Goals, Strategies, and Motivation

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Abstract

Goal-specificity has been found to affect performance: In difficult tasks, specific goals may be detrimental for learning. Locke and Latham (1990) claimed that goal-specificity has an impact on performance via motivation. Vollmeyer and Rheinberg's (1998) cognitive-motivational process model proposed that cognitive and motivational processes interact. Therefore, we investigated if goal-specificity may change the nature of this interaction, by trying to fit different structural equations models for groups given a specific goal (SG) or a nonspecific goal (NSG). Before beginning a complex dynamic task, the SG group was given a specific goal to reach, but the NSG group only received a goal when they had to transfer their knowledge. We found that the SG group learnt less and had lower motivation during learning. Contrary to earlier claims, there was no direct effect of goal-specificity on initial motivation, but it did alter the interaction between strategies and motivation during learning. The empirical model for the SG group showed a strong effect of initial motivation on the learning process and goal-directed strategies were effective. For the NSG group motivation during the task and systematic strategies were important.

Goals, Motivation, and Performance

When setting goals for performance, there has long been a debate in the industrial psychology literature over whether a nonspecific goal (e. g., "Do your best"), or a specific goal (e. g., "Get within ten points of the target") leads to better performance. For example, Tubbs (1986) in a meta-analysis found that specific goals lead to better performance (d = .82). However, this relationship may be moderated by task difficulty: For easy tasks specific goals lead to better performance; but for difficult tasks this effect may be reversed (see Kanfer & Ackerman, 1989; the meta-analysis by Wood, Mento, & Locke, 1987). Vollmeyer, Burns, and Holyoak (1996) also showed that specific goals can hinder learning of a difficult task.

To disentangle the complex relationship between goals and performance, two different types of mediators have been proposed: 1) motivation, and 2) strategies.

Locke and Latham (1990) proposed that goals directly affect motivational mechanisms (such as, intensity of effort, direction of attention, persistence), but that they only indirectly affect strategies. Kanfer and Ackerman's approach (1989) also emphasized motivation as a mediator, however, they defined motivation more narrowly as a "subject's total capacity actually devoted to the task." (p. 664)

Vollmeyer et al. (1996) found that goal specificity may affect the strategies that learners used. Participants given a nonspecific goal were more likely to use systematic strategies appropriate for learning about the underlying structure of the task, than were participants given a specific goal, who were more likely to focus on the goal rather than structure. DeShon and Alexander (1996) also found evidence of goal effects on strategies.

A third possibility, is that motivation and cognitive strategies may interact. This is the perspective of the cognitive-motivational process model of Vollmeyer and Rheinberg (1998). This model proposes that initial motivation affects the motivational state during learning, which in turn influences strategy use and the acquisition of knowledge. This model has been supported by experiments in which participants had a nonspecific goal. However, the structure of this model may change for participants given a specific goal, and this may explain the complex relationship between goals and performance. So in the current study we examined the model fit for participants given a specific goal and for those given a nonspecific goal.

In addition, we tested the direct impact that goals may have on participants' initial motivation, as motivation alone might explain the goal effects on performance. When a learner approaches a learning task, the literature suggests that several motivational factors can arise and be measured. (1) Learners can vary in their certainty that they will succeed in understanding the task. This factor we will call *mastery confidence* (similar concepts have been proposed, e.g., subjective probability of success [Atkinson, 1957]; self-efficacy [Bandura, 1977]). (2) Learners can differ in their anxiety about failing in the task. This factor we will call *incompetence fear* (a similar concept is Atkinson's fear of failure, however, for him this concept is measured as a trait). (3) Learners can perceive this task as a *challenge* (e. g., Czikszentmihalyi, 1975). (4) The task may or may not evoke the learner's *interest* (see Schiefele, 1991). All these motivational factors are part of the initial motivation.

Alternatively, goals could indirectly impact motivation during the task, because they present participants with evidence of success and failure, leading to lower motivation, if the task is difficult and complex. This in turn could affect their strategies. So, in contrast to Locke and Latham (1990), we measured motivation during the task.

