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The Effects of Instructional Sets on Reactions to and Performance on an Intelligent Tutoring System

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Abstract

The study examined the effects of a contextual factor, i.e., task instructions, on performance on and reactions to an ITS training RMS tasks. The results supported the first prediction that task instructions could be used to successfully induce a mastery versus an achievement orientation. Previous research suggests that a mastery orientation can result in beneficial effects on learning and performance of complex tasks (e.g., Dweck, 1991). Furthermore, the results supported the second prediction that a mastery orientation would have beneficial effects on learning and performance as well as affective and cognitive reactions to the ITS tasks. Moreover, the results indicated that a mastery orientation was especially beneficial for the more complex ITS tasks and later in task practice, i.e., when a task was performed for the second time. A mastery orientation is posited to have its beneficial effects by focusing more effort and attention on task performance. Conclusions are drawn with some caution due to the small number of subjects, although the results for these subjects were consistent across multiple trials and multiple measures of performance. ITS designers are urged to consider contextual factors such as task instructions and feedback in terms of their potential to induce a mastery versus an achievement orientation.

The Effects of Instructional Sets on Reactions to and Performance on an Intelligent Tutoring System

Providing appropriate education and training and ensuring that the maximum benefits from that training are obtained is rapidly becoming a critical issue in industry. Training and education have always been time-consuming and expensive. However, these costs--both time and money--are increasing more as tools and equipment become more sophisticated. Indeed, many of the tasks currently performed by NASA personnel, e.g., astronauts and mission specialists, require extensive training and elaborate simulation equipment. Tools are needed to reduce the high training costs and time requirements on complex tasks. Tools are also needed to facilitate training in situations in which ground-based training is not feasible either because the time delay between training and task performance is lengthy or because the parameters of the task are likely to change between training and inflight task performance. The feasibility and effectiveness of providing inflight training becomes especially important as progress is made in the development of the space station. Given the potential complexity and length of missions involving the space station, it becomes important to examine the viability of inflight training systems.

Intelligent Tutoring Systems (ITS's) offer a means for addressing these training needs. ITS's have already been developed to teach a variety of topics and task activities in educational settings and to a lesser extent in industry settings (Wenger, 1987). Moreover, ITS's have been successfully developed at NASA that provide training on specific tasks (e.g., Payload-assist module Deploys, RMS use), and a general architecture has been proposed to reduce the costs and time required to build ITS's for other tasks (Loftin, Wang, Baffes, & Hua, 1988). In addition, there is preliminary evidence suggesting that individuals can learn skills and procedures efficiently using ITS's in the NASA environment (Johnson, 1990a, 1990b, 1990c; Johnson, 1989; Johnson & Pieper, 1992).

As a result of building new ITS's, much attention has been given to the design issues of ITS's (based on Loftin's general architecture [Loftin et al., 1988]). However, little attention has been given to other factors that might enhance the training effectiveness of ITS's. More specifically, research has shown that individuals' approach or orientation to the task can influence the amount learned and performance (e.g., Dweck, 1991). That is, Dweck and her associates (Diener & Dweck, 1978; Dweck, 1991) describe two different orientations: achievement and mastery. An achievement orientation focuses individuals on evaluating their competence rather than on increasing competence, which could result in a maladaptive behavior pattern, including attributing failures to lack of ability and reducing effort and strategy development (Dweck, 1991). Dweck and her associates referred to this type of maladaptive pattern as a helpless orientation. In contrast, a mastery orientation focuses individuals on increasing their competence which results in a more adaptive behavior pattern, including viewing errors as information to learn from and increasing effort and strategy development in the face of failure.

Two contextual cues are likely to influence an individual's orientation. One contextual cue is the feedback provided. That is, performance feedback on tasks is often provided in terms of quantity measures (e.g., number correct, time required). This type of feedback has been called outcome feedback (Earley, Northcraft, Lee, & Lituchy, 1990; Ilgen, Fisher, & Taylor, 1979; Jacoby, Mazursky, Troutman, & Kuss, 1984). However, there is evidence that outcome feedback can have dysfunctional effects on learning and performance when the task is uncertain or complex (Jacoby et al., 1984). That is, outcome feedback can cue an achievement orientation (Dweck, 1991). In contrast, learning-oriented feedback (Johnson, Perlow, & Pieper, 1993) might cue a mastery orientation and thus result in more beneficial effects on learning and performance. Learning-oriented feedback provides descriptive information on how to perform a task or on how to improve performance. Similar types of feedback have also been referred to as descriptive feedback (Taylor, Fisher, & Ilgen, 1984), process feedback (Earley et al., 1990) or cognitive feedback (Jacoby et al., 1984).

A second contextual cue likely to influence an individual's orientation relates to the instructions provided. That is, similar to feedback, the nature of the task instructions provided might influence the orientation of the individual. Focusing the instructional set on increasing competence rather than on proving or evaluating competence might induce a mastery orientation in individuals and result in more adaptive behavior patterns.

Given the need to provide corrective feedback to individuals during training and the potential problems involved in completely eliminating the use of outcome feedback, the use of a mastery-oriented instructional set might be especially beneficial. That is, task instructions can be used to focus individuals on increasing competence rather than on proving their competence and can cue individuals to think that their ability can be increased rather than viewing ability as a fixed entity. Such instructions might induce a mastery orientation, cuing individuals to use errors as a learning tool, put forth more effort in the face of failure, and engage in strategy development. Indeed, it is expected that using task instructions that cue a mastery orientation might make individuals more resistant to the potential dysfunctional effects of outcome feedback.

Purpose

The purpose of the current research project was to examine the effects of the instructional set on learning and performance as well as other cognitive and affective reactions to the task. Specifically, it was expected that task instructions could be used to cue an achievement or a mastery orientation. Further, it was expected that individuals receiving the mastery orientation task instructions would learn the task more rapidly, perform at higher levels, be more intrinsically motivated in the task, and experience more satisfaction with their performance, compared to individuals receiving the achievement orientation task instructions.

Method

Subjects

Four subjects (two male; two female) participated in the study. Subjects volunteered for participation by responding to posted advertisements at a large southwestern university. Subjects were assigned to instructional set conditions: achievement orientation versus mastery orientation. All subjects performed 12 task trials (12 minutes each) in each of two 3-hour sessions. The task involved use of an ITS providing training in the use of Remote Manipulator System (RMS ITS). The RMS is a robotic arm used to deploy and/or retrieve shuttle payloads (e.g., satellites). Informed consent was obtained, and the subjects were debriefed at the end of the second session.

ITS Tasks

The RMS ITS was developed by Global Information Systems Technology (NASA P2T2 Intelligent Trainer Final Report, 1991). The ITS overlaid training content on the P2T2, an existing kinematic simulator of the shuttle's robotic arm. Subjects completed the ITS lessons on the Orbiter Unloaded and the Orbiter Loaded coordinate systems. These lessons were a subset of the part tasks available on the ITS. Part tasks are small tasks that comprise the basic components of the larger tasks of deploying and retrieving objects (e.g., satellites). Other ITS lessons available included two other coordinate systems and a number of procedural tasks (e.g., grapple, berth). Subjects were exposed only to lessons on the Unloaded and Loaded coordinate systems due to the complexity of the ITS tasks and time constraints.

To perform ITS lessons, subjects used translational and rotational hand controls and a mouse to manipulate task components viewed on a computer monitor. The left hand control, the translator, enabled movement of the RMS on the X, Y, and Z axes with the orientation of the axes dependent on the coordinate system being used. The right hand control enabled rotation of the RMS on the X, Y, and Z axes, with the orientation again dependent on the coordinate system being used. The mouse was used to signal task completion and enable movement between instructional screens.

The computer monitor displayed four windows. The lower left window displayed the control panel which was viewed but not manipulated during task performance. The upper left and upper right windows offered views of the RMS and shuttle bay. The lower right window provided task status information (e.g., a timer) and ITS task controls which were accessed using a mouse (e.g., exit the ITS, go on to the next task). For more complete information on displays and ITS usage, see the P2T2 Intelligent Trainer Final Report (Global Information Systems Technology, 1991).

Coordinate System Tasks. Subjects completed ITS part tasks relating to the Orbiter Unloaded and Orbiter Loaded coordinate systems. The part tasks relating to coordinate systems aided subjects in visualizing and moving the RMS. For each coordinate system, subjects first performed a set of translation (THC) tasks. The translation tasks had four levels of complexity (LOC's): movement in one, two, then three dimensions, and finally movement of greater distance in three dimensions and without a ghost arm (indicating the target position). Subjects next performed a set of rotation tasks (RHC), completing the same four levels of complexity. Then, subjects completed a set of integrated tasks (INT) requiring both translation and rotation, again at four levels of complexity. Subjects completed the translation, rotation, and integrated hand control tasks for the Unloaded coordinate system during Session 1 and for the Loaded coordinate system during Session 2.

Thus, subjects completed 12 task trials for the Unloaded coordinate system during Session 1: four trials reflecting the four LOC's for each of the three types of task: translation (THC), rotation (RHC), and integrated (INT). Subjects then completed the comparable 12 task trials for the Loaded coordinate system during Session 2. The two coordinate systems were very similar; thus, performing the Loaded trials functioned as a repetition of the Unloaded trials.

Within each level of complexity, subjects performed 2 to 5 cycles of the task. If subjects were unable to successfully pass 5 consecutive cycles within 12 minutes, they were advanced to the next trial by the experimenter to ensure all subjects experienced similar amounts of exposure to all task stimuli.

If subjects passed the first two cycles, they were advanced to the next level of complexity. Otherwise, subjects were required to pass 5 consecutive cycles to advance to the next level of complexity. (Note: Generally, if the subject failed a cycle, s/he was required to reattempt the 5 successive cycles required to pass to the next level of complexity. However, if the subject passed 3 or 4 cycles, then failed a cycle but passed the next, the subject was given another chance before being required to reattempt the 5 successive cycles required to advance. This was true of both the coordinate systems.)

<u>Performance Measures</u>

Five performance measures were assessed: total score, accuracy, efficiency, average time required per cycle, and number of cycles performed.

The major aspects of performance on the coordinate system part tasks were accuracy and efficiency. These were combined to form a **total score**. Specifically, accuracy accounted for 75% of the total score and efficiency for 25%. Subjects were required to attain at least 75 total points (out of 100) to pass a cycle. The default criteria levels provided by the RMS ITS that are described below were used (Global Information Systems Technology, 1991).

Accuracy referred to the distance from the target coordinates upon task completion. The translation allowance was 5 inches. The rotation allowance was 5 degrees for roll and 8 degrees for pitch and yaw.

Efficiency referred to the path and time, with path accounting for 80% of the efficiency score. The minimum passing score (a score of 75) for path was 1.5 times the minimum distance or rotation, i.e., no more than 50% farther than the minimum distance or rotation possible. For the time criteria, the minimum passing score (75) was obtained if one used the time allowed. A subject earned the maximum score on time (100) if s/he performed the task in half the allowed time.

In addition, **average time required per cycle** was assessed in seconds and the **number of cycles** performed in each trial was also assessed.

Cognitive and Affective Measures

General Cognitive Ability. The Wonderlic Personnel Test (Wonderlic, 1983) was used to assess general cognitive ability. The Wonderlic is a 12-minute timed test consisting of 50 items. This measure was administered to ensure that subjects were of comparable ability.

Perceived Task Difficulty. A seven-item self-report measure was used to assess perceptions of the task, including perceived difficulty, pressure to perform rapidly, and task understanding. Subjects responded on a seven-point Likert scale (from [1] not at all to [7] very) (see Appendix A-1). Perceived task difficulty was operationalized as the average of the seven items.

Intrinsic Motivation. An eight-item self-report measure was used to assess intrinsic motivation, addressing how interesting, boring, enjoyable, etc. that task was. Subjects responded on a five-point Likert scale (from [1] strongly disagree to [5] strongly agree) (see Appendix A-1). Intrinsic motivation was operationalized as the average of Items 1 through 7, with Item 5 reverse coded.

Satisfaction with Performance. Two items were used to address subjects' satisfaction with their performance. Subjects responded on a five-point Likert scale (from [1] very dissatisfied to [5] very satisfied) (see Appendix A-1).

Orientation to Task. A 12-item scale was used to address subjects' orientation toward the task. This measure was used to determine the effectiveness of the instructional set manipulation in inducing an achievement versus a mastery orientation. Subjects responded on a five-point Likert scale (from [1] strongly disagree to [5] strongly agree) (see Appendix A-2).

Demographics. Subjects completed a 9-item demographics questionnaire. However, the only information used from this questionnaire in the current study was subject's sex (male, female) (see Appendix A-3).

Procedure

In Session 1, subjects received a brief introduction to the study, provided informed consent, then completed the cognitive ability measure. Subjects next received task instructions and the instructional set manipulation. Subjects then performed the 12 task trials in the Unloaded coordinate system, completing a questionnaire assessing perceived task difficulty, intrinsic motivation, and satisfaction with performance after each trial. Subjects returned for Session 2 after approximately one week. In Session 2, subjects performed the 12 trials in the Loaded coordinate system, again completing a questionnaire assessing perceived task difficulty, intrinsic motivation, and satisfaction with performance after each trial. After the last trial, subjects completed a demographics questionnaire and an orientation to task questionnaire. The orientation questionnaire was administered at the end of the second session to avoid sensitizing subjects to the experimental manipulation. Subjects were then debriefed and paid for their time ($5.00 per hour).

Results

Cognitive Ability

The four subjects received very similar scores on the ability measure with the females scoring 27 and 29 points and the males 30 and 31 points out of a maximum possible of 50 points.

Manipulation Check: Orientation to Task.

The orientation to task survey was administered to determine the effectiveness of the instructional set manipulation in inducing an achievement versus a mastery orientation. The results generally provided evidence that the instructional set manipulation was effective in inducing a mastery versus an achievement orientation, although the effects were not as strong as expected. That is, the results revealed that responses were in the predicted direction on 6 out of 12 items, similar between groups on 4 items (i.e., 1/2 point difference or less), and opposite the predicted direction on 2 items. Subjects' responses to the 12 items are shown in Table 1. Comparisons reported below are based on mean scores for each condition.

More specifically, to a greater extent than subjects in the achievement condition, subjects in the mastery orientation condition reported that obstacles made the task more interesting (M = 5) and that they preferred tasks they had to struggle with (M = 4). Further, errors helped them learn (M = 4) and did not reflect poorly on their abilities (M = 2). Finally, these subjects disagreed more with the statements that feedback provided an evaluation of one's competence (M = 3.5) and abilities remain stable (M = 2).

