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# Behavioral and Physiological Correlates of Goal-Directed Behavior

Caran Colvin and Rick Jacobs
*The Pennsylvania State University*

The effects of a *task complexity system,* defined by a match or mismatch between subject's ability and task requirements, and goal setting on performance of a computer-based game were investigated in two studies using a 3 × 2 × 2 (Complexity System × Goal × Trial) design. In the first trial, undergraduate students (90 in Study 1 and 72 in Study 2) played the game under a low, balanced, or high task complexity system condition. The low complexity task system condition was characterized by high ability on the part of the subject coupled with low task demands. The reverse describes the high complexity task system condition. The balanced task complexity system condition matched subjects' ability with demands of the task. In the second trial, the same students either set performance goals or were told to do their best as they played the game. We concluded that balanced task complexity systems elicited active coping with task demands. Goal setting, however, altered the subjects' patterns of autonomic and behavioral responses. Across the goal and task complexity system conditions, performance outcomes were consistent with patterns of autonomic response. When parasympathetic withdrawal was accompanied by sympathetic overbalance, performance was lower. Performance was lower: (a) in the unbalanced task complexity systems when goals were self-set and (b) in the balanced systems when do-your-best goals were applied. When parasympathetic dominance was evident, performance was higher. Performance was higher: (a) in balanced task complexity systems when goals were self-set and (b) in the unbalanced systems when do-your-best goals were applied. Implications for these findings are discussed, and avenues for future research are outlined.

One of the most consistent findings in the organizational literature is the goal-performance relationship (Locke, Shaw, Saari, & Latham, 1981). In general, positive increments in performance are associated with difficult goals, whereas moderate or easy goals tend to have little or no impact on

Requests for reprints should be sent to Caran Colvin, Department of Psychology, San Francisco State University, San Francisco, CA 94132.

performance. Many researchers have suggested, however, that this goal-performance relationship is not valid across all conditions. As an example, goal-setting effects vary as a function of task difficulty (Huber, 1985), task complexity (Wood, Mento, & Locke, 1987), and individual differences, particularly task-related abilities (Campion & Lord, 1982; Hollenbeck & Brief, 1987; Kanfer & Ackerman, 1989; Locke et al., 1981).

Huber (1985), for example, found that the physiological response associated with setting a difficult goal on a difficult task accounted for performance decrements. Given sufficient ability, however, it is probable that the physiological response associated with setting a difficult goal on a difficult task will result in performance increments. Although this assumption has not been empirically examined, Hollenbeck and Brief (1987) and Campion and Lord (1982) provided indirect support: They found positive correlations between ability and self-set goal level. An extension of these findings is that ability and task difficulty define a system of task complexity in which physiological and behavioral effects vary as a function of the congruence or fit between them.

## TASK COMPLEXITY SYSTEMS

### Individual Differences: Ability

In an extensive review of the moderating effects of individual differences on the goal–performance relationship, Hollenbeck and Brief (1987) suggested that past research has erroneously assumed that goal setting affects every individual in the same manner. Hollenbeck and Brief (1987) and Campion and Lord (1982) applied control systems theory to explain the relationship between past performance, ability, and self-set goal level. The basic premise of this theory is that initial goal level will be higher when past performance and ability are high, rather than low. Hollenbeck and Brief (1987) found a correlation of .71 between objective ability and self-set goal difficulty, and Campion and Lord (1982) found a correlation of .37 between past performance and self-set goal difficulty and a correlation of .29 between objective ability and self-set goal difficulty.

Although these researchers have provided sufficient support for the moderating effects of ability on the goal–performance relationship, its effect relative to task difficulty is unclear. In other words, these researchers have assumed that ability will moderate the goal–performance relationship, in the same manner, for all levels of task difficulty. However, in the context of the task complexity systems model developed here, self-set goal difficulty varies as a function of the congruence or fit between ability and task difficulty, rather than ability per se.

### Task Difficulty

Huber (1985) noted that it is unclear whether the relationship between performance and goal setting is the same at all levels of task difficulty. Furthermore, she suggested that goal-setting effects are unclear because researchers often confound goal difficulty and task difficulty. Wood et al. (1987) suggested that it is difficult to examine task complexity effects because researchers do not apply a standard operationalization of the moderator, and they confound individual and task characteristics. Wood et al. (1987) applied meta-analytic techniques to evaluate the moderating effects of task complexity on the goal-performance relationship. They concluded that goal-setting effects were strongest for easy tasks and weakest for more complex tasks.

One problem with this conclusion, however, is its neglect of the relative contribution of ability to task difficulty effects. Given sufficient ability, it is probable that difficult goals may indeed enhance performance on a complex task, so that performance is a positive linear function of goal level.

### Summary

Ability and task difficulty are important moderators of the goal-performance relationship. To date, researchers have ignored their relative effects. Yet, it is possible to examine these effects by emphasizing the fit or congruence between them. Consistent with this analysis, three systems of task complexity are described here. The first system is defined as *low task complexity* and is characterized by high ability/easy task. *Balanced task complexity,* characterized by a fit between ability and task difficulty, represents the second system. The final system is defined as *high task complexity,* and it is characterized by low ability/difficult task.

## PHYSIOLOGICAL CORRELATES

A recent explanation of performance decrements associated with setting a difficult goal on a difficult task has been physiological response. Huber (1985) concluded that it was the physiological response caused by a difficult task and a difficult goal that generated lower performance. Organ (1977) failed to find physiological effects associated with setting a difficult goal on a difficult task, reporting a positive correlation between performance and goal level.