Biology-Lab: A Complex System

Vollmeyer et al. (1996) studied goal-specificity using a computer-driven system called biology-lab, which was constructed with the shell DYNAMIS (Funke, 1991). We again used this system, but changed the variables names. In our cover story, participants were told that they were in a chemical lab in which they had to study the effects of chemical elements (iron, carbon, aluminum) on the results of chemical processes (oxygenation, chlorine concentration, and temperature). Figure 1 shows the system's hidden structure, which is complex in that it involves multiple input variables that are manipulated to control multiple output variables. A decay factor (marked as a circle connected to temperature) adds a dynamic aspect, and was implemented by subtracting a percentage of the output's previous value on each trial, therefore, the variable changes even if there is no input. Participants tried to learn how to control this system, then they applied their knowledge to trying to reach a goal (i.e., bring it to specific values).

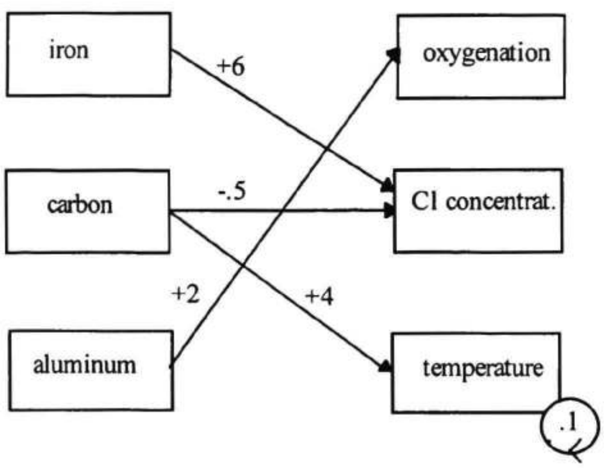

Figure 1: Biology-lab system (same structure but different variable names than in Vollmeyer, Rollett, & Rheinberg, 1997).

Experiment

Method

Participants. One hundred and sixty students (80 male, 80 female) at the University of California, Los Angeles participated in the experiment for course credit.

Design. There were two levels of goal specificity. The specific goal group (*SG*) consisted of 80 participants who received a goal at the beginning of the learning phase. The nonspecific goal group (*NSG*) consisted of 80 participants who were not given the goal until the transfer round. In the transfer round the goal states were new to both groups.

Procedure. To learn about the biology-lab system, required participants on each trial to set the levels of the three input variables and to observe the resulting values of the output variables (numbers for each of three chemical processes). A series of six trials was defined as a *round.* All participants received three initial learning rounds (the specific goal group with a goal, the nonspecific goal group with no goal) followed by a fourth round (the transfer round) in which they were asked to reach a specific goal state.

The procedure varied slightly from previous studies (Vollmeyer et al., 1996). Although, the specific goal participants were told that they should explore the system, they were also told that they only had three rounds and should try to reach the goal as soon as possible. Thus, we maximized SG participants' focus on the goal. Vollmeyer et al. had found that this change of focus appeared to be a major effect of giving a specific goal. Nonspecific goal participants were given no goal until the fourth round, as in Vollmeyer et al. For both groups, the fourth round goal was the same, but it was different to that given to SG participants at the start of the learning rounds.

Before starting the learning rounds all participants received general instructions about the task. In addition, we explained that the best strategy for exploring the system was to vary one input variable at a time (Vollmeyer et al., 1996, showed that this was a good strategy). After having read the instructions, the participants answered the QCM (*Q*uestionnaire of *C*urrent *M*otivation, by Vollmeyer & Rheinberg, 1998) which measured their initial motivation on the four factors *mastery confidence*, *incompetence fear, interest*, and *challenge* (see Table 1).