However, contrary to predictions, subjects in the mastery orientation condition reported a stronger preference for tasks that they could do right the first time (M = 3) and disagreed more with the statement that feedback provides information for increasing competence (M = 3.5), compared to subjects in the achievement orientation condition.

Task Performance

Performance data for the Unloaded and Loaded part tasks are shown in Tables 2 through 6. Note that due to computer malfunctions, no performance data was retained for Subject 4 and performance data was also unavailable for Subject 1 for the Loaded RHC and INT trials. Due to the missing data and the possibility of sex effects in this type of task, two separate comparisons will be discussed below. First, comparisons will be made focusing on the two females, Subjects 1 and 3, in the achievement and mastery orientation conditions, respectively across Unloaded Trials 1 through 12 and Loaded Trials

1 through 4. Second, comparisons between Subjects 2 and 3, a male in the achievement condition and a female in the mastery condition, will be made to provide additional explanation relating to Unloaded Trials 1 through 12 and Loaded Trials 1 through 4 and enable discussion of Loaded Trials 5 through 12.

Total Score. Subjects rarely successfully passed a LOC, a trial; that is, they usually failed to successfully complete five consecutive cycles in any given trial. However, comparing Subjects 1 and 3 across the Unloaded Trials 1 through 12 and the Loaded Trials 1 through 4 revealed that the subject in the mastery orientation condition was successful more often. That is, Subject 3 in the mastery orientation condition successfully passed four LOC's (Unloaded Trial 1 and Loaded Trials 1, 2, 3) while Subject 1 in the achievement orientation successfully passed only one LOC (Loaded Trial 1).

However, Subject 1 exceeded Subject 3's total score on 14 out of 16 trials, though on 6 of those 14 trials Subject 3 obtained scores quite similar to Subject 1 (i.e., within 10 points) (See Figure 1). Subject 3 scored better than Subject 1 on only 2 trials, and the subjects' scores were quite similar on both trials. To summarize, Subject 3 (mastery orientation) scored substantially worse then Subject 1 (achievement orientation) on 8 trials and scored similarly to Subject 1 on 8 trials. Thus, there might be some costs associated with the higher LOC success rate obtained by the subject in the mastery orientation condition.

It is unclear, though, what would happen in the Loaded Trials 5 through 12, so Subjects 2 and 3 were compared also. Here a different pattern of results emerged. For the Unloaded trials, Subject 3 (female, mastery orientation) exceeded Subject 2's (male, achievement orientation) total score on 7 of the Unloaded trials, although scores were similar (i.e., within 10 points) on 4 trials (See Figure 2a). Subject 2 exceeded Subject 3's total scores on 5 trials, but scores on 1 trial were similar. Thus, for the Unloaded trials, Subject 3 demonstrated superior performance on 3 trials, similar performance on 5 trials, worse performance on 4 trials. These results suggest that the subject in the achievement orientation condition did not perform better than the mastery orientation subject; rather, subjects in both conditions performed at very similar levels.

Moreover, a somewhat different pattern emerged for the Loaded trials, the 12 trials performed in Session 2. That is, for the Loaded trials, Subject 3 exceeded Subject 2's total score on each of the last 7 trials--Trials 6 through 12, although scores on 2 trials were quite similar (i.e., within 10 points) (See Figure 2b). Subject 2 exceeded Subject 3's total scores on 5 Loaded trials, but scores on 3 trials were similar. Thus, for the Loaded trials, Subject 3 in the mastery orientation condition demonstrated superior performance on 5 trials, similar performance on 5 trials, and worse performance on only 2 trials. Moreover, Subject 3 consistently outperformed Subject 2 in the last 7 of the Loaded trials. That is, Subjects 2 and 3 performed similarly in the Loaded THC tasks, then Subject 3's performance began to improve in relation to Subject 2's performance in the Loaded RHC and INT trials which reflect more complex tasks. These results suggest that some of the gains associated with the mastery orientation condition might be observed either later in task practice or on more complex tasks.

These comparisons must made with some caution due to the confound between sex and orientation condition. However, given the spatial skills required to perform the task and given that males tend to score higher on spatial ability tests, one would expect the male to perform better not worse than the female. Moreover, the male successfully passed 4 out of 24 LOC's, compared to the female (Subject 3) who passed 5 out of 24 LOC's. Thus, using number of LOC's passed as an index suggests that it is appropriate to compare the male and the female.

Accuracy. A similar pattern of results was obtained on performance accuracy. This is not surprising given that the accuracy score accounted for 75% of the total score (and efficiency only 25%).

Subject 1 (female, achievement orientation) exceeded Subject 3's (female, mastery orientation) accuracy score on 14 out of 16 trials, although in 6 of these trials Subject 3 scored quite similarly to Subject 1 (i.e., within 10 points) (See Figure 3). Subjects 1 and 3 scored similarly on the remaining 2 trials. Thus, Subject 1 demonstrated superior performance compared to Subject 3 on 8 trials and similar performance on 8 trials, suggesting that the achievement orientation is more beneficial to performance.

However, comparing Subjects 2 and 3 revealed a different pattern of results. For the Unloaded trials, Subject 3 (female, mastery orientation) exceeded Subject 2's (male, achievement orientation) accuracy score on 8 trials, although 4 scores were quite similar (See Figures 4a). Subject 3 performed worse than Subject 2 on 4 trials but scores on 1 of these trials were similar. Thus, compared to Subject 2, Subject 3 demonstrated superior performance on 4 trials, similar performance on 5 trials, and worse performance on 3 trials. Moreover, all 4 of the superior trials occurred in the later Unloaded trials--in the RHC and INT tasks, suggesting that gains associated with a mastery orientation are reflected in the performance of more complex tasks. It might be that a mastery orientation results in subjects being more careful or accurate in performing the more complex tasks, compared to subjects with an achievement orientation.

For the Loaded Trials, Subject 3 (female, mastery orientation) exceeded Subject 2's (male, achievement orientation) accuracy score on 7 trials, although 4 scores were quite similar (See Figure 4b). Subject 3 performed worse than Subject 2 on 5 trials, but scores on 3 of these trials were similar. Thus, compared to Subject 2, Subject 3 demonstrated superior performance on 3 trials, similar performance on 7 trials, and worse performance on 2 trials. Moreover, all 3 of the superior trials occurred in the later Loaded trials--in the RHC and INT tasks. These results again suggest that a mastery orientation might be more beneficial for more complex tasks. The results from both the Unloaded and Loaded trials are consistent with previous research suggesting that individuals with a mastery orientation will focus more effort and attention on tasks they are likely to have difficulty with, i.e., more complex tasks, compared to individuals with an achievement orientation (Dweck, 1991).

Efficiency. A similar pattern also emerges when examining performance efficiency. That is, Subject 1 (achievement orientation) exceeded Subject 3's (mastery orientation) efficiency score on 12 out of 16 trials, although these subjects scored quite similarly on 7 of these 12 trials (See Figure 5). Subject 3 performed substantially better than Subject 1 on 3 trials. Thus, compared to Subject 3, Subject 1 demonstrated superior performance on 5 trials, similar performance on 8 trials, and worse performance on 3 trials. Similar, to previous results comparing Subjects 1 and 3 suggests that the achievement orientation is more beneficial to performance in terms of efficiency.

Comparing Subject 2 (male, achievement orientation) and Subject 3 (female, mastery orientation) produced a similar pattern of results. For the Unloaded trials, Subject 3 exceeded Subject 2's efficiency score on 5 trials, although 2 scores were similar (See Figure 6a). Subject 3 performed worse than Subject 2 on 7 trials, although 2 scores were similar. Thus, compared to Subject 2, Subject 3 demonstrated superior performance on 3 trials, similar performance on 4 trials, and worse performance on 5 trials. These results suggest that the subject in the mastery orientation condition took longer to perform the tasks and/or used less efficient paths or movement.

For the Loaded trials, Subject 3 (female, mastery orientation) exceeded Subject 2's (achievement orientation) efficiency score on 7 trials, although scores were similar on 5 trials (See Figure 6b). Subject 3 performed worse than Subject 2 on 5 trials, although 2 scores were similar. Thus, compared to Subject 2, Subject 3 demonstrated superior performance on 2 trials, similar performance on 7 trials, and worse performance on 3 trials. These results also suggest that the mastery condition resulted in slower performance and/or less efficient paths of movement.

Thus, although a mastery orientation appears to result in higher accuracy for subjects, the increased accuracy comes at a cost. That is, subjects were less efficient, taking longer to perform tasks and/or using less efficient paths of movement.

<u>Average Time per Cycle.</u> With respect to time, Subject 1 (achievement orientation) required more time to complete the task than Subject 3 (mastery orientation) in 10 out of 16 trials, although these subjects scored quite similarly (i.e., within 10 seconds) on 2 trials (See Figure 7). Subject 1 required less time to do the task than Subject 3 on 6 trials. Thus, compared to Subject 3, Subject 1 demonstrated superior performance (i.e., less time) on 6 trials, similar performance on 2 trials, and worse performance on 8 trials. These results suggest that the subject in the achievement orientation condition required more time to perform the task than the subject in the mastery orientation condition. Moreover, a closer examination of the data also shows that while Subject 3 consistently required more time to perform the task in the last 4 Unloaded trials, the INT trials, Subject 1 consistently required more time in the first 4 Loaded trials, the THC trials. Thus, it might be that a mastery orientation results in spending more time to master a task initially but then speeds performance on easier tasks or later in task practice.

A comparison of Subjects 2 and 3 across all 24 trials supports this explanation. For the Unloaded trials, Subject 3 (female, mastery orientation) required less time than Subject 2 (male, achievement orientation) on 1 trial, and subjects scored similarly on this trial (i.e., within 10 seconds) (Figure 8a). Subject 3 required more time to perform the task for 11 trials, although scores were similar on 3 trials. Thus, Subject 3 demonstrated superior performance (i.e., took less time) on 0 trials, similar performance on 4 trials, and worse performance on 8 trials. These results suggest that the subject in the mastery condition consistently took longer to complete the task in the Unloaded trials.

However, for the Loaded trials, Subject 3 (female, mastery orientation) required less time than Subject 2 (male, achievement orientation) on 7 trials, although subjects scored similarly on 1 trial (See Figure 8b). Subject 3 required more time to perform the task on 5 trials, although subjects scored similarly on 1 trial. Thus, Subject 3 demonstrated superior performance (i.e., took less time) on 6 trials, similar performance on 2 trials, and worse performance on 4 trials.

These results support an explanation that subjects with a mastery orientation condition will spend more time initially to master a task, but then subjects will require less time later in task practice as tasks are encountered a second time or are mastered. These results are also similar to the results comparing Subjects 1 and 3. Compared to Subject 1, Subject 3 required substantially more time to complete the last 4 Unloaded trials, the INT trials but required substantially less time to complete the initial 4 Loaded trials, the THC trials. Thus, both comparisons suggest that a mastery orientation results in subjects spending more time to master a task initially but then speeds performance on later tasks.

<u>Number of Cycles.</u> Given that the more time spent per cycle, the fewer cycles it would be possible to complete in a timed (i.e., 12-minute) trial period, we expected number of cycles to reflect a pattern similar to that observed for average time per cycle.

Indeed, we observed that Subject 3 (mastery orientation) performed more task cycles than Subject 1 (achievement orientation) in 10 out of 16 trials (See Figure 9). Subject 3 performed fewer task cycles than Subject 1 on 3 trials. Thus, compared to Subject 1, Subject 3 demonstrated superior performance (i.e., performed more cycles) on 10 trials, similar performance on 3 trials, and worse performance on 3 trials.

Moreover, the results revealed an interesting pattern. That is, Subject 3 performed more cycles than Subject 1 in 6 out of the first 8 Unloaded Trials, the THC and RHC tasks but performed the same number or fewer cycles than Subject 1 in Unloaded Trials 9 through 12, the more complex INT task. However, Subject 3 again performed consistently more trials than Subject 1 in the last 4 trials--Loaded Trials 1 through 4, a simpler THC task. These results suggest that a mastery orientation resulted in performing fewer trials as the task became more complex, i.e., in the Unloaded INT task, but more trials when an easier task, i.e., a THC task, was performed for a second time. These results are consistent with the results relating to time per cycle which showed that Subject 3 in the mastery orientation condition spent more time on the Unloaded INT trials but then less time per cycle on the Loaded THC trials, an easier task.

Comparing Subject 2 (male, achievement orientation) and Subject 3 (female, mastery orientation) revealed a similar pattern. That is, for the Unloaded trials, Subject 3 performed fewer cycles on 8 trials, the same number of trials on 2 trials, and more cycles on 2 trials, compared to Subject 2 (See Figure 10a). Moreover, Subject 3 performed consistently fewer cycles on the last 4 Unloaded trials, the more complex INT task.

However, for the Loaded trials, Subject 3 performed fewer cycles on 4 trials, the same number on 3 trials, and more cycles on 5 trials, compared to Subject 2 (See Figure 10b). Moreover, Subject 3 performed consistently more cycles on the first 4 Loaded trials, the easier THC task. Subject 3 then generally performed the same number or fewer cycles on the RHC and INT tasks. Thus, one would expect that subjects with a mastery orientation would spend more time working to master complex tasks but demonstrate greater speed compared to those with an achievement orientation on easier or more familiar tasks.

These results are consistent with the results relating to time per cycles that showed that Subject 3 in the mastery condition required consistently more time to perform each cycle in the last 4 Unloaded trials, the more complex INT task but consistently less time per cycle in the first 4 Loaded trials, the simpler THC task. Moreover, Subject 3 required more time to perform 5 of the last 8 Loaded trials, the RHC and INT tasks. These results support an explanation that a mastery orientation will result in subjects taking more time to perform more complex tasks, but the additional time spent can lead to performance speed gains when an easier or more familiar task is encountered.

<u>Cognitive and Affective Reactions</u>

<u>Perceived Task Difficulty.</u> For the Unloaded trials, Subject 1 ($\underline{M}$ = 5.5) and Subject 2 ($\underline{M}$ = 5.2) perceived the task as more difficult than Subject 3 ($\underline{M}$ = 4.7) (See Table 7). Moreover, Subjects 1 and 3 perceived that task difficulty increased slightly across the 12 trials, reporting scores ranging from 4.4 to 6.1 for Subject 1 and from 3.4 to 5.1 for Subject 3 (See Figure 11a). Subject 2 perceived that task difficulty increased substantially across trials, with scores ranging from 1.7 to 6.7, although his reports were more variable than those of the other subjects.