Nevertheless, the general acceptance of physiological interpretations of goal setting has been limited by pragmatic as well as by theoretical deficiencies of physiological theory itself. One deficiency of the Organ (1977) and Huber (1985) studies, for example, was their neglect of physiological measures. Organ (1977) and Huber (1985), obtained pre- and postmeasures of physiological response using an anxiety questionnaire. This operationalization implies that physiological response represents an overall, nonspecific index of the degree of stimulation of the system as a whole.

Numerous researchers cited evidence suggesting that the physiological response system can be considered neither a unitary nor a nonspecific mechanism (e.g., Hockey, 1984; Hockey & Hamilton, 1983; Lacey, 1967; Obrist, 1981). For example, Obrist (1981) suggested that the heart rate (HR) changes associated with various task demands are functionally different from one another, and they reflect the differential influence of the two divisions of the autonomic nervous system. Obrist (1981) noted that HR is controlled by the parasympathetic and the sympathetic divisions of the autonomic nervous system. Excitation of the parasympathetic division is associated with decreased HR, whereas excitation of the sympathetic division is associated with increased HR.

## Coping Style

Obrist (1981) also suggested that the two divisions of the autonomic nervous system are differentially associated with an individual's style of coping with task demands. He concluded that passive coping tasks, accompanied by HR decrease, are dominated by parasympathetic activity. In contrast, active coping tasks, accompanied by HR acceleration, are dominated by sympathetic activity.

More specifically, Obrist (1981) described active coping tasks as engaging; subjects are able to deal with task demands. Active coping, in which the subject's actions influence the environment, is characterized by avoiding an electrical shock by pressing a button. Passive coping tasks are described as not very engaging, and the subject is unable to cope with task demands. During passive coping, the subject has little control over the environment, such as when he or she receives electric shocks regardless of his or her responses.

Obrist et al. (1978) examined the moderating effect of task difficulty on coping style and cardiovascular response. They manipulated the difficulty of an active coping task, concluding that, if the task was either too easy or too difficult, cardiovascular activity tended to drop over the duration of the task. In contrast, if the task was difficult, but possible, cardiovascular activity remained high.

Carroll, Turner, and Hellawell (1986) also provided empirical evidence of task difficulty effects on coping style and cardiovascular response. They found that cardiovascular response was sensitive to task difficulty manipulations. Specifically, they demonstrated that the easy task condition was associated with significantly less cardiovascular response than both the hard and impossible task conditions. Similarly, self-report measures of task engagement and physiological response resembled cardiovascular response: Subjects perceived the easy task condition as unarousing and unengaging.

The effects of task difficulty described by Obrist et al. (1978) and Carroll et al. (1986), however, are inconsistent. These discrepant findings may be explained in terms of individual differences: Neither Obrist et al. (1978) nor Carroll et al. (1986) accounted for the subjects' ability to cope with task demands. Thus, when the effects of task difficulty were considered, relative to ability, physiological responses systematically varied across the task complexity conditions.

### Summary

Sufficient evidence exists so that several physiological characteristics of the task complexity systems may be proposed. Research suggests that balanced task complexity systems (i.e., matched ability/task difficulty) are similar to the "difficult, but possible task" described by Obrist et al. (1978). This implies that balanced systems elicit sympathetic control (i.e., elevated HR) characteristic of active coping.

A similarity between low task complexity systems (i.e., high ability/easy task) and the "easy task" described by Obrist et al. (1978) is also proposed. The "impossible task" described by Obrist et al. (1978) is characteristic of a high task complexity system. Both unbalanced systems will elicit parasympathetic control (i.e., low HR) characteristic of passive coping.

Although individuals in the two unbalanced systems of low and high task complexity may become similarly disengaged from the task, the process by which this occurs varies across the two systems. An individual who performs a task of low complexity may become disengaged due to boredom. In contrast, an individual who performs a task of high complexity may become disengaged due to frustration or anxiety elicited by excessive task demands.

## BEHAVIORAL CORRELATES

The studies conducted by Obrist et al. (1978), Obrist (1981), and Carroll et al. (1986) did not examine the behavioral correlates associated with coping style. Thus, in contrast to the relatively straightforward effects on physiological indicators, the behavioral responses associated with the various systems of task complexity are less clear. Given the analogy between coping style and task complexity systems, however, reasonable assumptions may be proposed. For example, greater performance increments will be found in balanced (active coping) than in unbalanced (passive coping) systems.

Of particular interest is the shift in behavioral effects of task complexity systems created by the application of goals. A comprehensive examination of goal-setting effects, however, requires the use of self-set goals, rather than assigned goals. Locke et al. (1981), for example, concluded that assigned goals prevent personal styles and preferences from affecting performance. They suggested that, in situations of free choice in setting goals, individual styles may have a greater effect on the goal–performance relationship. Empirical support for the use of the self-set goals has been provided by Campion and Lord (1982), Locke, Frederick, Lee, and Bobko (1984), and Hollenbeck and Brief (1987). These researchers have found a strong goal–performance relationship under conditions of self-set goals.