Table 1: Example items for the motivational factors (with factor loadings), and all items for the *motivational state.*

	factor loading
Mastery confidence	
I think everyone could do this task.	.73
I can't wait to start.	.67
I think I am up to the difficulty of the task.	.65
Challenge	
This task is a real challenge for me.	.76
If I can do this task, I will feel proud of myself.	.75
I'm excited about how well I will perform in this task.	.70
Incompetence fear	
I'm a little bit worried.	.72
I feel paralyzed by the demands of the task.	.72
I'm afraid I will make a fool out of myself.	.71
Interest	
After having read the instruction, the task seems to be very interesting.	.75
I like riddles and puzzles.	.75
I would work on this task even in my free time.	.75
Motivational State (all items)	Cronbach $\alpha = .80$
The task is fun.	
I'm sure I will find the correct solution.	
It's clear to me how to continue.	

After each of the three learning rounds, participants completed a *structure diagram*, in which they indicated how they believed the input variables affected the output variables. The participants were provided with a diagram showing the inputs and outputs as in Figure 1, but with all links and weights omitted, which now had to be filled in. After this, they answered three items that measured their *motivational state* (see Table 1). After the transfer round, participants did not fill in a structure diagram, they were to focus on reaching the goal.

Mediating variables. Two mediating variables were measured that may intervene between motivational factors and the learning outcomes. (1) *Motivational state.* At the end of every learning round participants answered three questions (see Table 1) on a seven-point scale, which were averaged together. (2) *Strategy systematicity.* For each learning round, the six trials were coded for either systematicity, or whether participants tried reaching the goal states. We had four categories: *low systematicity*, all input variables were varied; *medium systematicity*, a systematicity was recognizable (e. g., two variables are varied; for one variable there is a positive number, for two a negative); *high systematicity*, only one or no input variable was varied (i. e., the strategy explained to participants at the beginning); *goal-directed strategy*, participants either reached a goal, or on three consecutive trials they came closer to a goal state. The last category was difficult to code, but the inter-rater reliability ($\kappa = .84$, Cohen, 1960) was acceptable.

Dependent variables. We measured two indicators for learning. (1) *Structure score.* For each of the three structure diagrams (one for each learning round) we computed a structure score: the sum of the number of correct specifications of links, directions, and weights, adjusted with a correction for guessing. (2) *Transfer score.* In order to calculate how well participants were able to approach the target goal, accuracy in reaching the goal state during Round 4 (the transfer round) was computed. This was the sum of the absolute differences between the target value and the obtained value for each of the three output variables (as this measure produced a skewed distribution, the variance was corrected by applying a natural log transformation), computed for each of the six trials that comprised Round 4. The mean of these six sums was then subtracted from an arbitrary constant, so that high transfer scores indicated good performance, just as for structure scores. Therefore, we could consistently predict correlations in the same direction for both scores.

Results

Preliminary analyses. For the four motivational factors of the QCM we calculated the means for the items on each factor. Therefore, we could interpret the absolute level of these means, unlike the factor scores calculated in Vollmeyer et al. (1997). However, this resulted in higher correlations between factors than previously reported, as Table 2 shows.

As Locke and Latham (1990) assumed that goal-specificity affects motivation, we analyzed the initial motivation as indicated by our four factors. After having read the instructions, including our goal-specificity manipulation, there was no difference between the experimental groups regarding the four QCM-factors (all p's $> .20$). The overall means (on a seven-point scale) for the four factors were: for challenge, $M = 4.52$, $SD = 1.01$; for interest, $M = 4.02$, $SD = 1.04$; for fear, $M = 3.32$, $SD = 0.91$; and for confidence, $M = 4.43$, $SD = 1.00$.