For the Loaded trials, Subject 1 ($\underline{M}$ = 5.3) perceived the task as more difficult than Subject 2 ($\underline{M}$ = 4.0) or Subject 3 ($\underline{M}$ = 4.4). Subjects 1 and 3 again perceived task difficulty as increasing slightly across trials, with scores ranging from 3.8 to 5.7 for Subject 1 and from 3.6 to 5.3 for Subject 3 (See Figure 11b). Subject 2 again perceived that task difficulty increased substantially across trials, with scores ranging from 1.0 to 6.0.

Thus, subjects in both conditions tended to perceive the RHC and INT tasks (Trials 5 through 12) as more difficult than the THC tasks (Trials 1 through 4) for both the Unloaded and Loaded trials. Moreover, Subject 3 in the mastery orientation condition tended to perceive the task as less difficult than Subjects 1 and 2 in the achievement condition for the Unloaded trials, although Subjects 2 and 3 reported similar perceived task difficulty in the Loaded trials.

Intrinsic Motivation. All three subjects reported stable levels of intrinsic motivation across both the Unloaded and Loaded trials (See Table 8). Subject 1 reported consistently the lowest levels of intrinsic motivation (Unloaded M = 3.5; Loaded M = 3.3), Subject 3 reported higher levels (Unloaded M = 4.1, Loaded M = 4.0), and Subject 2 reported the highest levels of intrinsic motivation (Unloaded M = 4.8; Loaded M = 4.6). Thus, neither the complexity of the task nor a mastery versus achievement orientation appeared to influence subjects' reported interest in the task.

Satisfaction with Performance. All three subjects reported stable levels of satisfaction with performance on the previous trial in both the Unloaded and Loaded trials (See Table 9a). Further, all three subjects reported similar levels of satisfaction (M = 2.5, 2.1, and 2.2 for Subjects 1, 2, and 3, respectively) for the Unloaded trials. However, while Subject 1 continued to report a similar level of satisfaction for the Loaded Trials (M = 2.2), Subjects 2 and 3 reported much higher levels of satisfaction with their performance on the Loaded trials. Thus, task practice appeared to result in increased satisfaction with performance, but the orientation manipulation appeared to have little effect on reported satisfaction with performance on the previous trial.

A somewhat different pattern emerged, however, when subjects reported how satisfied they would be if they performed the same on the next trial. Subjects reported stable levels of satisfaction across trials in both the Unloaded and Loaded trials (See Table 9b). However, Subject 1 (M = 2.6) and Subject 2 (M = 2.3) reported that they would be more satisfied with the same level of performance on the next trial, compared to Subject 3 (M = 1.2) for the Unloaded trials. Similarly, for the Loaded trials, Subject 2 reported that he would be more satisfied with the same performance on the next trial (M = 3.7), compared to Subject 3 (M = 2.2). Thus, the subject in the mastery orientation condition appeared to be more concerned with improving performance on the next trial than subjects in the achievement orientation condition. This is consistent with the theory suggesting that subjects in a mastery orientation condition would be more concerned with increasing competence, while subjects in an achievement orientation condition would be more concerned with proving their competence.

Discussion and Conclusions

The results provided support for the first prediction. That is, we were able to successfully induce a mastery versus an achievement orientation in subjects through the use of instructional sets, i.e., task instructions. Although the effect was not as strong as expected, the results revealed that task instructions can be effective in inducing a mastery versus an achievement orientation even in the presence of outcome feedback. These results demonstrate that although it would be difficult and perhaps inappropriate to eliminate the use of outcome feedback, other contextual cues such as instructional sets can be used to induce a mastery orientation toward a task. This is important given the benefits in terms of having a mastery orientation when learning and performing novel, complex tasks.

In addition, the results supported the second prediction that a mastery orientation would have beneficial effects on performance of and reactions to a complex task on an ITS. However, somewhat unexpectedly, the results indicated that the benefits of a mastery orientation might not appear until later in task practice as the task becomes more familiar and better learned. More specifically, we observed that the individuals with an achievement orientation performed better in terms of total scores, accuracy, and efficiency than the individual with a mastery orientation in the Unloaded trials. Furthermore, the performance differences between individuals increased as the task became more complex. However, this pattern of results reversed when the THC, RHC, and INT tasks were repeated in the Loaded trials. That is, the individual with a mastery orientation demonstrated superior performance in the Loaded trials. Indeed, the individual with a mastery orientation outperformed the individual with an achievement orientation not only in the THC tasks but also in the more complex RHC and INT tasks.

These results suggest that individuals with a mastery orientation initially focus more attention and effort in order to learn a task, compared to those with an achievement orientation. These investments come at a cost to initial performance levels. However, these investments also produce substantial gains in later performance of familiar and more complex tasks, especially in terms of total scores and accuracy.

The greater accuracy achieved appears, though, to come at an initial cost to efficiency in terms of time spent per cycle and/or the path of movement of the RMS. The results showed that individuals in both conditions spent similar amounts of time per cycle in the simpler, i.e., the THC, tasks. However, the individual with a mastery orientation spent substantially more time per cycle in the more complex Unloaded trials (INT task), relative to the individuals with an achievement orientation. Thus, as the task became more complex the individual with a mastery orientation devoted relatively more time to the task, compared to the individuals with an achievement orientation. This additional time spent was beneficial in terms of performance accuracy on the Unloaded trials but resulted in lower efficiency scores.

However, spending the time to attempt to master the more complex Unloaded tasks produced performance gains in the Loaded trials. Specifically, the individual with a mastery orientation performed the initial THC Loaded trials more rapidly than the individual with an achievement orientation. Furthermore, the individual with a mastery orientation also demonstrated superior performance with respect to total scores and accuracy in the more complex RHC and INT tasks during the Loaded trials.

Yet another interesting feature related to how productive individuals with different orientations were. Specifically, the individual with a mastery orientation performed more cycles per trial during the easier THC tasks in the Unloaded trial but the same or fewer cycles during the more complex INT tasks. These results reflect the time spent. This pattern was repeated in the Loaded trials, with the individual with a mastery orientation performing more cycles per trial during the easier THC tasks and fewer cycles during the more complex

INT tasks. Such results suggest that an individual with a mastery orientation adjusts his/her attention and effort according to the difficulty of the task, devoting more attention and effort to more complex tasks. Such a strategy should ultimately be beneficial in mastering a task and appears to reflect a focus on increasing one's competence. These results are consistent with Dweck's (1991) research showing that individuals with an achievement orientation prefer easier rather complex tasks and, further, that when faced with a complex tasks these individuals might try to avoid an evaluation of competence by exerting less effort or quitting.

The cognitive and affective reactions support these interpretations. Specifically, the individuals with an achievement orientation tended to perceive the task as more difficult, especially in the Unloaded trials. Additionally, individuals with an achievement orientation expressed less interest in the task, i.e., intrinsic motivation, compared to the individual with a mastery orientation. This result is important given that intrinsic motivation is likely to lead to increased effort and persistence--both of which are important components of mastering complex, novel tasks. Moreover, the individual with a mastery orientation expressed much greater dissatisfaction with continuing to perform at the same level, compared to the individuals with an achievement orientation. Thus, the individual with a mastery orientation appeared to be more concerned with continuing to improve her performance than those with an achievement orientation. And, a focus on continuing to improve performance would seem to be another important component necessary for mastering complex tasks.

In summary, we demonstrated that one could successfully use task instructions to induce a mastery versus an achievement orientation. Further, consistent with previous research (e.g., Dweck, 1991), the results provided preliminary evidence of the beneficial long term effects of possessing a mastery orientation when performing a complex, novel task. These results must, of course, be interpreted with some caution due to the small number of subjects. Clearly, additional research is needed to determine the extent to which these results generalize to the population. However, the results can not be dismissed due to the consistent patterns observed across multiple trials and multiple measures of performance. Thus, our results are suggestive of the beneficial effects of a mastery orientation on complex, novel tasks. Future research will more precisely determine the strength of those effects.

In the meantime, the results suggest the need for ITS designers to be aware of the potential dysfunctional effects of an achievement orientation on complex, novel tasks, especially given that the tasks trained using ITS's tend to be very complex. Additionally, designers need to be aware that contextual factors such as feedback provided or task instructions can induce an achievement versus a mastery orientation, and thus, they should consider structuring the feedback and/or the task instructions to cue individuals to adopt the more beneficial mastery orientation.

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Author Notes

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Table 1

Orientation to Task Questionnaire

	Achievement Orientation		Mastery Orientation	
Item	Subject 1	Subject 2	Subject 3	Subject 4
1	5	5	5	5
2	3	1	4	2
3	4	4	5	5
4	4	2	4	3
5	5	5	3	4
6	3	2	4	4
7	4	2	4	2
8	5	5	3	4
9	2	4	2	3
10	4	3	2	2
11	4	4	2	2
12	2	3	4	4

Table 2

Performance: Total Scores

		Unloaded Trials			Loaded Trials		
		Achievement Orientation		Mastery Orientation	Achievement Orientation		Mastery Orientation
Trial	Task	Subject 1	Subject 2	Subject 3	Subject 1	Subject 2	Subject 3
1	THC	94.7	89.3	90.2	93.0	96.0	92.1
2	THC	71.9	78.9	44.0	77.0	92.7	87.1
3	THC	70.0	61.8	65.2	77.0	85.6	85.3
4	THC	73.8	89.0	67.7	85.1	90.5	73.7
5	RHC	87.9	53.3	81.7	--	88.9	64.7
6	RHC	60.1	52.1	39.9	--	31.6	57.0
7	RHC	80.0	61.0	75.4	--	69.2	80.4
8	RHC	86.7	65.5	67.7	--	56.7	58.6
9	INT	84.3	56.1	64.9	--	89.1	92.3
10	INT	78.5	33.2	48.0	--	77.1	80.1
11	INT	81.8	61.2	37.4	--	61.7	82.9
12	INT	76.6	66.0	61.8	--	67.1	80.5

Table 3

Performance: Accuracy

		Unloaded Trials			Loaded Trials		
		Achievement Orientation		Mastery Orientation	Achievement Orientation		Mastery Orientation
Trial	Task	Subject 1	Subject 2	Subject 3	Subject 1	Subject 2	Subject 3
1	THC	95.2	98.2	91.9	96.6	97.6	96.6
2	THC	73.3	84.1	44.3	90.8	96.8	90.5
3	THC	79.3	71.7	73.5	92.1	93.8	88.6
4	THC	82.3	94.2	79.7	93.5	96.1	72.5
5	RHC	91.9	56.7	88.7	--	91.4	65.1
6	RHC	80.1	51.3	53.2	--	33.9	60.6
7	RHC	88.2	63.9	85.6	--	80.2	90.2
8	RHC	92.3	60.4	68.7	--	54.9	56.6
9	INT	93.5	62.6	75.7	--	95.2	98.0
10	INT	94.8	36.3	57.1	--	83.3	91.2
11	INT	92.8	68.0	41.8	--	69.3	64.4
12	INT	89.3	69.6	71.6	--	76.1	93.8

Table 4

Performance: Efficiency

		Unloaded Trials			Loaded Trials		
		Achievement Orientation		Mastery Orientation	Achievement Orientation		Mastery Orientation
Trial	Task	Subject 1	Subject 2	Subject 3	Subject 1	Subject 2	Subject 3
1	THC	93.2	62.7	85.2	82.4	91.0	78.4
2	THC	68.0	63.2	43.0	35.4	80.4	76.1
3	THC	42.0	31.9	40.0	57.5	76.2	75.7
4	THC	48.2	73.2	31.9	59.9	73.7	77.1
5	RHC	76.1	43.3	60.4	--	80.9	63.3
6	RHC	0.0	54.5	0.0	--	24.8	46.1
7	RHC	55.1	52.6	44.6	--	36.3	50.9
8	RHC	69.8	60.6	64.3	--	62.2	64.4
9	INT	56.1	37.3	48.7	--	71.2	75.1
10	INT	29.4	24.4	20.5	--	58.7	46.7
11	INT	49.0	40.8	24.0	--	38.7	48.6
12	INT	38.3	55.6	32.3	--	40.2	40.6

Table 5

Performance: Average Time per Cycle

		Unloaded Trials			Loaded Trials		
		Achievement Orientation		Mastery Orientation	Achievement Orientation		Mastery Orientation
Trial	Task	Subject 1	Subject 2	Subject 3	Subject 1	Subject 2	Subject 3
1	THC	30.3	34.2	24.0	49.6	34.0	33.0
2	THC	56.2	50.3	53.8	139.0	74.6	50.0
3	THC	99.4	80.5	106.3	145.5	106.6	61.7
4	THC	118.7	73.8	98.0	151.3	139.8	74.2
5	RHC	58.7	38.0	40.3	--	92.0	176.0
6	RHC	19.9	45.0	240.0	--	64.8	155.5
7	RHC	118.5	81.5	104.4	--	217.3	137.8
8	RHC	108.3	85.6	95.2	--	135.3	158.7
9	INT	85.3	84.7	168.7	--	102.3	88.8
10	INT	168.7	100.0	188.7	--	181.0	188.0
11	INT	126.0	131.0	183.0	--	237.5	101.6
12	INT	191.0	90.8	202.3	--	275.0	301.0

Table 6

Performance: Number of Cycles

		Unloaded Trials			Loaded Trials		
		Achievement Orientation		Mastery Orientation	Achievement Orientation		Mastery Orientation
Trial	Task	Subject 1	Subject 2	Subject 3	Subject 1	Subject 2	Subject 3
1	THC	3	6	5	5	5	10
2	THC	6	6	8	2	5	6
3	THC	5	4	4	4	5	6
4	THC	3	5	4	4	4	6
5	RHC	3	6	9	-	5	3
6	RHC	2	7	2	-	5	4
7	RHC	4	6	5	-	3	4
8	RHC	3	5	5	-	4	3
9	INT	4	6	3	-	4	5
10	INT	3	5	3	-	3	3
11	INT	4	3	2	-	2	2
12	INT	3	4	3	-	2	2

Table 7

Perceived Task Difficulty

		Unloaded Trials			Loaded Trials		
		Achievement Orientation		Mastery Orientation	Achievement Orientation		Mastery Orientation
Trial	Task	Subject 1	Subject 2	Subject 3	Subject 1	Subject 2	Subject 3
1	THC	4.4	1.7	3.4	3.8	1.0	3.6
2	THC	4.6	3.0	5.0	4.6	1.8	3.8
3	THC	4.8	5.3	4.1	4.8	2.7	4.0
4	THC	5.1	1.8	5.0	5.4	4.0	4.1
5	RHC	6.1	6.7	4.1	5.6	4.3	4.8
6	RHC	6.0	5.4	5.1	5.6	6.0	5.3
7	RHC	6.1	6.7	5.0	5.7	5.7	4.7
8	RHC	6.0	6.7	4.8	5.6	5.8	5.3
9	INT	5.7	5.7	4.8	5.6	3.8	3.8
10	INT	6.0	6.1	5.0	5.7	4.1	4.6
11	INT	5.7	6.6	5.1	5.6	4.3	4.7
12	INT	5.7	6.3	4.8	5.6	4.7	4.6