## GOAL-SETTING EFFECTS

Geen (in press) reviewed several articles that provide a framework for examining the behavioral and physiological correlates of goal-directed behavior. Wood et al. (1987), for example, suggested that goal complexity may influence the type of mechanism that operates following the establishment of a goal. They noted that the motivational effects of goal setting (effort and persistence) may affect behavior when goals are simple. The cognitive effects (strategy development), however, may predominate when goals are complex.

Chesney and Locke (1991) provided support for this goal complexity hypothesis: Goal complexity increased the importance of cognitive effects over more motivational processes. Geen (in press) concluded that, when goals are simple, they are most easily attained through increased motivation (effort and persistence) because complex cognitive processes are not needed. When goals are complex, however, motivation becomes less important than cognitive processes such as strategy development.

Table 1 shows how the goal complexity hypothesis may generalize to our research. During the pregoal trial, physiological response is higher in the balanced systems than it is in the unbalanced ones. The application of high complex goals

TABLE 1
Behavioral and Physiological Changes Elicited by Goal-Setting Task Complexity System

| *Goal Condition* | *Low* | *Balanced* | *High* |
|---|---|---|---|
| Pregoal trial[a] | Low HR and low performance | High HR and high performance | Low HR and low performance |
| Self-set goals[b] | Lower HR and lower performance | Moderate HR and higher performance | Lower HR and lower lower performance |
| Do-your-best goals[b] | Moderate HR and higher performance | Higher HR and lower performance | Moderate HR and higher performance |

[a]The entries in this row refer to hypothesized states relative to each other. [b]The entries in these rows refer to comparisons relative to the pregoal trial.

(or self-set goals) decreases effort (or physiological response) across all three systems. Thus, relative to the pregoal levels, physiological response declines to an insufficient level in the unbalanced systems and declines to an optimal level in the balanced one. Performance increments describe the balanced systems, whereas performance decrements describe the unbalanced ones.

The application of low complexity goals (or do-your-best goals) has the opposite effect: They increase effort (or physiological response) across all three systems. Relative to the pregoal levels, physiological response is elevated to an optimal level in the unbalanced systems, but it is excessive in the balanced one. Performance decrements describe the balanced system, whereas performance increments describe the unbalanced ones.

## HYPOTHESES

We identify patterns of autonomic response associated with goal-directed behavior. The patterns of sympathetic and parasympathetic control associated with various levels of goal setting and task complexity are examined. We proposed that:

1. During the pregoal-setting trial, subjects in balanced task complexity systems will exhibit physiological indices associated with sympathetic control (i.e., active coping). In unbalanced systems, parasympathetic control will be elicited (passive coping).

2a. Balanced task complexity systems will elicit parasympathetic control when goals are self-set. Do-your-best goals will elicit sympathetic control on this type of task.

2b. Unbalanced task complexity systems will elicit sympathetic control when goals are self-set. Do-your-best goals, however, will elicit parasympathetic control in these systems.

3a. In balanced task complexity systems, greater performance increments will be associated with self-set goals as compared to do-your-best goals.

3b. In unbalanced task complexity systems, greater performance increments will be associated with do-your-best goals as compared to self-set goals.

## STUDY 1

### Method

#### *Subjects*

Ninety subjects (45 men and 45 women) enrolled in an introductory psychology course voluntarily participated in the experiment to assess the goal and task complexity manipulations. Each student received extra course credit for their participation in the study.

### *Design*

A 3 × 2 × 2 (Task Complexity System × Goal × Trial) mixed design was used. Task complexity system was operationalized as low (easy task/high ability), balanced (matched task difficulty and ability), and high (difficulty task/low ability). Goal was operationalized as do-your-best and self-set. The repeated measure—trial—consisted of three conditions: base rate (BR), task assignment, and goal.

### *Task*

The task was a video game played on a microcomputer. In *Rogue*©, the player attempts to recover an amulet hidden on the lowest level of the dungeon. There are 26 levels in the dungeon, with a maze of rooms on each level. The player moves throughout the maze on each level, locates the stairway, and descends to the next level.

As the player progresses through the castle, he or she encounters various monsters and traps, as well as various types of magical potions, weapons, and scrolls that facilitate survival, if properly used. Progression down the levels of the castle is associated with greater difficulty and a lower probability of survival. That is, the monsters become more dangerous, and the traps become more severe at lower levels.

### *Measures*

*Ability.* To measure task-related ability, a pretest was administered to each subject. This pretest consisted of actual trials of the video game. Each subject's ability score was determined as the highest level of the castle attained during the pretest. The subjects were pretested for 15 min.

*Task difficulty.* Pilot trials of the game were conducted to determine the number of levels necessary to detect a meaningful difference in the difficulty of the game. We found that the completion of three levels of the game was associated with an increase in difficulty level. After any three levels of play, the survival rate decreased precipitously. For example, the monsters became more difficult to defeat, and the traps became more life threatening.

*Task complexity system.* Task complexity system was determined as a function of subject's ability and task difficulty. Because three levels of the castle generated a meaningful difference in the difficulty of the game, this value was used to manipulate the task difficulty component. Similarly, the level attained by the subject in the pretesting represented the ability component.

Thus, assignment to the low task complexity system condition consisted of subtracting three levels from the subject's ability level, so that the subject started the game at the ability −3 level. Assignment to the balanced task complexity system condition consisted of starting the game at the subject's ability level. Assignment to the high task complexity system condition consisted of adding three levels to the subject's ability level, so that the subject started the game at the ability +3 level.