Table 2: Correlations of the motivational factors and the dependent variables. The first coefficient belongs to the NSG-group ($n = 80$), the second to the SG-group ($n = 80$).

	mastery confidence	incompet. fear	challenge	interest
incompetence fear	-.31**/ -.26*			
challenge	.51**/ .26*	.07/ .35**		
interest	.71**/ .67**	-.30**/ -.26*	.58**/ .39**	
motivat. state (Round 3)	.37**/ .56**	-.23*/ -.41**	.39**/ -.11	.49**/ .47**
structure score (Round 3)	.24*/ .14	-.23*/ -.09	.24*/ -.17	.37*/ .15
transfer score	.19/ .22	-.25*/ -.43**	.25*/ -.23*	.29**/ .13

* $p < .05$ ** $p < .001$

Goal-specificity effects on strategies. As reported in Vollmeyer et al. (1996), the strategies for the SG group differed from the NSG group, in that they tried in the learning phase to reach the goal states (i.e., use a goal-directed strategy). In this experiment, SG participants were told to reach goal states as soon as possible. As shown in Figure 3, they changed to a goal-directed strategy. Figure 2 shows that the NSG group mainly used the instructed high systematicity strategy (67% of all learning trials).

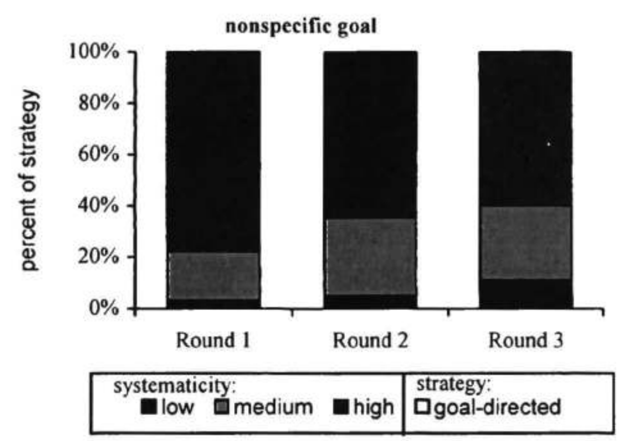

Figure 2: Percentage of NSG participants using each of the four types of strategies in each round.

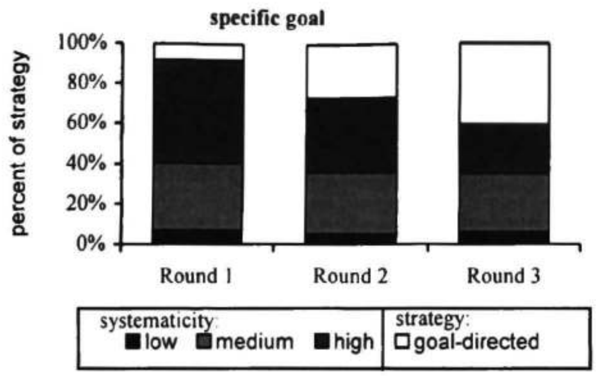

Figure 3: Percentage of SG participants using each of the four types of strategies in each round.

Goal-specificity effects on learning. Our research question was, whether goal-specificity affects performance via motivation. Initial motivation was not affected by the manipulation, but the four motivational factors had effects on learning (motivational state, structure score, transfer score) as shown in Table 2. Although correlations demonstrated relationships between variables, a more complex statistical analysis was required to examine the interdependencies in the data. So initial motivation (as a predictor), the mediator and dependent variables' scores from the three measurement points in the learning phase, and final performance, were analyzed together using structural equations modeling (using EQS, see Bentler, 1995). Linear structural equations modeling is a methodology for specifying, estimating, and testing hypothesized interrelationships among a set of variables. There are two criteria for whether the hypothesized model fits the empirical data: (1) the goodness of fit (e.g., *C*omparative *F*it *I*ndex), which has the maximum value 1.0, (2) and X^2, which should not be significant.

We expected that goal-specificity would lead to fundamentally different relationships in the data because it influences the whole learning process. Therefore, we analyzed two empirical models, one for participants with a specific goal, one for participants with a non-specific goal. The model for the non-specific group was theoretically derived from our cognitive-motivational process model (Vollmeyer & Rheinberg, 1998), which was empirically supported by Vollmeyer et al. (1997).