Table 8

Intrinsic Motivation

		Unloaded Trials			Loaded Trials		
		Achievement Orientation		Mastery Orientation	Achievement Orientation		Mastery Orientation
Trial	Task	Subject 1	Subject 2	Subject 3	Subject 1	Subject 2	Subject 3
1	THC	3.7	4.7	4.3	3.8	4.0	4.1
2	THC	3.7	4.6	3.8	3.4	4.6	4.1
3	THC	3.6	4.8	4.3	3.4	4.6	4.1
4	THC	3.7	4.6	4.3	3.4	4.6	4.3
5	RHC	3.1	4.8	4.3	3.4	4.6	4.1
6	RHC	3.3	4.8	4.3	3.1	4.7	4.1
7	RHC	3.4	4.8	3.8	3.1	4.6	3.7
8	RHC	3.4	4.8	4.0	3.3	4.8	3.8
9	INT	3.4	4.8	4.1	3.1	4.6	4.1
10	INT	3.4	4.8	4.1	3.1	4.6	3.7
11	INT	3.4	4.8	4.1	3.1	4.7	3.8
12	INT	3.4	4.8	3.8	3.1	4.6	4.1

Table 9

Satisfaction with Performance: (a) Performance on Previous Trial

		Unloaded Trials			Loaded Trials		
		Achievement Orientation		Mastery Orientation	Achievement Orientation		Mastery Orientation
Trial	Task	Subject 1	Subject 2	Subject 3	Subject 1	Subject 2	Subject 3
1	THC	2	3	2	4	4	4
2	THC	3	2	2	2	4	4
3	THC	2	1	2	3	4	4
4	THC	2	4	2	2	4	4
5	RHC	2	1	3	2	4	4
6	RHC	2	2	2	2	2	4
7	RHC	3	1	2	2	2	4
8	RHC	3	1	3	2	4	3
9	INT	3	3	3	2	4	4
10	INT	2	3	2	2	4	4
11	INT	3	2	2	2	4	3
12	INT	3	2	2	2	4	2

Table 9 - continued

Satisfaction with Performance: (b) If Perform the Same on Next Trial

		Unloaded Trials			Loaded Trials		
		Achievement Orientation		Mastery Orientation	Achievement Orientation		Mastery Orientation
Trial	Task	Subject 1	Subject 2	Subject 3	Subject 1	Subject 2	Subject 3
1	THC	2	2	1	4	4	3
2	THC	4	3	1	2	4	3
3	THC	2	2	1	3	4	3
4	THC	2	4	1	2	4	4
5	RHC	2	1	2	2	4	2
6	RHC	2	2	1	2	2	1
7	RHC	3	1	1	2	2	2
8	RHC	3	1	2	2	4	2
9	INT	3	3	2	2	4	3
10	INT	3	3	1	2	4	2
11	INT	3	3	1	2	4	1
12	INT	2	3	1	2	4	1