*Cardiovascular responses.* The measures and procedures described by Grossman and Svebak (1987) were used to record HR. HR (measured as beats per minute) was recorded continuously throughout the study using a Cole Palmer 8376–30 Polygraph. The last 90-sec period of each condition (BR, task assignment, and goal) was designated as the measurement period for HR.

*Performance.* The behavioral response measured was the level of the castle attained by the subject.

### Procedure

Upon entering the lab room, the subject was seated in a chair facing a computer screen. The electrodes and the strain gauge were then attached to the subject.

*Task orientation.* The subject was provided with a job description of his or her role as the "hero" of the video game. The job description illustrated the behavioral dimensions and definitions of the game. The experimenter then demonstrated *Rogue* to the subject and answered any questions concerning the game. The subject was permitted to practice the game for 15 min.

*Pretest session.* The subject was informed that the first session was a "selection test" in which his or her video game ability would be assessed. The subject was instructed to play the game for 15 min and to begin a new game if he or she was defeated by a monster. The levels of the castle attained by the subject were automatically recorded in the video game program. Upon completion of the pretest session, the experimenter accessed the performance file to record the subject's ability score.

*Task assignment.* In this session, the subject was randomly assigned to one of the three task complexity system conditions. The subject was told that the task assignment (TA) was to start the game at his or her designated task complexity level and to play three levels of the game. For example, a subject with a Level 5 ability, who was randomly assigned to the low task complexity system condition, started the session at Level 2 (ability −3) and played Levels 2 through 4 of the castle. Upon completion of the three levels or defeat by a monster, the subject repeated the three levels for a 30-min period. During this session, the experimenter continuously recorded both the level of the castle attained by the subject for each set of levels played.

*Goal.* In the final session, the subject was randomly assigned to the do-your-best or the self-set goal condition. The subject started the game at the level assigned during the TA session. The subject played the game for 15 min. In the do-your-best condition, the subject was instructed to play the game as well as possible. In the self-set condition, the subject set performance goals related to the level of the castle that he or she expected to attain. The experimenter recorded these performance goals before the start of the self-set goal condition.

*Base rate measures.* Upon completion of the goal condition, the subject was instructed to relax for 10 min. After this time, the subject's base rate HR and RR were recorded for a 10-min period.

## Results

### *Cardiovascular Response*

HR was analyzed with a 3 × 2 × 3 (Trial × Goal × Task Complexity System) mixed analysis of variance (ANOVA), with trial serving as the repeated measure. The results revealed a significant main effect of task complexity system, $F(2, 83) = 11.78$, $p < .01$; a significant main effect of trial, $F(5, 83) = 28.58$, $p < .01$; and a significant Goal × Task Complexity System interaction, $F(2, 83) = 29.27$, $p < .01$.

Comparisons across the task complexity system conditions revealed that (a) in the self-set goal condition, the high task complexity system elicited higher HR than the other two systems; and (b) in the do-your-best condition, the balanced task complexity system elicited higher HR than the other two systems. Across the goal conditions we found that do-your-best goals elicited higher HR. Table 2 shows the means and standard deviations for HR across the Goal × Task Complexity System conditions.

### *Performance*

A 2 × 3 (Goal × Task Complexity System) ANOVA was conducted on the level of the castle attained (controlled for starting level). The results revealed a significant Goal × Task Complexity System interaction, $F(2, 83) = 2.96$, $p < .05$.

Comparisons across the task complexity system conditions revealed that (a) in the self-set goal condition, balanced task complexity system subjects performed better than either the low or high task complexity system subjects; and (b) in the do-your-best condition, subjects in the low task complexity system condition performed better than subjects in the balanced or

TABLE 2
Study 1: Means and Standard Deviations of Dependent Measures

| Dependent Measure | *Task Complexity System* | | | | | |
|---|---|---|---|---|---|---|
| | *Low* | | *Balanced* | | *High* | |
| | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| HR | | | | | | |
| Self-set goal | −0.27 | 7.99 | −0.87 | 4.91 | −1.4 | 4.45 |
| Do-your-best goal | −1.93 | 6.22 | −2.53 | 7.71 | −1.6 | 4.36 |
| Performance | | | | | | |
| Self-set goal | 0.47 | 1.84 | 0.95 | 1.28 | 0.76 | 1.23 |
| Do-your-best goal | 1.49 | 1.87 | 0.39 | 1.63 | 0.14 | 1.05 |

high task complexity system conditions. Comparisons across the goal conditions revealed that (a) in the low task complexity system, do-your-best goals elicited better performance; and (b) in both the balanced and high task complexity systems, self-set goals elicited better performance. Table 2 shows the means and standard deviations for performance across the Goal × Task Complexity System conditions.

Prior to any discussion, note that the results, although consistent with the hypotheses, placed heavy reliance on a single measure of physiological response. By only measuring HR, a question arises as to the stability of the findings across other physiological measures. Consistent with this concern, a second study was conducted. A full discussion of both studies follows the presentation of methods and results for Study 2.