The model for the NSG group is presented in Figure 4. The empirical data fit to our theoretical expectations, CFI = .98, $X^2(61) = 71.28$, $p = .17$. As before, we found a cognitive path: Participants using the instructed good strategy learnt more about the system's structure (links from strategies to structure scores), which led to more knowledge, that could be applied to reaching the goal state more accurately in the transfer round (structure score –> transfer score). This cognitive path was affected by motivation. The initial motivation, *incompetence fear, interest* and *mastery confidence,* combined as the latent variable *motivation,* affected how the participants felt during learning (*motivational state*). Participants who initially had less fear, but more confidence and interest, enjoyed learning more.

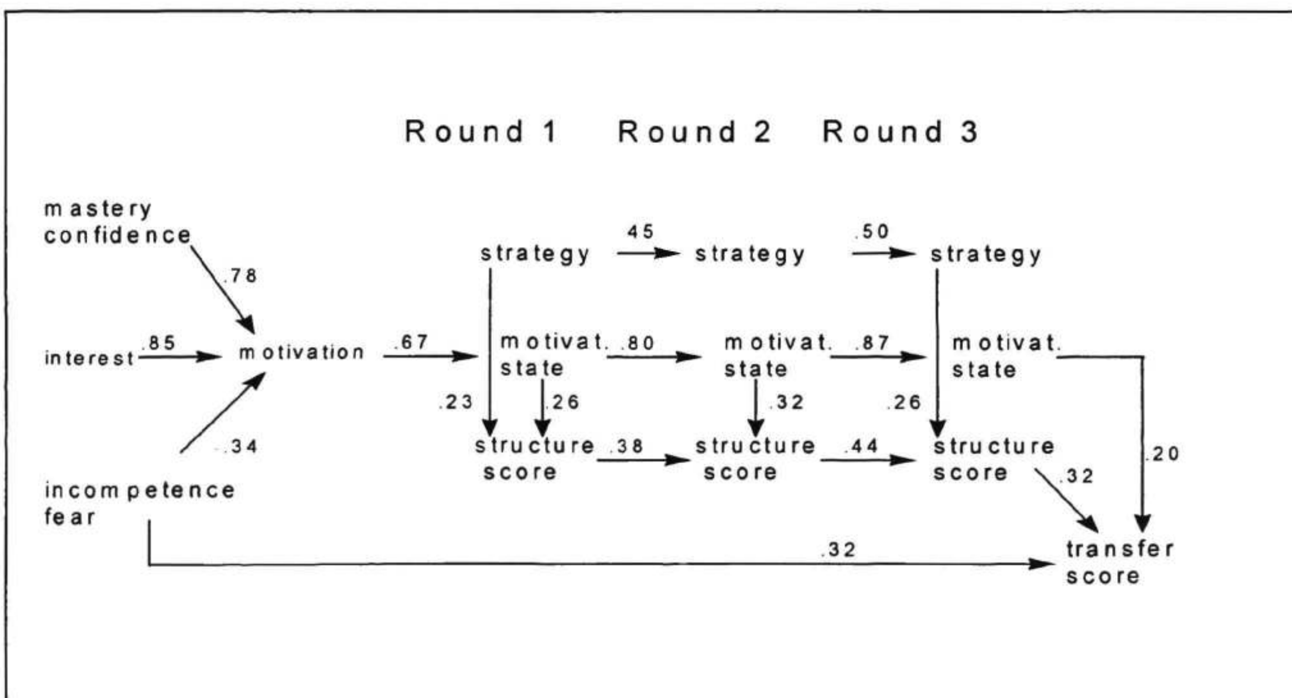

Figure 4: Path analysis for the cognitive-motivational process model for participants with a nonspecific goal.

Participants in a more positive *motivational state* gained more knowledge, perhaps because they put more effort into calculating the system's weights. The positive motivational state also helped participants reach the goal state more accurately in the transfer round (motivational state -> goal achievement). This path analysis replicated the Vollmeyer and Rheinberg (1998) model of how initial motivation affects learning (knowledge and application) via mediating variables (*motivational state* and *strategy systematicity*).