Figure 1. Total Scores for Subject 1 and Subject 3

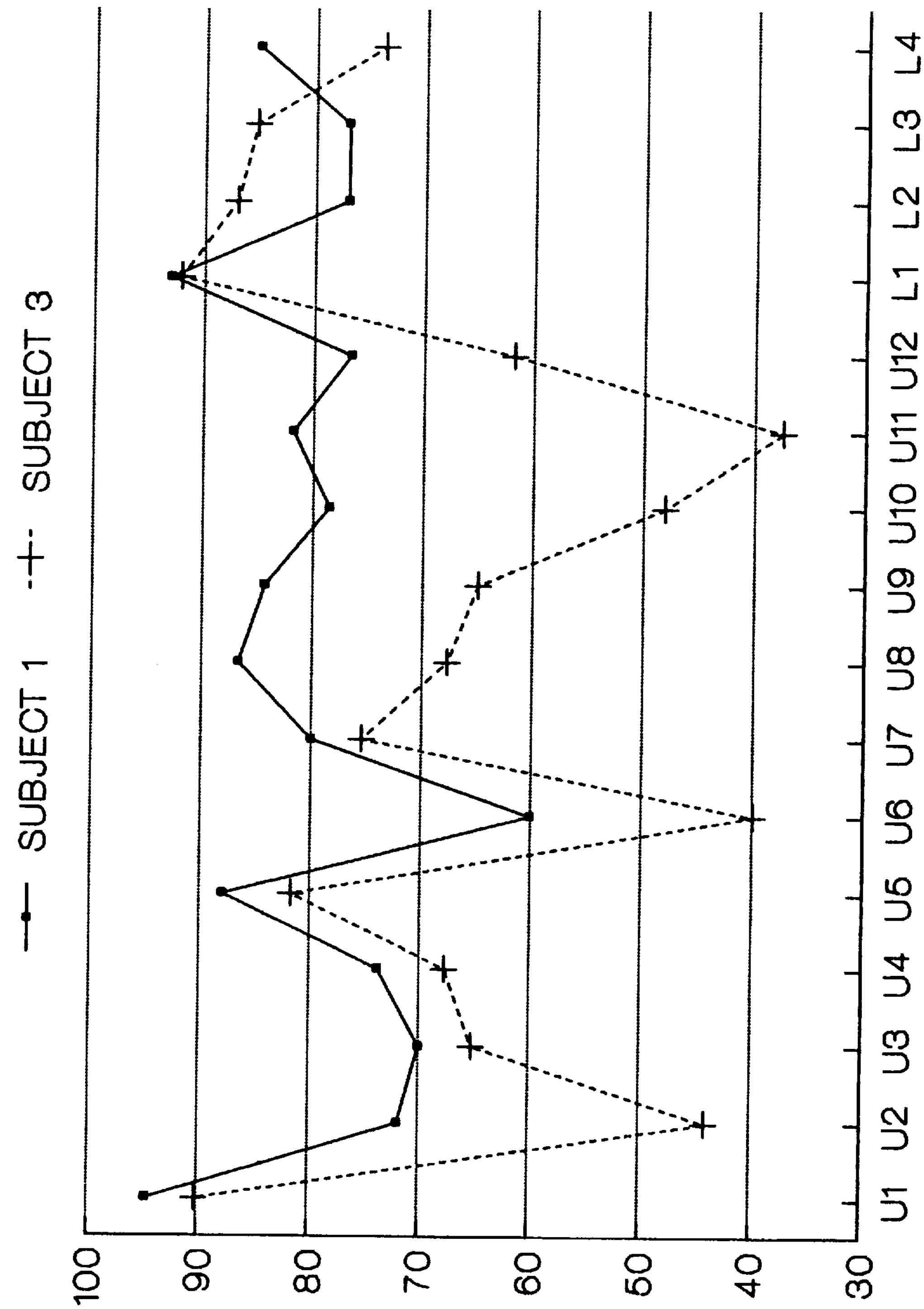


Figure 2a. Unloaded Total Scores for Subject 2 and Subject 3

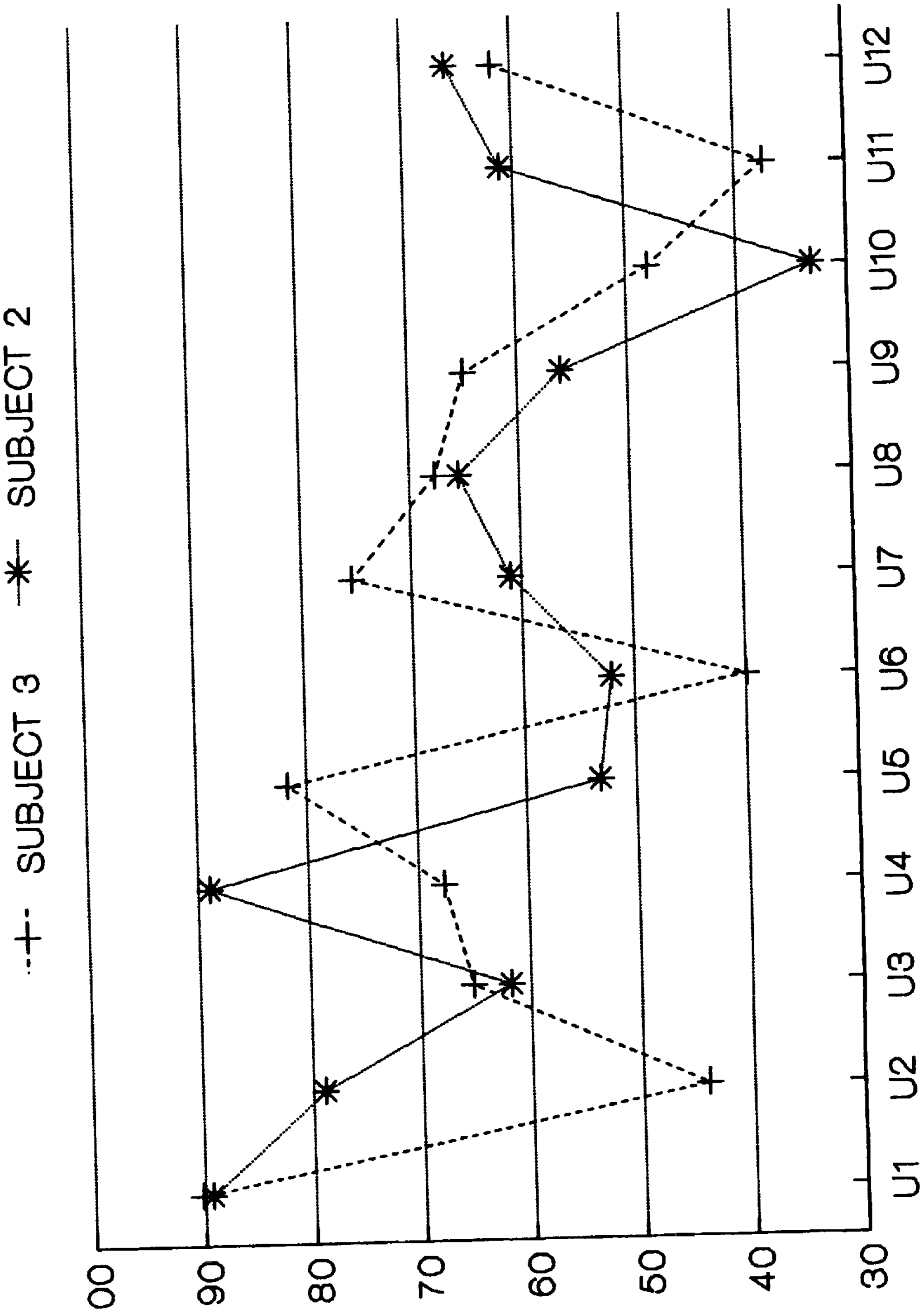


Figure 2b. Loaded Total Scores for Subject 2 and Subject 3

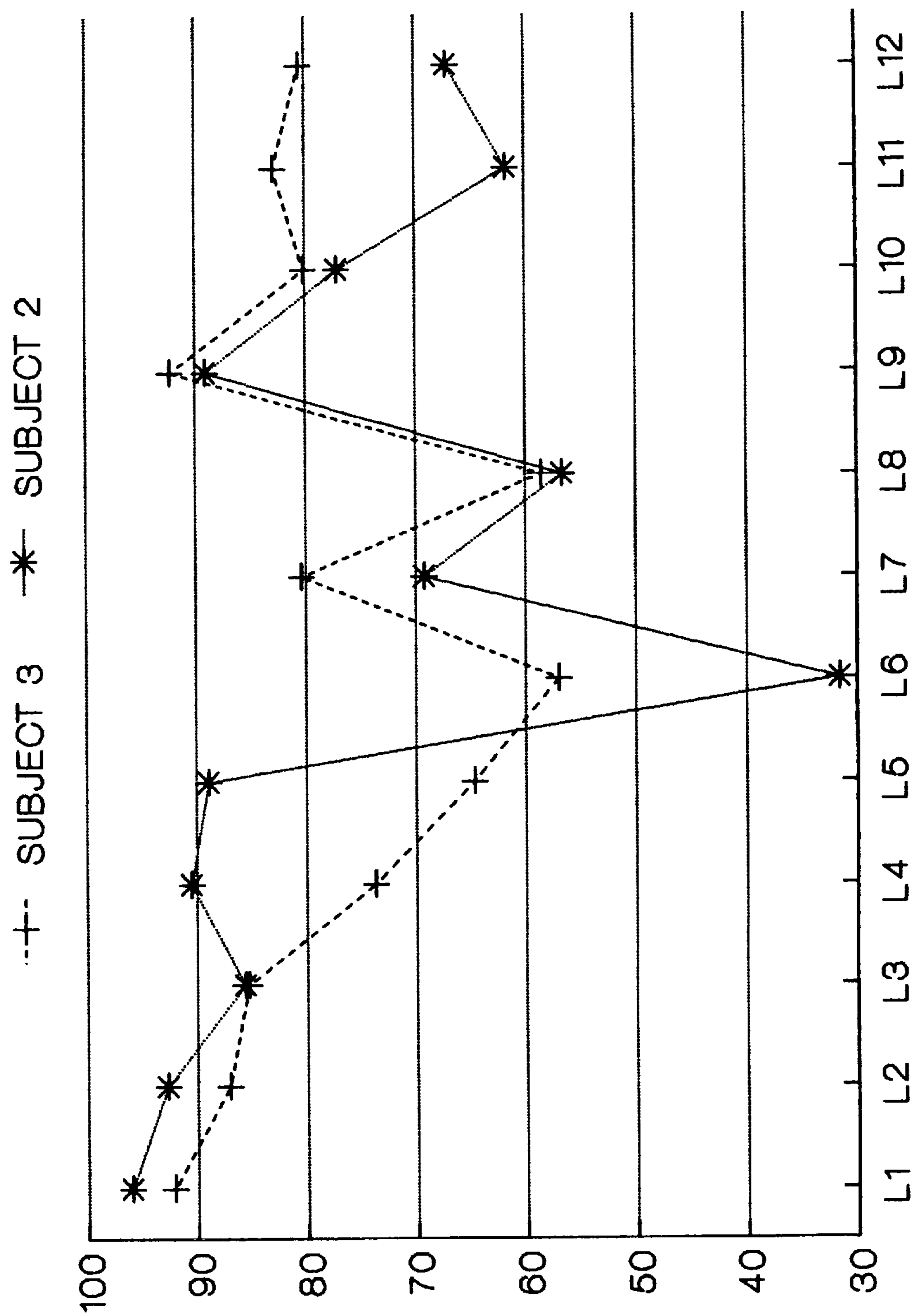


Figure 3. Accuracy Scores for Subject 1 and Subject 3

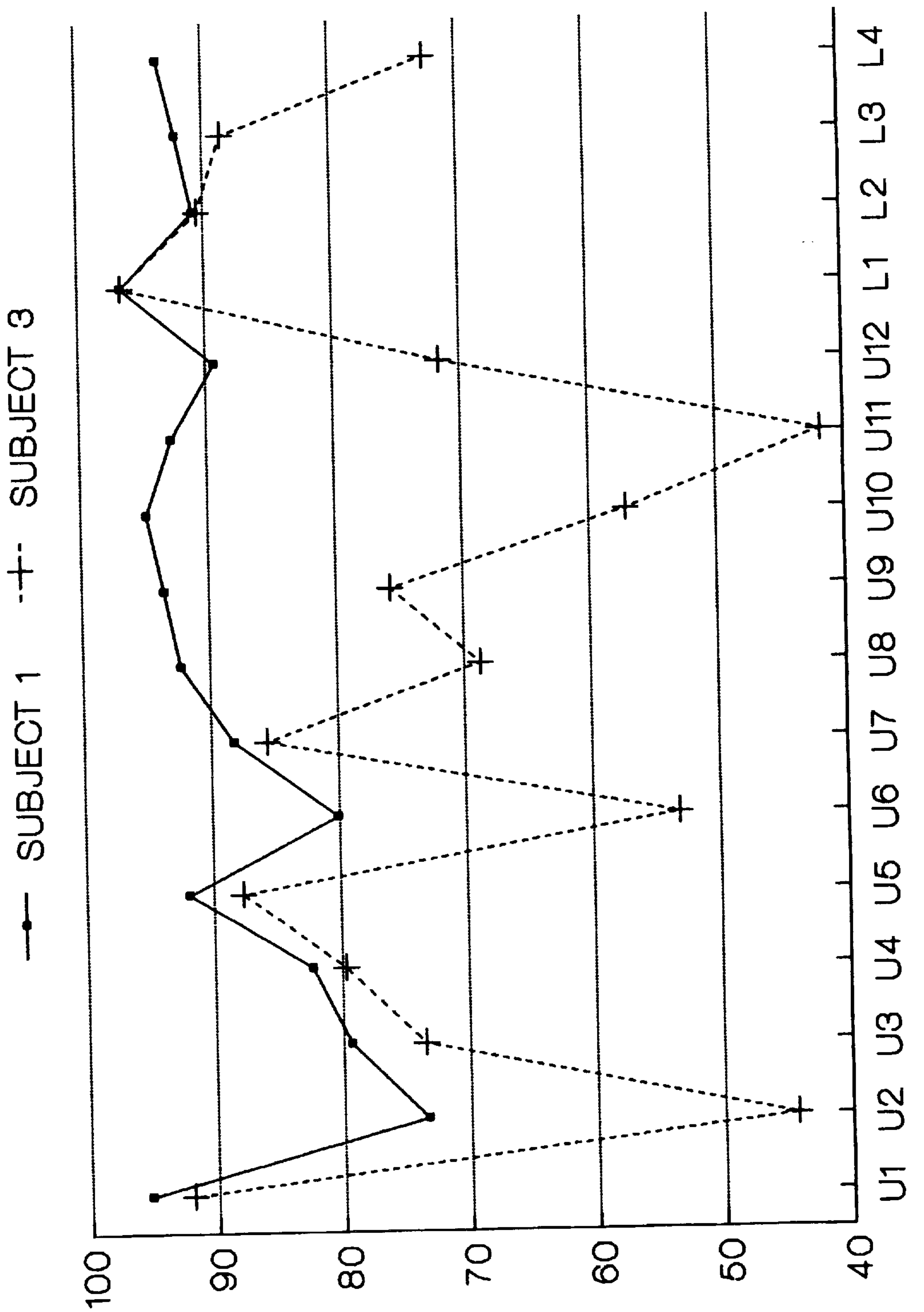


Figure 4a. Unloaded Accuracy Scores for Subject 2 and Subject 3

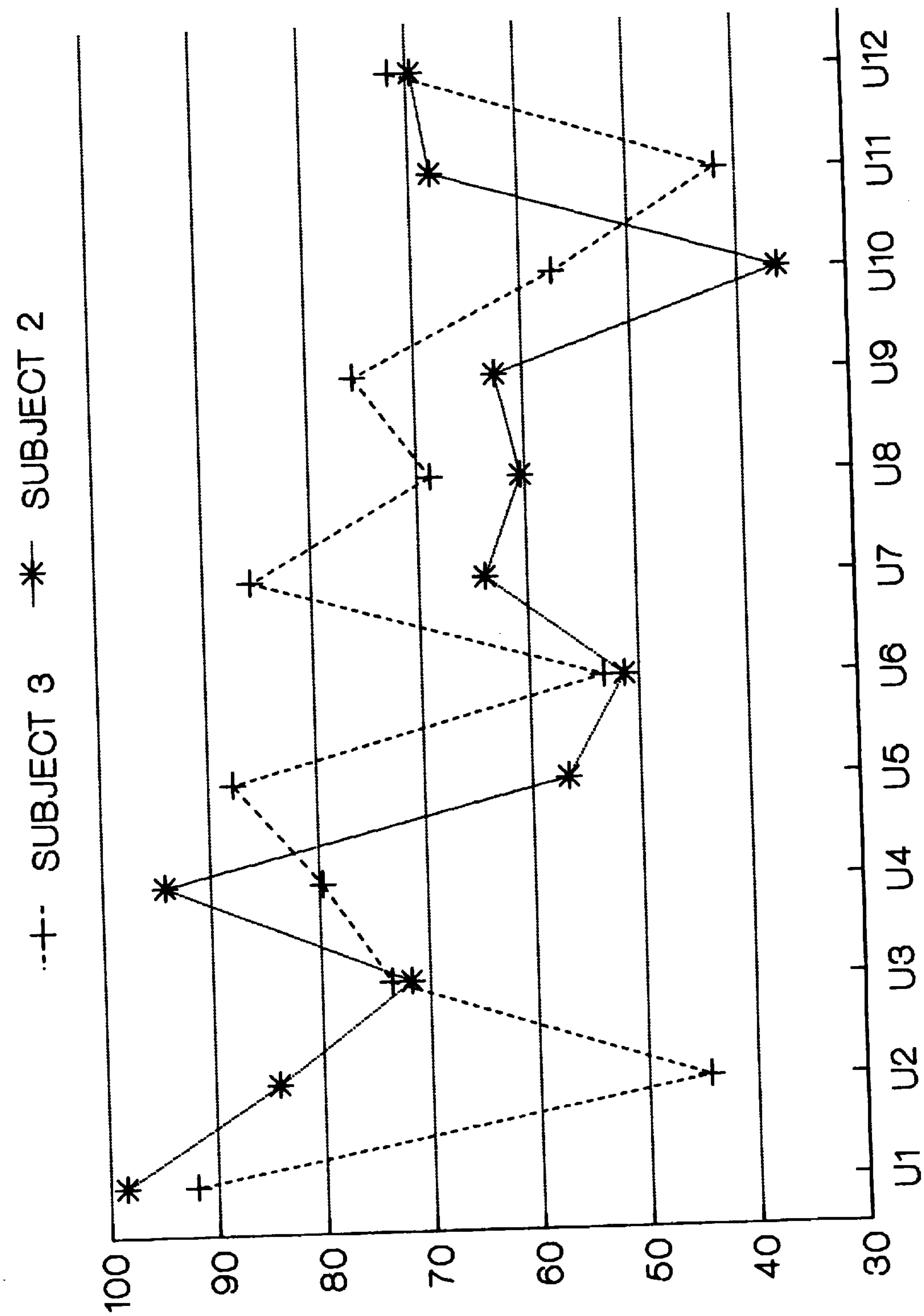


Figure 4b. Loaded Accuracy Scores for Subject 2 and Subject 3

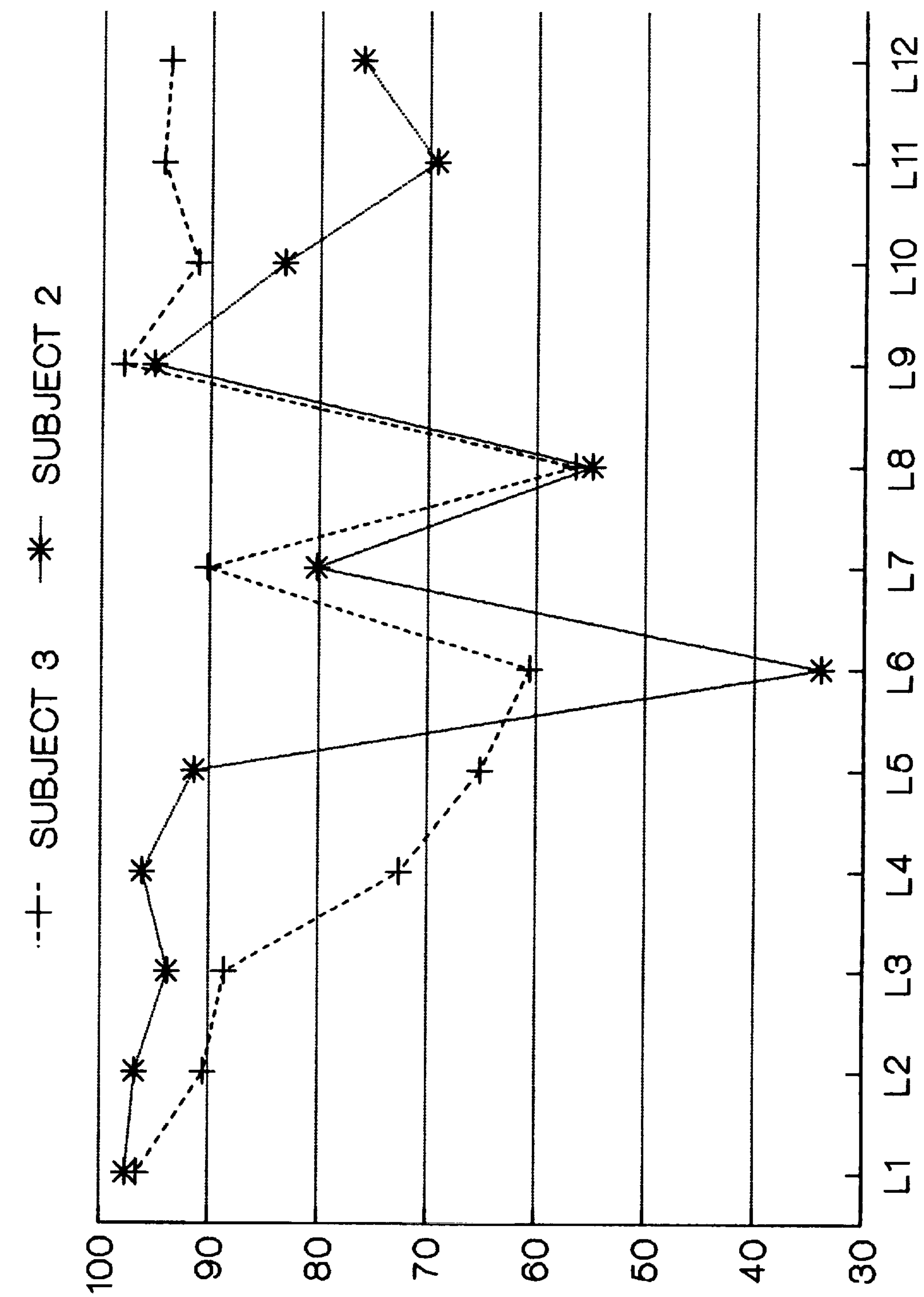


Figure 5. Efficiency Scores for Subject 1 and Subject 3

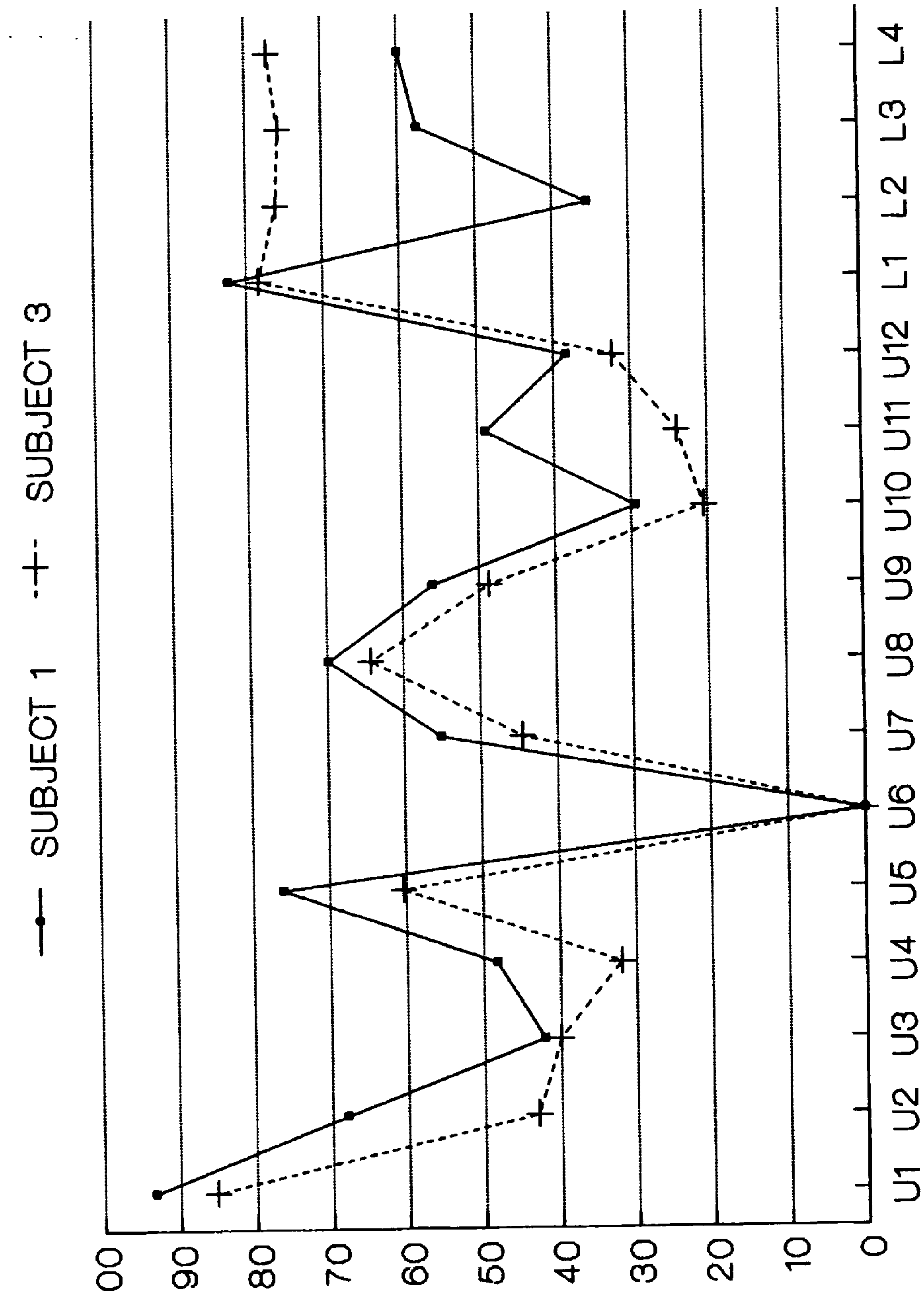


Figure 6a. Unloaded Efficiency Scores for Subject 2 and Subject 3

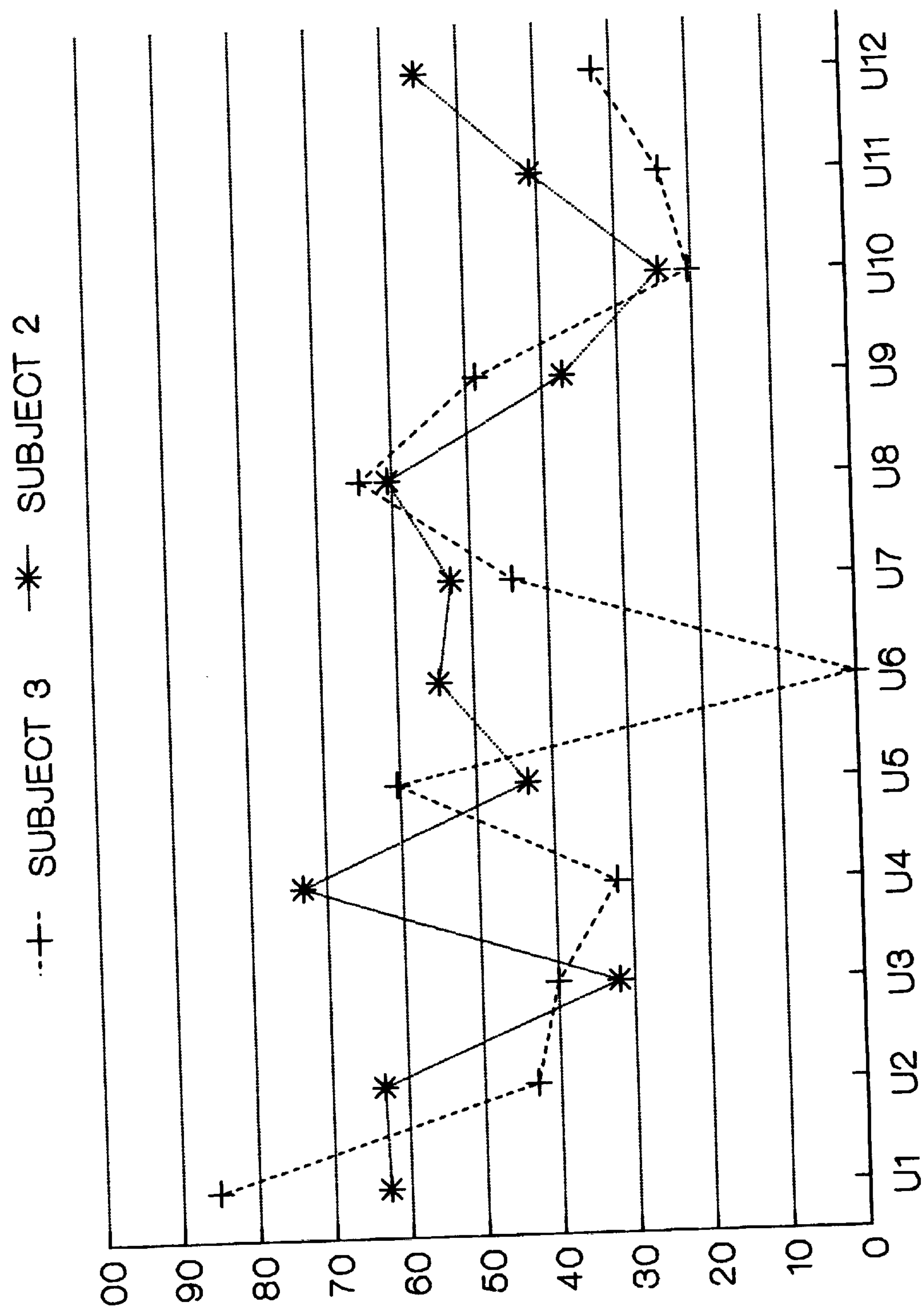


Figure 6b. Loaded Efficiency Scores for Subject 2 and Subject 3

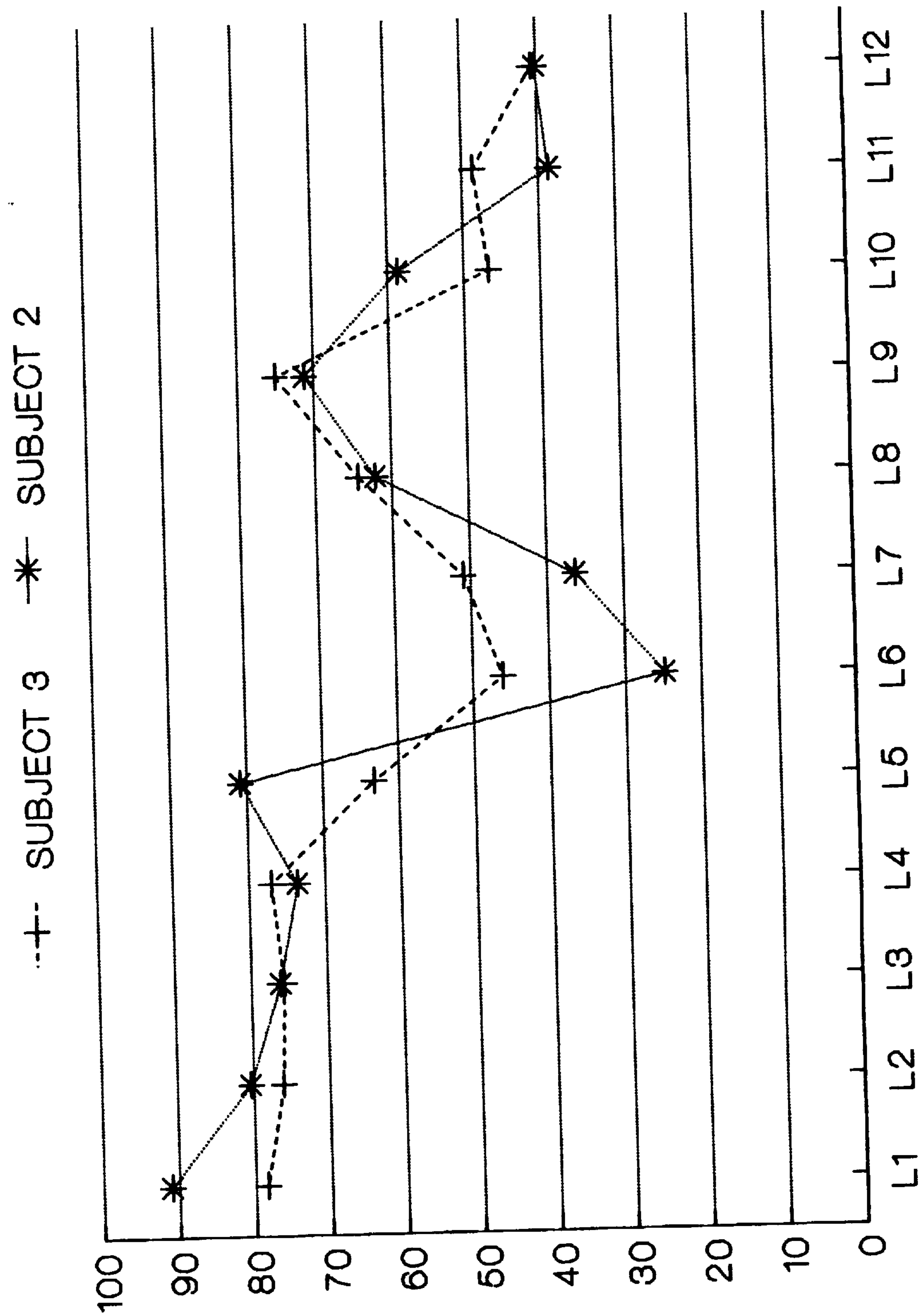


Figure 7. Average Time per Cycle for Subject 1 and Subject 3

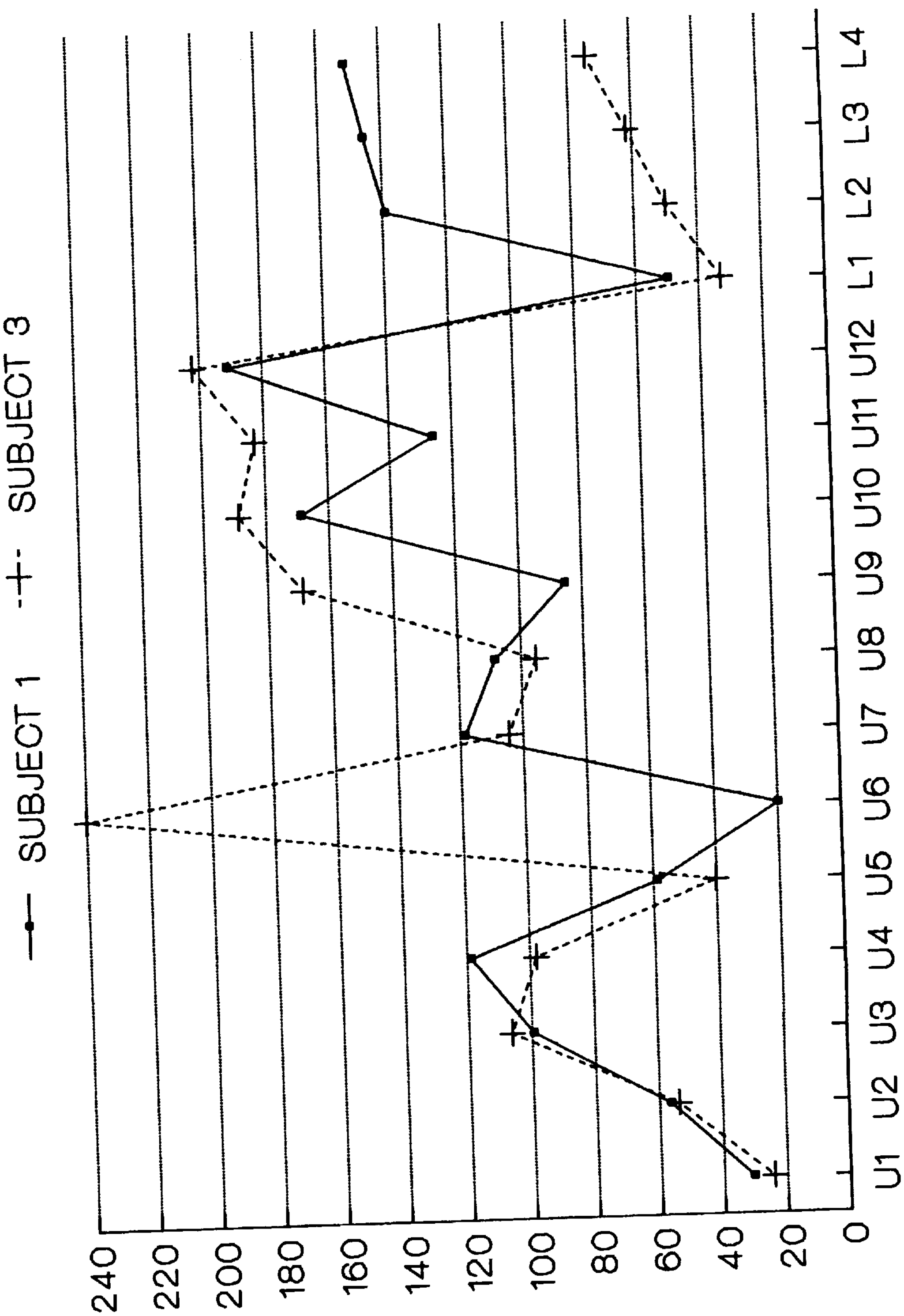


Figure 8a. Unloaded Avg. Time per Cycle for Subject 2 and Subject 3

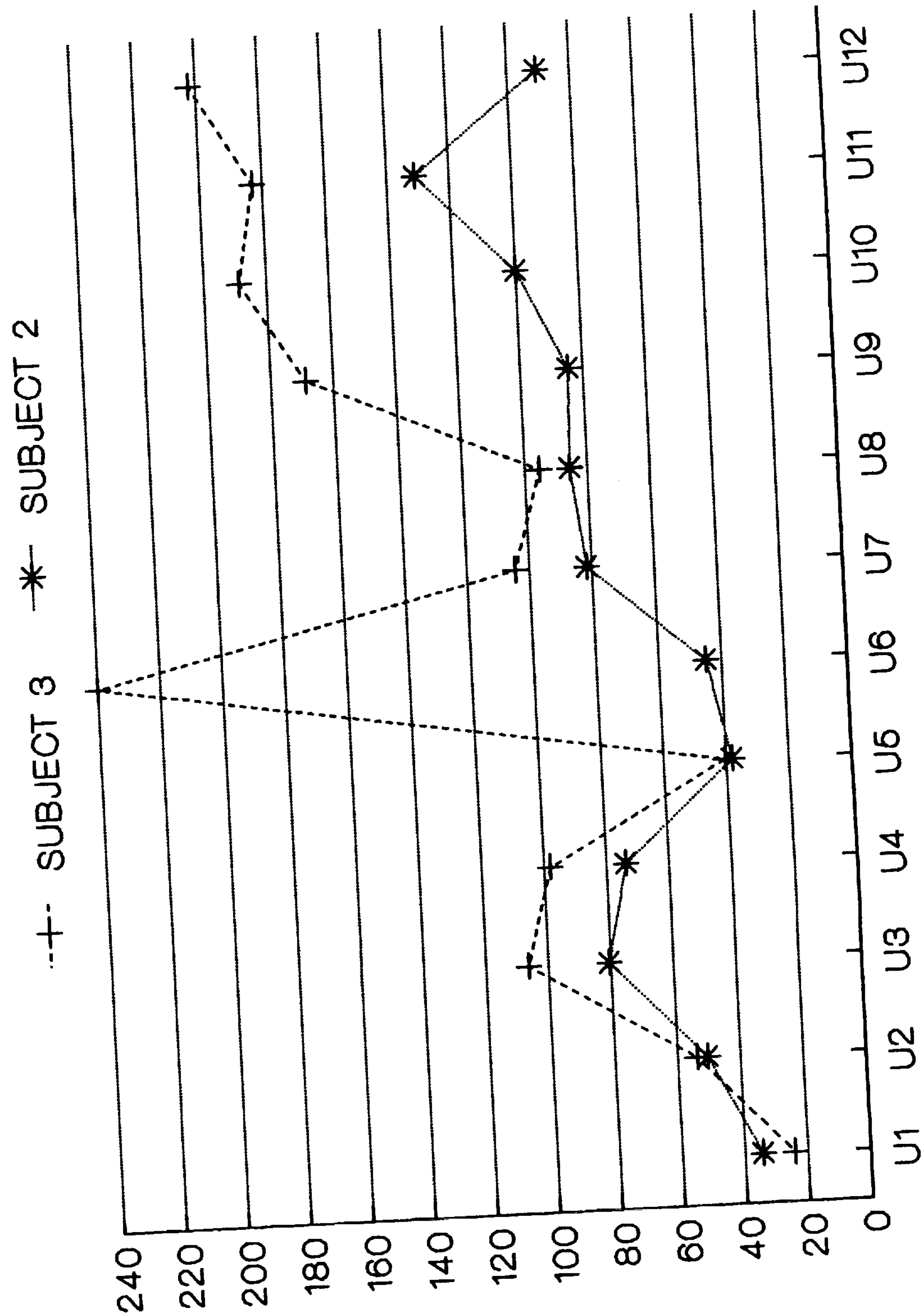


Figure 8b. Loaded Avg. Time per Cycle for Subject 2 and Subject 3

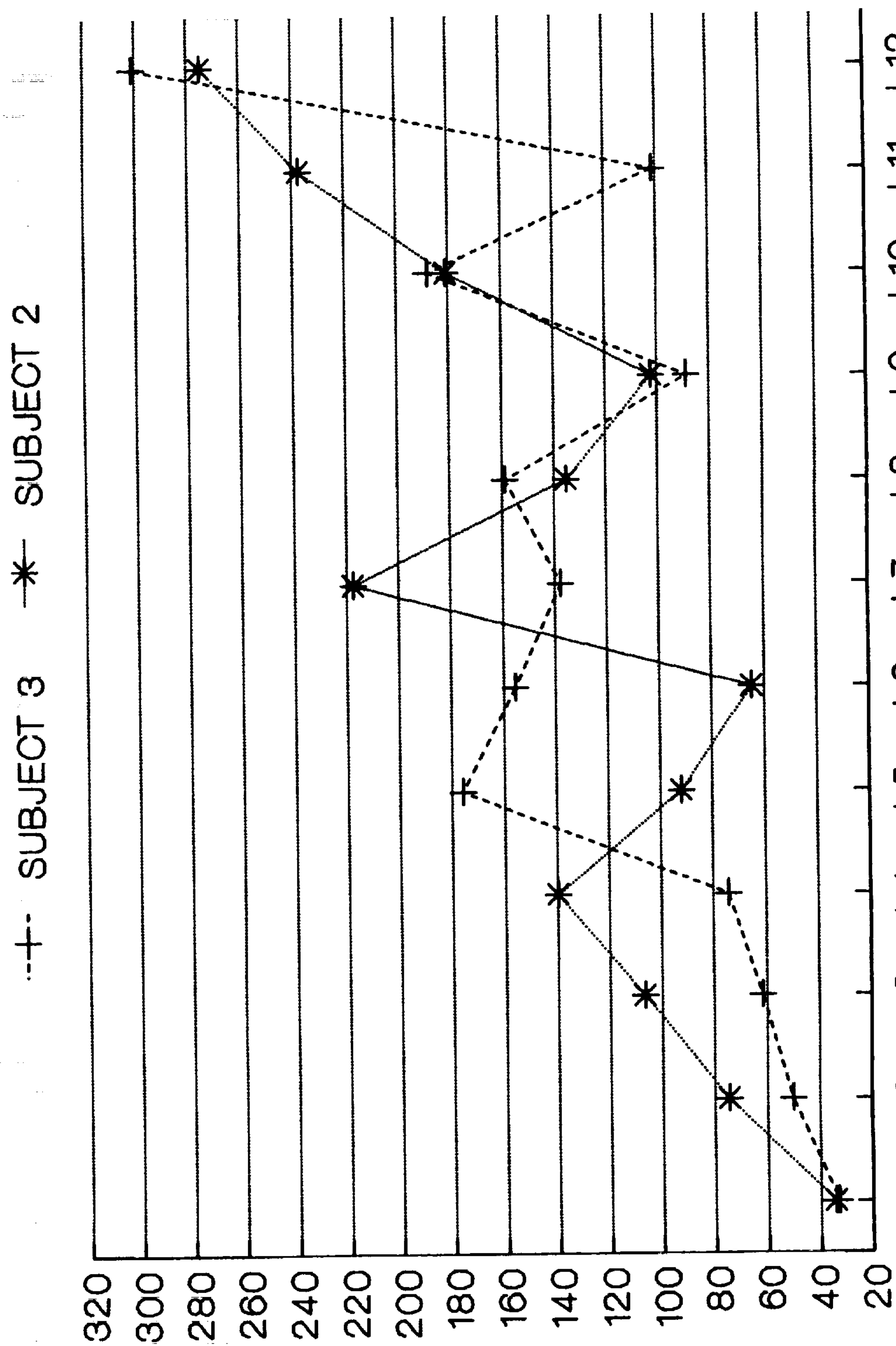


Figure 9. Number of Cycles for Subject 1 and Subject 3

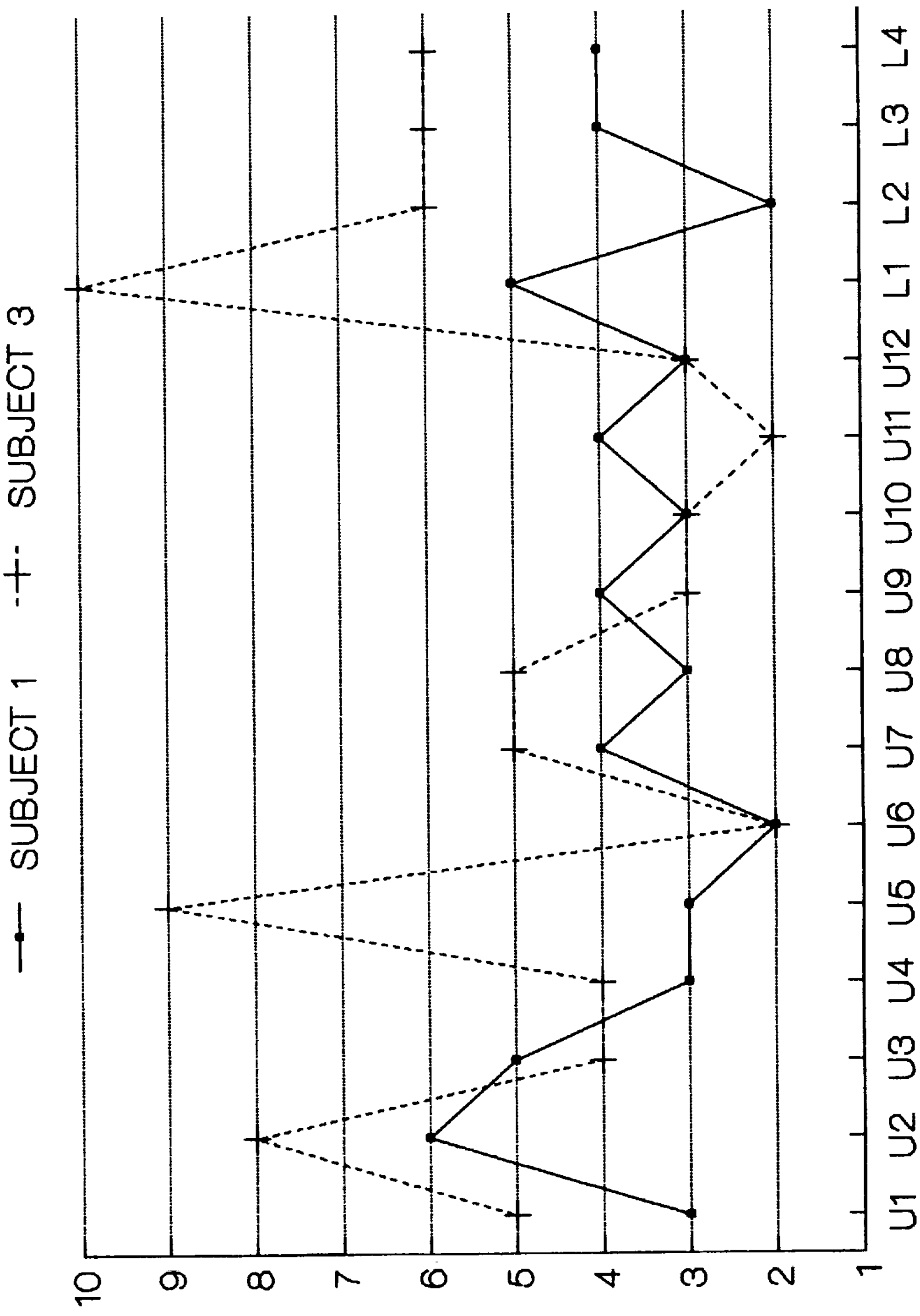


Figure 10a. Unloaded Number of Cycles for Subject 2 and Subject 3