## STUDY 2

### Method

Study 1 and Study 2 were similar with the following three exceptions. The first exception is that in Study 1, a single index of physiological response (HR) was measured, whereas multiple indices were measured in Study 2. These measures of the autonomic nervous system included: HR, RR, respiratory sinus arrhythmia (RSA), and sympathetic overbalance (HR and RR). A mercury strain gauge strapped around the chest cavity was used to measure RR. To measure HR, Beckman biopotential electrodes were attached on each side of the rib cage and on the lower right side of the neck. Average RSA for a condition was computed as the sum of the interbeat-interval HR differences divided by the number of respiratory cycles per measurement period. Sympathetic overbalance, or the degree to which sympathetic influences upon HR exceeded parasympathetic influences, was estimated using an analysis of covariance (ANCOVA) of HR, with RSA as a covariate. The second exception is that a Cole–Palmer 8376–30 single channel recorder was used in Study 1, whereas a Beckman R511A four-channel polygraph was used in Study 2. The third exception is that, in Study 1, subjects played the game for 30 min, whereas in Study 2, the time was shortened to 15 min.

Aside from these differences, all information relevant to the methods of Study 1 are also relevant to Study 2.

### *Subjects*

Seventy-two subjects (36 men and 36 women) enrolled in an introductory psychology course voluntarily participated in this study. They received extra course credit for their participation.

## Results

### *Preliminary Analyses*

HR and RR were obtained from the last 90-sec period of the TA condition, the last 90-sec period of the goal condition, and the last 90-sec period of the posttask BR condition. RSA was statistically computed for each of these conditions using its respective HR and RR responses.

Analyses of baseline HR and baseline RSA indicated that the subjects did not differ on these measures across the Goal × Task Complexity System conditions. Table 3 shows the correlations between HR and RSA both within and across each experimental condition. The correlations with performance during TA trial and the goal are also shown.

Table 3 shows that RSA BR, RSA TA, and RSA goal were inversely correlated with HR BR, HR TA, and HR goal. Significant correlations between performance during the goal trial and each of the three trials of HR are also shown in Table 3. Overall, the three trials of HR were inversely related to performance during the goal trial.

TABLE 3
Means, Standard Deviations, and Correlations Among Dependent Measures

| Dependent Measure | *M* | *SD* | Correlation *1* | *2* | *3* | *4* | *5* | *6* |
|---|---|---|---|---|---|---|---|---|
| HR BR | 110.58 | 14.25 | | .84 | .85 | −.54 | −.36 | −.28 |
| HR TA | 112.72 | 13.63 | | | .95 | .52 | −.40 | −.37 |
| HR goal | 112.24 | 13.75 | | | | −.48 | −.33 | −.36 |
| RSA BR | 92.71 | 32.67 | | | | | .49 | .47 |
| RSA TA | 64.47 | 22.01 | | | | | | .69 |
| RSA goal | 65.08 | 21.51 | | | | | | |

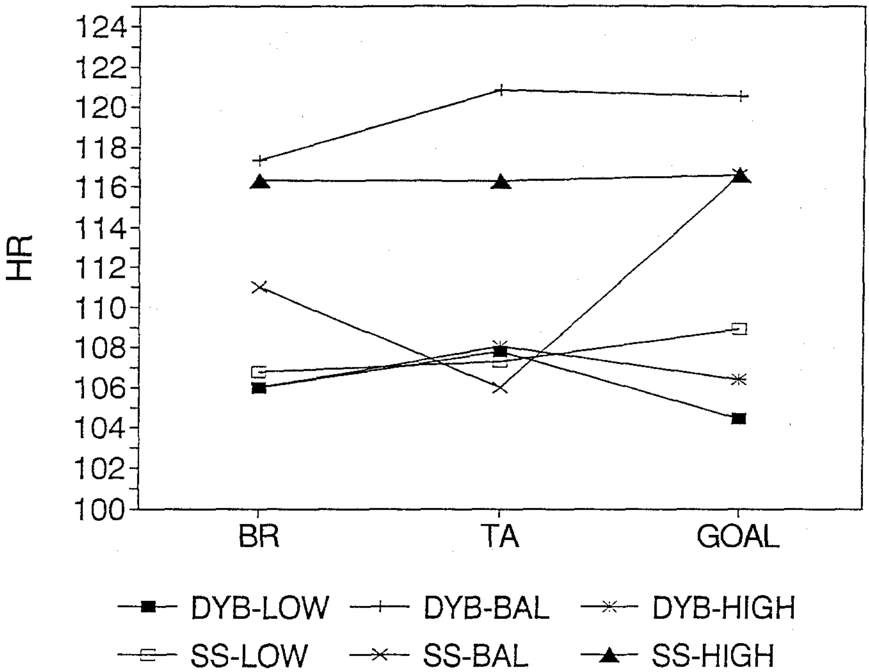


FIGURE 1 Mean HR levels for each Goal × Task Complexity System condition across experimental conditions.

### *Cardiovascular Response*

*HR × Experimental Conditions.* HR within each of the Goal × Task Complexity System conditions was analyzed across the BR, TA, and goal trials. The mean HR levels for each of the Goal × Task Complexity System conditions across the three trials are shown in Figure 1.

HR was analyzed with a 3 × 2 × 3 (Trial × Goal × Task Complexity System) mixed ANOVA, with trial serving as the repeated measure. As shown in Table 4, the results revealed main effects for trial, $F(2, 215) = 3.82$, $p < .05$; goal, $F(1, 215) = 9.53$, $p < .01$; and task complexity system, $F(2, 215) = 78.34$, $p < .01$. Also, a significant interaction was found for Goal × Task Complexity System, $F(2, 215) = 40.45$, $p < .01$. Overall, these results support Hypothesis 1: Balanced task complexity systems elicited physiological indices associated with sympathetic control, and unbalanced task complexity systems elicited physiological indices associated with parasympathetic control.