The model for SG participants, was more explorative as there were no exact theories explaining how goal-specificity has an impact on performance via motivation. First, we tried to fit the same model as shown in Figure 4 for NSG participants. To do this we, combined the category low systematicity with the goal-directed strategy, as in Vollmeyer, et al. (1996). Both strategies were inappropriate for discovering the underlying structure of the system. As expected, the model fit dropped to a $CFI = .90$, $X^2(61) = 94.99$, $p = .004$. So we tested alternative models based on the theoretical principle discussed earlier.

Goal-directed strategies seem qualitatively different to systematic strategies appropriate for discovering the structure. So we examined a new model for the SG group using a strategy measure which was the frequency of how often the goal-directed strategy was used during the whole learning phase, a measure which was not possible for the NSG group. Therefore, in the model shown in Figure 5, there is no indicator for strategy systematicity but instead for the frequency of goal-directed strategies.

The model in Figure 5 had a $CFI = 1.00$, $X^2(30) = 24.38$, $p = .76$. For the SG group the initial motivation (a latent variable derived from interest, incompetence fear, mastery confidence) influenced learning not only in Round 1 of the learning phase (motivation -> motivational state) but also in Round 3 (motivation -> motivational state and structure score) and in the transfer phase (motivation -> transfer score). This strong influence of initial motivation appears to be due to participants who had a good knowledge in Round 1 changing their instructed strategy to a goal-directed strategy (link from structure score to goal-directed strategy). As previous studies (Vollmeyer et al., 1996) have suggested, SG participants experienced failure because they started reaching the goal states without having enough knowledge. We tested this hypothesis by calculating for Round 3 the difference between the SG and NSG group on motivational state and structure score. As expected, the SG group had less knowledge ($M = 1.08$, $SD = .92$) than the NSG group ($M = 1.45$, $SD = 1.0$), $t(158) = 2.43$, $p = .016$, which could be why their motivational state is also lower, $t(159) = 2.33$, $p = .021$ ($M_{SG} = 3.32$, $SD = 0.91$; $M_{NSG} = 3.70$, $SD = 1.60$). Therefore, although initial motivation was not affected by goals specificity, for SG participants it had a major effect on performance, as only those participants with high initial motivation were still confident at the end of the learning phase (motivation -> motivational state), gained more knowledge (motivation -> structure score), and were more accurate in reaching a second goal state (motivation -> transfer score). As expected, SG participants were not able