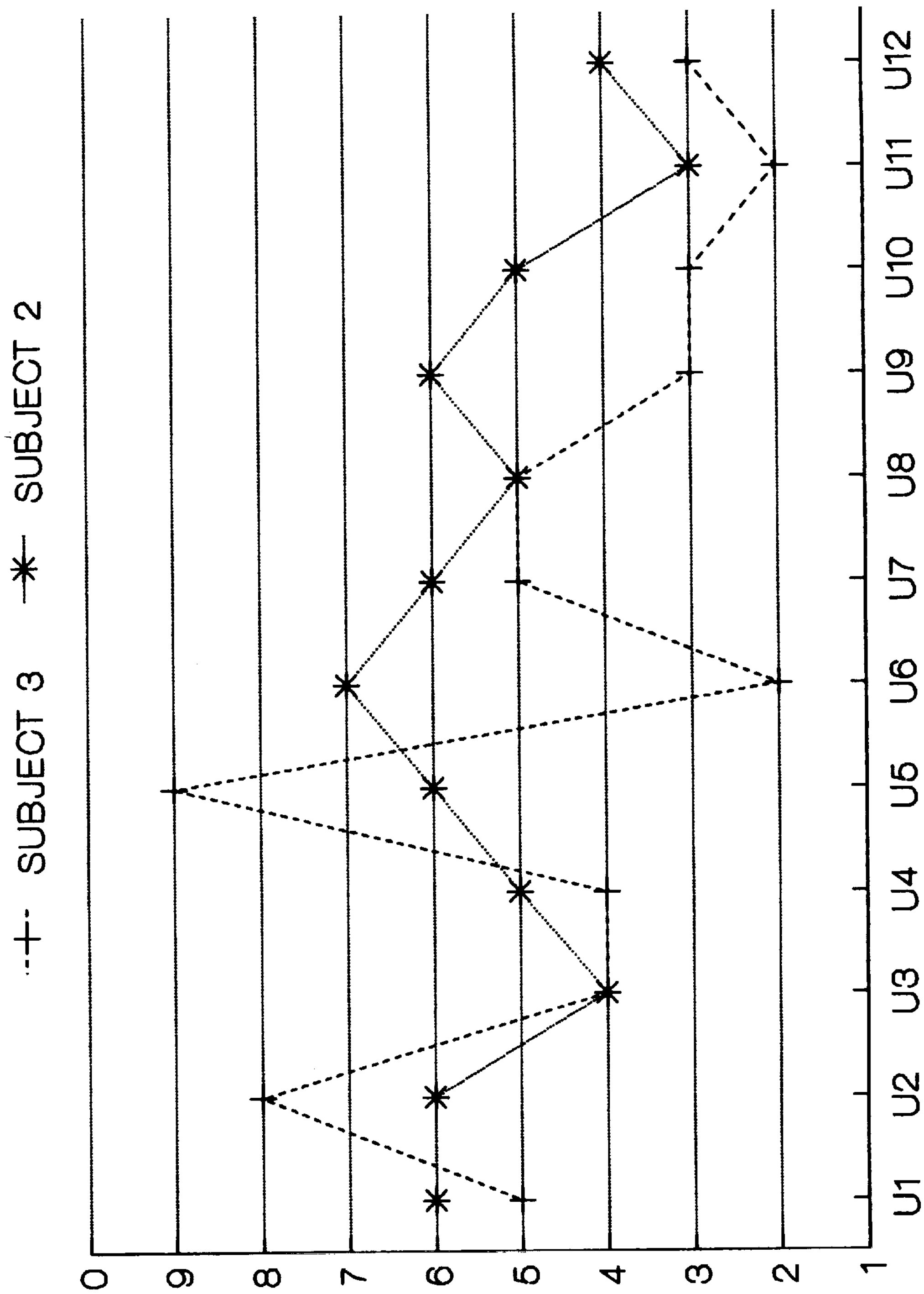


Figure 10b. Loaded Number of Cycles for Subject 2 and Subject 3

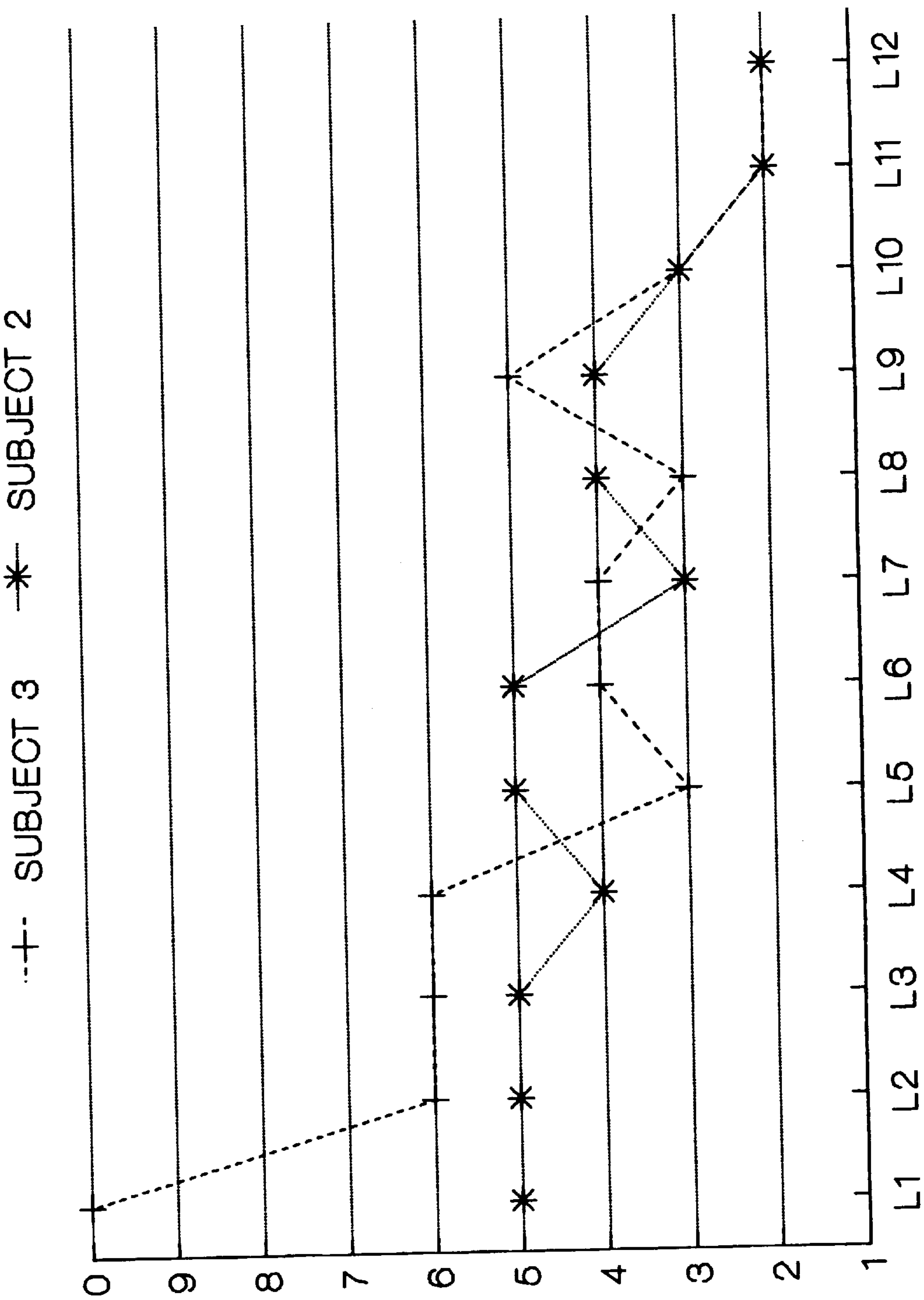


Figure 11a. Perceived Task Difficulty in Unloaded Trials

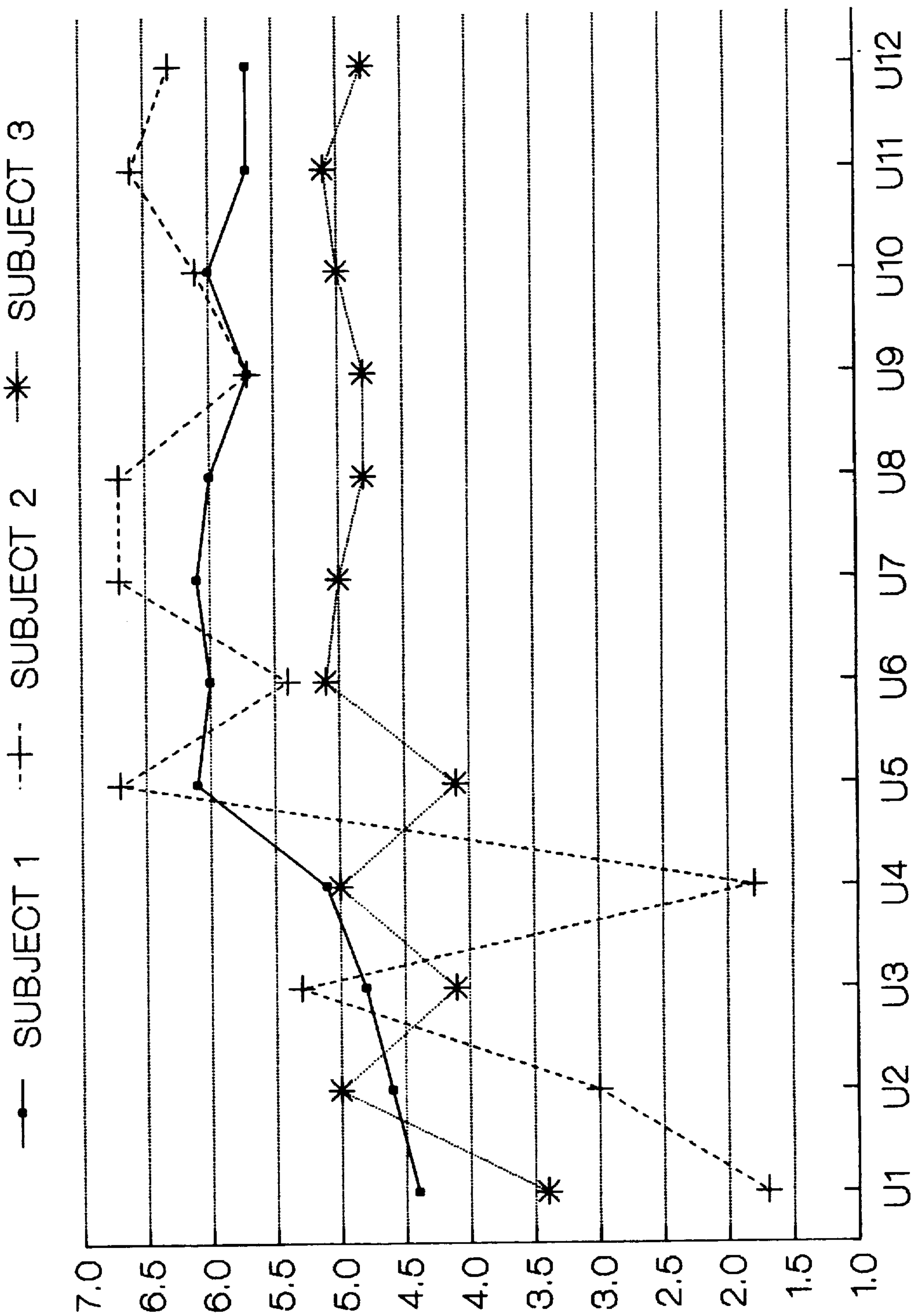
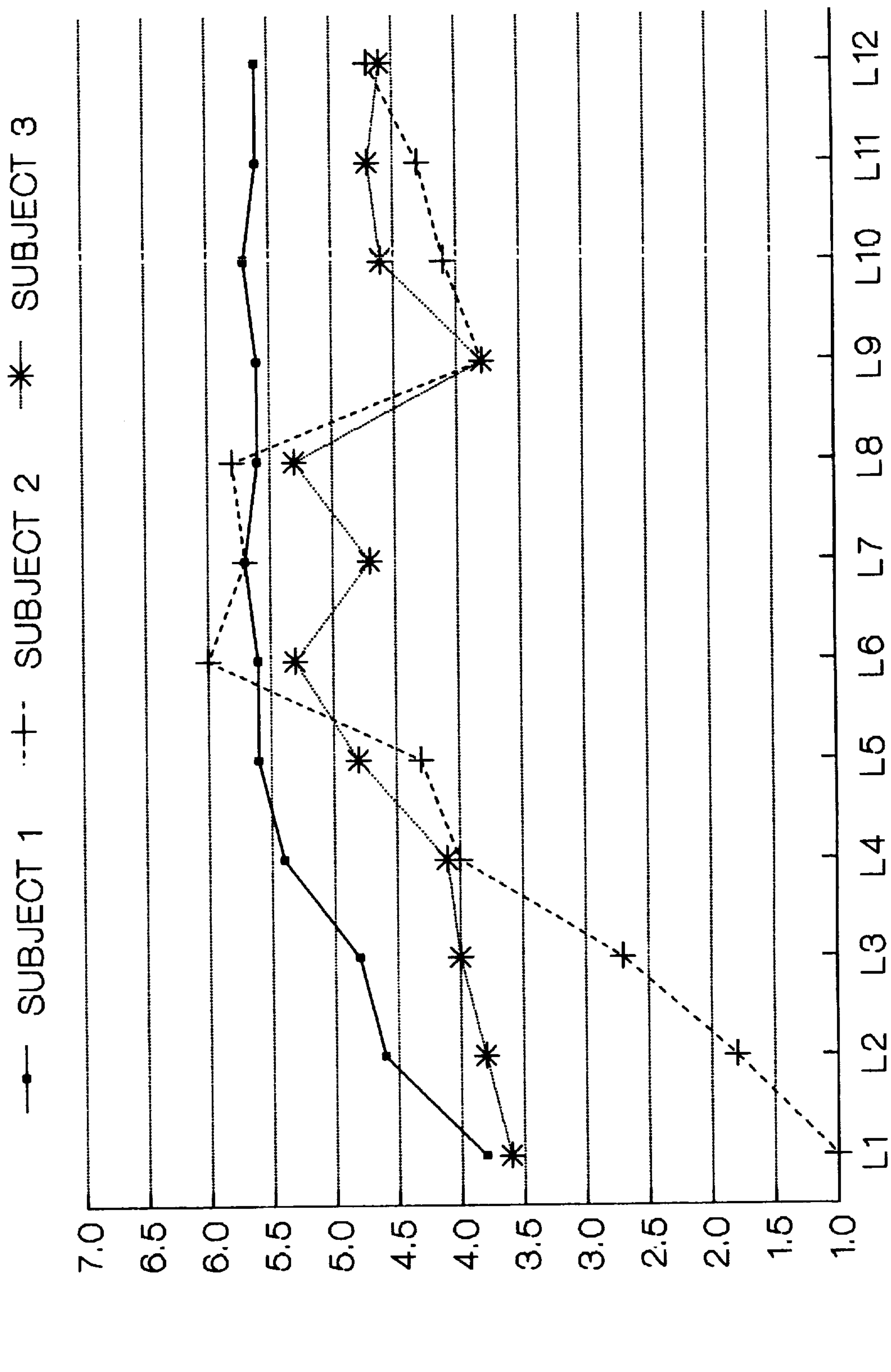


Figure 11b. Perceived Task Difficulty in Loaded Trials



Appendix A-1.

Subject #__________ Trial #__________ Date__________________

Please answer each of the following questions by circling the appropriate number.

(Perceived Task Difficulty)		Not at All						Very
	1. How difficult are the rules for performing this task?	1	2	3	4	5	6	7
	2. To what extent does this task require you to work fast?	1	2	3	4	5	6	7
	3. How complex is this task?	1	2	3	4	5	6	7
R	4. How well do you understand all the rules involved in performing the task?	1	2	3	4	5	6	7
	5. How difficult is this task?	1	2	3	4	5	6	7
	6. To what extent did you experience pressure to work quickly on this task?	1	2	3	4	5	6	7
	7. How challenging is this task?	1	2	3	4	5	6	7

The next questions use a slightly different scale. Indicate the extent to which you agree with each of the following statements by circling the appropriate number.

(Intrinsic Motivation)	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. This task was fun.	1	2	3	4	5
2. I had a lot of interest in this task.	1	2	3	4	5
3. This task was absorbing.	1	2	3	4	5