*RSA × Experimental Conditions.* RSA within each of the Goal × Task Complexity System conditions was analyzed across the BR, TA, and goal trials. Figure 2 shows the mean RSA levels for the Goal × Task Complexity System conditions across the three trials.

TABLE 4
Study 2: ANOVAs for HR, RSA, Sympathetic Overbalance, and Performance

| | *HR* | | *RSA* | | *Sympathetic Overbalance* | | *Performance* | |
|---|---|---|---|---|---|---|---|---|
| *Condition* | *F* | $\omega^2$ | *F* | $\omega^2$ | *F* | $\omega^2$ | *F* | $\omega^2$ |
| Goal | 9.53** | .01 | 0.46 | | 2.97** | .03 | 22.37** | .02 |
| Task Complexity | 78.34** | .08 | 1.41 | | 7.52** | .13 | 163.48*** | .28 |
| Trial | 3.82* | .01 | 57.6** | .20 | | | 78.76** | .13 |
| Goal × Task Complexity | 40.45** | .05 | 7.54** | .02 | 3.79** | .05 | 3.91** | .01 |
| Trial × Goal | 1.43 | | 0.51 | | | | 0.41 | |
| Trial × Task Complexity | 1.55 | | 0.98 | | | | 6.70** | .02 |
| Trial × Goal × Task Complexity | 0.51 | | 2.53* | .01 | | | 0.74 | |

*$p < .05$. **$p < .01$.

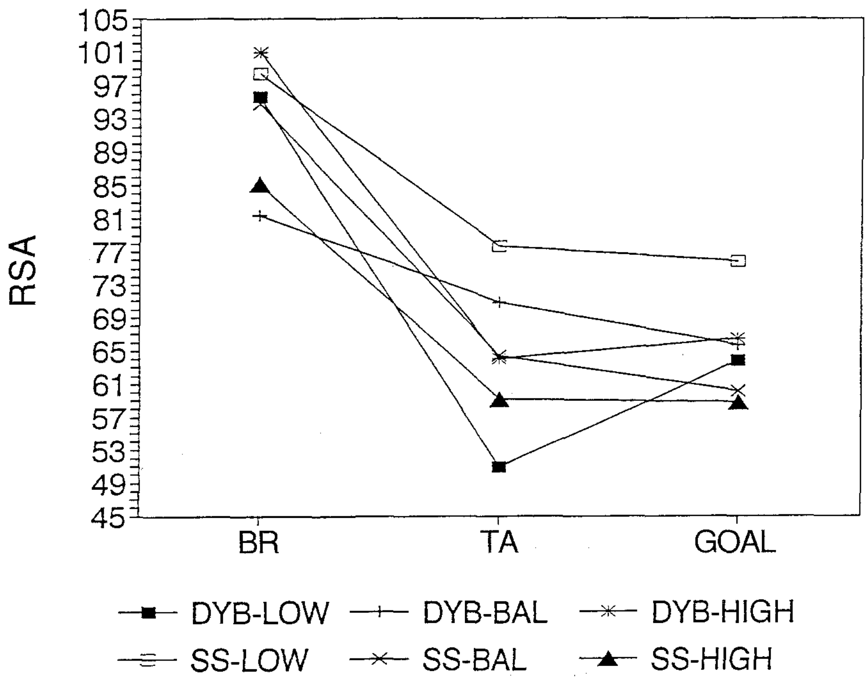


FIGURE 2 Mean RSA levels for each Goal × Task Complexity System condition across trials.

RSA was analyzed with a 3 × 2 × 3 (Trial × Goal × Task Complexity System) mixed ANOVA, with trial serving as the repeated measure. As shown in Table 4, the results revealed a significant trial main effect $F(2, 215) = 57.60$, $p < .01$. Also, significant interactions were found for Goal × Task Complexity System, $F(2, 215) = 7.54$, $p < .01$; and for Trial × Goal × Task Complexity System, $F(4, 215) = 2.53$, $p < .05$. Overall, these results supported Hypothesis 1.

*Sympathetic overbalance of HR.* HR measured during the goal trial, with RSA as a covariate, was analyzed across the goal and task complexity system conditions. Figure 3 shows the mean HR levels, adjusted for RSA, for the goal and task complexity system conditions.

A 2 × 3 (Goal × Task Complexity System) ANCOVA of HR, with RSA as a covariate, revealed significant main effects for RSA, $F(1, 71) = 10.88$, $p < .01$; task complexity system, $F(2, 71) = 7.52$, $p < .01$; and goal, $F(1, 71) = 2.97$, $p < .01$. A significant interaction was also found for Goal × Task Complexity, $F(2, 71) = 3.79$, $p < .01$. These results, shown in Table 4, provide support for Hypotheses 2a and 2b. The balanced task complexity systems elicited parasympathetic control when goals were self-set, and sympathetic control when do-your-best goals were set; the unbal-

