When Social and Cognitive Perspectives Blur: The Case of Developing Expertise in Science and Engineering

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Keywords: expertise; psychology of science; group cognition; social cognition

Introduction (Paletz & Schunn)

Building on the recent official formation of the field called psychology of science, this symposium shows why elements traditionally thought to be in the domain of social psychology are in fact integral to cognitive science research. Specifically, cognitive psychology, social psychology, personality psychology, developmental psychology, and human factors psychology are brought together in this symposium to bring new perspectives to a common topic in cognitive science—the nature of expert performance. In addition, this theme parallels recent movements in neuroscience and AI to include social elements in theoretical models of cognition.

We consider two directions—the development of individual expertise, and the development of team expertise—showing that social elements are critical to cognitive science research on expertise. We focus on the setting of science and engineering to provide a common element across the four presentations.

The discussant will be Michael Gorman.

Development of Individual Expertise

The presentations by Feist and by Paletz will examine the nature of self-selection in the development of expertise. Specifically, why do novices stay within a discipline to go on to high levels of expertise versus drop out? For the core cognitive science method of expert/novice contrasts to be informative about cognition, the assumption must be that the selection process is either random or irrelevant to cognition. However, there are a number of non-random possible factors that cause self-selection, including some that are cognitive. For example, gender and fundamental quantitative skills have both been found to influence student attrition in the natural sciences and mathematics (e.g., Benbow & Stanley, 1983; National Science Foundation, 1999). Whether such effects are social perception or performance-based is of great societal importance. The presentations will present new data on factors associated with scientific interest (Feist) and scientific career choice (Paletz).

G. Feist & A. Larson: Domains of Intelligence as Predictors of Domains of Scientific Interest

Greg Feist's presentation examines whether different forms of scientific interest are a direct function of different domains of intelligence. Specifically, high ability in mechanical reasoning along with a high Asperger's quotient (thing-orientation) should predict interest in the physical sciences (physics, chemistry, engineering, and math), just as high social and emotional intelligence should predict interest in the social sciences (psychology, anthropology, and sociology). These predictions were tested on a sample of freshman and senior undergraduates. Participants were given a battery of tests including Baron-Cohen's Autism Quotient inventory, a mechanical reasoning test from the Differential Aptitude Test (DAT) as an index of physical intelligence, and an emotional intelligence test (MSCEIT) as an index of social-emotional intelligence. A logistic regression model found that a linear combination of scores on distinct domains of intelligence (psychological and physical) predicted dichotomous group membership in science (social or physical science).

S. Paletz, G. Feist, & W. Weitzer: Identity Mismatch, Gender, and Attrition from Science and Mathematics

Susannah Paletz's presentation unpacks some of the factors that might explain gender differences in attrition from natural science and mathematics majors. A recent review suggests that gender differences in science and mathematics skill have been overblown (Spelke, 2005). Literature on stereotype threat and implicit theories suggests that the association of science with being male may be detrimental to women's interest and performance in science careers (e.g., Inzlicht & Ben-Zeev, 2000, Nosek, Banaji, & Greenwald, 2002). Paletz surveyed over 200 second-year undergraduates to examine the correlates of scientific self-image and interest. Science interest was measured using a composite of number of science courses taken, age of interest in science, and whether a science/math major was chosen. Scientific self-image was the strongest predictor of choosing scientific careers. Scientific self-image, in turn, was significantly associated with quantitative skills. In addition, there was a significant negative correlation between scientific self-image and image of the self as a "people person," which suggests that people who want to work with others are selecting away from science careers. The studies by Feist and Paletz reveal effects of personality, skill, and self-perception on the choice to pursue science expertise.

Development & Problems in Team Expertise

Once individuals have decided to embark on science careers, the next layer of social cognition becomes important—science and engineering work often takes place in a team context. While there has been much cognitive science research on the skills and abilities of experts as individuals, there are important remaining questions about how experts coordinate to make decisions (Hutchins, 1995), how such decision making breaks down at a socio-cognitive level, and on how expert teams adapt to new situations. The next two presentations focus on the development and maintenance of group-level expertise in science, engineering, and exploration teams.

I. Tollinger, C. Schunn, & A. Vera: From Radical Colocation to Fully Distant—How Developed Team Expertise Weathers the Transition

Traditional expertise situations often confound the acquisition of new general skills with the adaptation to a particular setting. The presentation by Irene Tollinger and Chris Schunn is on the maintenance of team expertise in the face of a change in setting. They examine the case of a very successful large team (Mars Exploration Rover science and engineering team working at JPL) that has become expert in working face-to-face but then adapts to collaborating through email and videoconferencing alone. Although the setting change was dramatic, this team's productivity across several measures remained high. Using video and electronic archive data, several cognitive and socio-cognitive factors are explored for how the team was able to adapt. Note that the adaptation is primarily at the team level because the basic tasks and the individual computer interfaces for performing those tasks have remained the same.

C. Bearman, S. Paletz, & J. Orasanu: The Breakdown of Coordinated Expert Decision Making in Safety-Critical Domains

Developed expertise is thought to be discipline-specific and important for higher levels of performance. Yet, many real world tasks inherently require cross-discipline performing teams. Safety critical domains contain unpredictable problems with evolving constraints and multiple acceptable solutions (Klein, 1999), providing plenty of opportunities for experts to disagree (Shanteau, 2001). Christopher Bearman's presentation investigates how decision making breaks down at a socio-cognitive level between different experts with non-overlapping expertise. Study 1 investigates the breakdown in coordinated decision making between pilots and air traffic controllers as reported in incident reports. Study 2 validates and extends these findings in the context of a NASA space mission. Breakdowns in coordinated decision making were found to be caused, in part, by different types of lower level breakdowns (or disconnects): operational, informational and evaluative. These different disconnects show different patterns of correlation with aspects of the decision making situation and different rates of resolution.

Together, the four presentations delineate new, core interconnections between social and cognitive layers in the development and maintenance of individual and team expertise. The factors discussed challenge and deepen existing research on the cognitive science of expert complex problem solving and the psychology of science.

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