4. I tried very hard at this task.	1	2	3	4	5
5. This task was boring.	1	2	3	4	5
6. I put a lot of effort into trying to do well on this task.	1	2	3	4	5
7. This task was enjoyable.	1	2	3	4	5
8. I could have worked harder on this task.	1	2	3	4	5

R indicates Reverse Coded

Appendix A-1 - Continued

The next questions use a slightly different scale. Circle the number that best represents your satisfaction level.

VDis = Very Dissatisfied
Dis = Dissatisfied
Neu = Neutral
Sat = Satisfied
VSat = Very Satisfied

(Performance Satisfaction)

	VDis	Dis	Neu	Sat	VSat
1. How satisfied were you with your overall performance on the previous trial?	1	2	3	4	5
2. How satisfied would you be with the same level of performance on the next trial?	1	2	3	4	5

Appendix A-2. Orientation to Task

The next questions use a slightly different scale. Indicate the extent to which you agree with each of the following statements by circling the appropriate number.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Abilities are something you can increase.	1	2	3	4	5
2. I prefer tasks that I can do right the first time.	1	2	3	4	5
3. Having to overcome obstacles makes a task more interesting.	1	2	3	4	5
4. I prefer to work on tasks I am familiar with.	1	2	3	4	5
5. Feedback provides an evaluation of one's competence.	1	2	3	4	5
6. I don't mind making mistakes because they help me learn.	1	2	3	4	5
7. Having to overcome obstacles makes a task more frustrating.	1	2	3	4	5