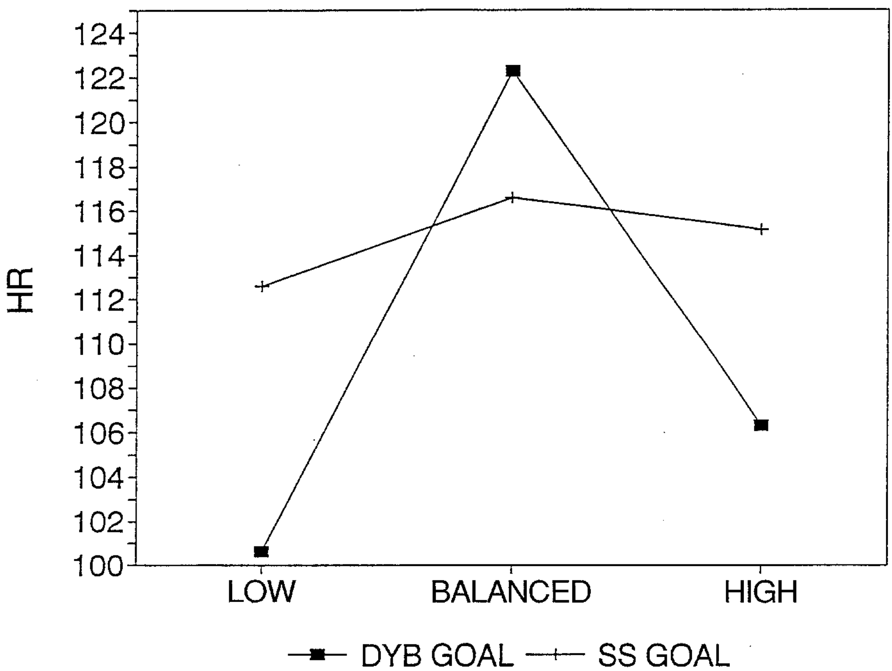


FIGURE 3 Mean HR levels, adjusted for RSA, across the Goal × Task Complexity System conditions during the goal trial.

anced task complexity systems elicited sympathetic control when goals were self-set, and they elicited parasympathetic control when do-your-best goals were set.

### *Behavioral Response*

Three performance measures were examined in this study: BR performance measured as the castle level at which the subject started the game in the TA trial and in the goal trial, the castle level attained during the TA trial, and the castle level attained during the goal trial. Figure 4 shows the mean performance scores for the Goal × Task Complexity System conditions across the BR, TA, and goal trials.

Performance was analyzed with a 3 × 2 × 3 (Trial × Goal × Task Complexity System) mixed ANOVA, with trial as the repeated measure. The results, shown in Table 4, revealed significant main effects for trial, $F(2, 215) = 78.76, p < .01$; goal, $F(1, 215) = 22.37, p < .01$; and task complexity system, $F(2, 215) = 163.48, p < .01$. Significant interactions were found for Goal × Task Complexity System, $F(2, 215) = 3.91, p < .01$; and Trial × Task Complexity System, $F(4, 215) = 6.70, p < .01$. Overall, these results support Hypotheses 3a and 3b: Greater performance increments

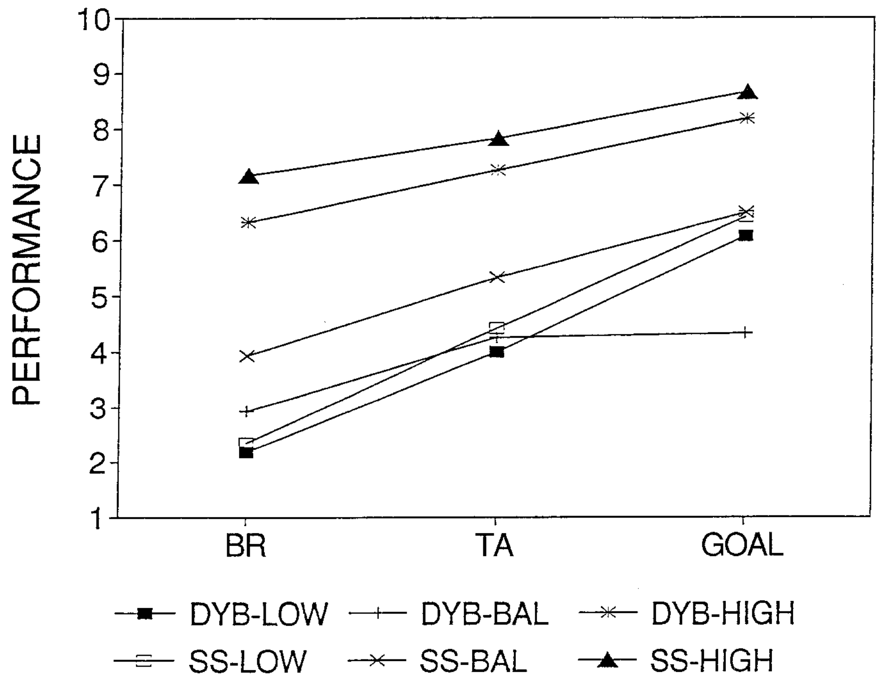


FIGURE 4 Mean performance levels for each Goal × Task Complexity System condition across the experimental conditions.

were found in the balanced task complexity condition when goals were self-set and in the unbalanced task complexity systems when do-your-best goals were set.

## COMBINED DISCUSSION

Goal-directed behavior is a dynamic process. The notion that performance is a linear function of goal level is too simplistic to account for the findings of these studies and numerous studies performed by many investigators. Several variables appear to moderate the goal–performance relationship. One important moderator is task complexity systems, specifying the match or mismatch between the capability of the performer and the requirements of the task. The results of this set of studies indicate that cardiovascular and behavioral responses varied as a function of task complexity systems.

