>
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<td>2 Program 7</td>
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<td>8 Program 8</td>
<td></td>
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<tr>
<td>Residents Completed all Surveys</td>
<td>142</td>
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Figure 2 The Effects of Meaning Directed and Undirected Learning Patterns in ITE Percentiles

The Effects of Meaning Directed and Undirected Learning Patterns on ITE Percentiles

Table 1 Descriptive Statistics of Measures of ITE Percentile by Program

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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<tbody>
<tr>
<td>N</td>
<td>14</td>
<td>18</td>
<td>11</td>
<td>45</td>
<td>22</td>
<td>4</td>
<td>19</td>
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<td>ITE% Mean</td>
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<td>ITE% SD</td>
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<td>30.86</td>
<td>24.55</td>
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<td>31.33</td>
<td>33.76</td>
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Table 2  Correlation of OSI-R with MDLS and ULDS

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<tr>
<td>UD</td>
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<td>.17*</td>
<td>.26**</td>
</tr>
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</table>

Note. *p < .05. **p < .01.

OSI-R = Occupational Stress Inventory-Revised; MDLS = Meaning Directed Learning Style; UDLS = Undirected Learning Style; RO = Role Overload; RI = Role Insufficiency; RA = Role Ambiguity; VS = Vocational Strain; PSY = Psychological Strain; IS = Interpersonal Strain; PHS = Physical Strain; RE = Recreation; RC = Rational Cognitive Coping.

Low MD
High UD