8. Feedback provides information for increasing one's competence.	1	2	3	4	5
9. I prefer to work on tasks that are new to me.	1	2	3	4	5
10. Abilities are something that remain fairly stable.	1	2	3	4	5
11. I don't like making mistakes because they reflect poorly on my abilities.	1	2	3	4	5
12. I prefer tasks that I have to struggle to to complete.	1	2	3	4	5

Appendix A-3. Demographics

Subject # __________ Trial # __________ Date ________

Directions: Please circle the number next to your classification.

1. Sex: 1. Male 2. Female

2. Age: ______ years

3. Year:
   1. Freshman
   2. Sophomore
   3. Junior
   4. Senior
   5. Post Baccaluareate
   6. Graduate Student

4. Major:
   1. Business
   2. Communication
   3. Education
   4. Engineering
   5. Mathematics
   6. Psychology
   7. Sociology
   8. Other

5. Overall GPA: ___.___ (Leave blank if you don't have a GPA)

6. On the average, how often did you play video games during the past 12 months? (Circle the appropriate letter.)

   a. Never
   b. Once a month
   c. 5 times a month
   d. 15 times a month
   e. 20 times a month
   f. 30 or more times a month

7. How much do you enjoy playing video games?

1	2	3	4	5	6	7
not at all						very much

8. How comfortable are you in working with computers?

1	2	3	4	5	6	7
not at all						very comfortable

9. How much do you enjoy working with computers?

1	2	3	4	5	6	7
not at all						very much