### Cardiovascular Response

This set of measures clearly demonstrated the physiological properties of goal-directed behavior and the importance of identifying task complexity systems. Overall, these measures have provided support for Hypothesis 1: Balanced task complexity systems were characterized by higher HR than unbalanced (either low or high) systems. The results corroborate those of Obrist (1981): HR during active coping remained high, but during easy or difficult tasks HR decreased.

These measures have also provided support for Hypotheses 2a and 2b. In both low and high task complexity systems, for example, HR was higher when goals were self-set, as opposed to do-your-best. Balanced systems, however, showed the opposite effect; HR was lower when goals were self-set as compared to a do-your-best goal.

Parasympathetic withdrawal (measured by RSA) varied across the goal and task complexity system conditions in a manner consistent with HR responses. In both low and high complexity systems, parasympathetic withdrawal increased when goals were self-set, but it decreased when do-your-best goals were applied. In balanced systems, parasympathetic withdrawal increased when both self-set and do-your-best goals were applied. Furthermore, sympathetic overbalance was evident in both the low and high task complexity systems when goals were self-set. In balanced task complexity systems, sympathetic overbalance was evident when do-your-best goals were applied.

In general, these results are consistent with Grossman and Svebak (1987) who found an inverse relationship between RSA and HR. Similarly, sympathetic overbalance was consistent with HR, but it was inversely related to RSA.

## Behavioral Outcomes of Task Engagement

The behavioral outcome of the task complexity system approach examined in this set of studies was performance. These results have provided support for Hypotheses 3a and 3b. Performance was higher in both the low and high task complexity systems for do-your-best goals. In the balanced system, performance was higher for self-set goals.

Across the goal and task complexity system conditions, performance outcomes were consistent with the patterns of autonomic response elicited in these conditions. That is, when parasympathetic withdrawal was accompanied by sympathetic overbalance, performance decrements occurred. On the other hand, when parasympathetic dominance was evident, performance increments occurred.

These results provide support for the goal complexity hypothesis described by Geen (in press), Chesney and Locke (1991), and Wood et al. (1987). During the pregoal trial, effort (or physiological response) was higher in the balanced systems than it was in the unbalanced ones. The application of self-set goals decreased effort (or physiological response) across all three systems. Thus, relative to the pregoal levels, physiological response declined to an insufficient level in the unbalanced systems, but declined to an optimal level in the balanced one. Performance increments described the balanced systems, whereas performance decrements described the unbalanced ones.

The application of do-your-best goals had the opposite effect: They increased effort (or physiological response) across all three systems. Relative to the pregoal levels, physiological response was elevated to an optimal level in the unbalanced systems, but it was excessive in the balanced one. Performance decrements described the balanced system, whereas performance increments described the unbalanced ones.

Within the context of these studies, the interest was to compare the outcome of two different goal-setting processes: self-set versus do-your-best. Although information regarding the level of self-set goals was collected (mean self-set goal approached Level 7 of the castle), no hypotheses regarding this variable were generated or tested. Future research should investigate the impact of setting high goals versus more modest aspirations on HR and performance in various task complexity systems.

## SUMMARY

The results of these two studies, coupled with the conclusions of past research, suggest several characteristics of task complexity systems. The first relates to understanding the match between ability and task difficulty and the importance of understanding, what has been labeled here as task complexity system. The balance between these two dimensions has important implications for the way employees respond to task demands.

When a match exists between ability and task difficulty (i.e., balanced task complexity system), an organization will derive greater performance increments if the organization allows employees to set their own goals. In this condition, self-set goals decrease physiological responses to an optimal level and increase performance.

When task demands are inconsistent with an employee's ability (either greatly exceeding ability or requiring minimal amounts of ability), do-your-best goals appear to maximize performance. These two goal-setting findings can be seen as complementing the results of Kanfer and Ackerman's (1989) study in which goals were shown to be dysfunctional early in performance trials (unbalanced) and beneficial later in the performance cycle (balanced).

The findings of the studies described here suggest several paths for further research. One primary considerations is the effect of task complexity systems and goal setting on strategy development. The goal complexity hypothesis suggests that a strong link exists between the task complexity systems and the strategies that are developed in response to various types of goals. It is likely, for example, that complex strategies will be effectively applied in balanced task complexity systems when goals are self-set. However, simple strategies will likely be applied in these systems when do-your-best goals are set. Unbalanced task complexity systems elicit the development of complex strategies when do-your-best goals are set and simple strategies when goals are self-set.

Another consideration is the effect of assigned goals on employees' responses to the demands of task complexity systems. It is suggested that assigned goals of different difficulty levels will generate variability in both the physiological and behavioral indices of task engagement associated with this system. An important issue is the discovery of the specific assigned goal level that will elicit maximum performance across the task complexity systems. Assigned goals may be manipulated, for example, so that the point at which shifts in autonomic patterns (and their corresponding behavioral outcomes) occur may be identified. Regardless of task complexity, then, the effectiveness of assigned goals may be maximized so that the adverse tradeoffs between physiological responses and behavioral outcomes will be minimized.

The studies described here reflect a more definitive statement regarding the boundary conditions involved in goal setting and further define what we believe is an important dimension in not only the goal setting paradigm, but also in the more general area of work performance. The match between worker ability and task difficulty defines a meaningful task complexity system, one that influences performance and is tied to the physiological functioning of the performer. Based on the results of the studies described here and the integration of past research, it is clear that the effective application of goal setting requires a more careful analysis of the match between worker capabilities and task demands.

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