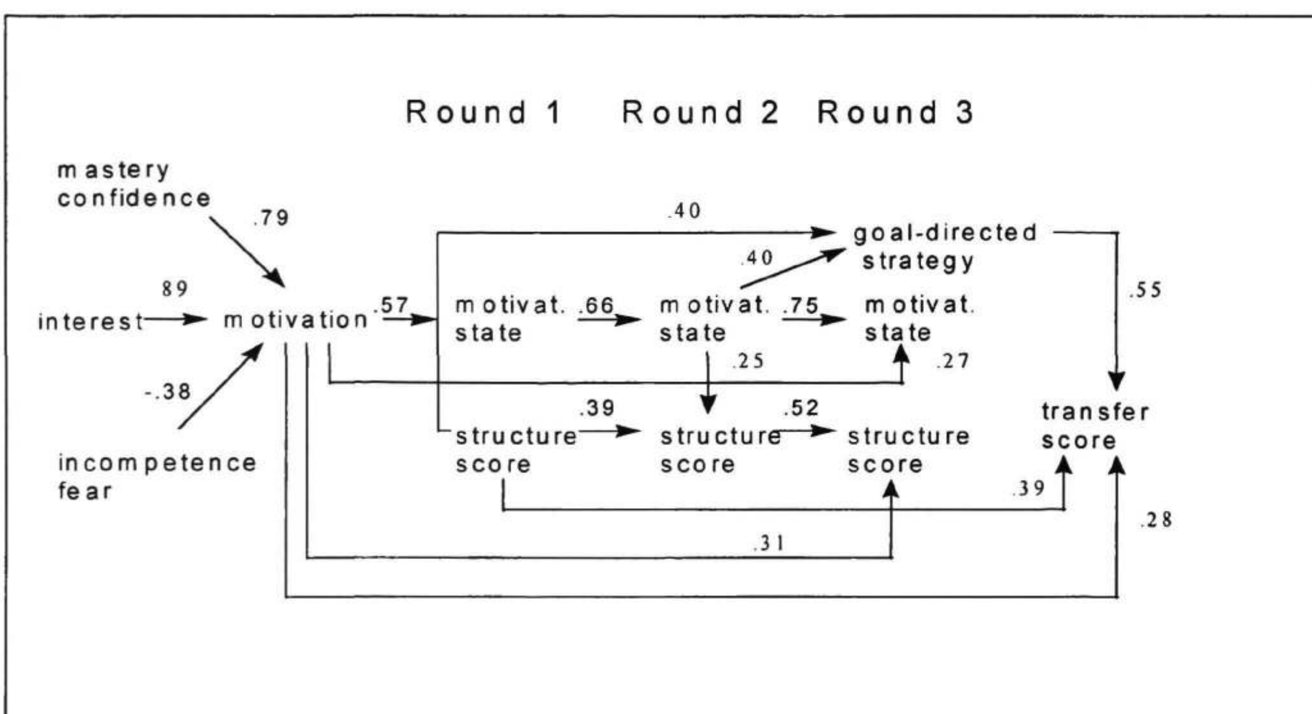

Figure 5: Path analysis for the cognitive-motivational process model for participants with a specific goal.

to transfer what they learnt about the system's structure to a new goal state (missing link from structure score in Round 3 to transfer score). Instead the structure score in Round 1 was a better predictor (structure score -> transfer score) because this knowledge level affected their subsequent strategies. For reaching the transfer goal more accurately a high utilization of the goal-directed strategy during learning was more helpful than acquiring knowledge (structure score).

Discussion

The aim of our study was to investigate how the way people learn about a complex system is influenced by the type of goal they are given: specific or nonspecific. In contrast to Locke and Latham (1990), who assumed that specific goals motivate people more than nonspecific, we did not find such a difference in initial motivation. Instead a specific goal affected the strategy which people used (although we did tell specific goal participants to consider the goal, unlike Vollmeyer et al., 1996). Motivation also had an impact on strategies, but more critically, goals affected the nature of the interaction between motivation and strategies. The same model did not fit to data from both experimental groups.

Structural equations modeling showed that initial motivation was a more important aspect for SG than for NSG participants. Initial motivation appeared to influence SG participants' ability to maintain the motivation necessary to persist with a goal-directed strategy, a strategy that was associated with successful performance. Perhaps initial motivation is important because they experienced failure, as indicated by the lower structure scores for SG participants. For NSG participants, current motivation influenced knowledge acquisition. However, initial motivation was not an independent contributor to motivation at the end of the task, perhaps because failure was not so clearly experienced by NSG participants. Vollmeyer et al. (1997) fit a very similar model for NSG participants, except that there was also a link from current motivation to strategy systematicity in that model, a link that was not statistically significant for this data.

The results support Vollmeyer and Rheinberg's (1998) cognitive-motivational process model and illustrate the importance of measuring mediating variables between goal-specificity and performance. Further, they show the importance of treating learning as a process, which makes it critical to measure these mediators during the task. Other theories (Locke & Latham, 1990; Kanfer & Ackerman, 1989) also assume that motivation is a mediator, but they have not measured it during learning. By providing a model of how goals change the process by which other variables (i.e., motivation and strategies) affect performance, these results provide a way to start to disentangle the inconsistencies found in the studies of how goal specificity affects performance in learning tasks.

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