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Transfer Function Analysis Of Pursuit Tracking In Adults

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In a previous study of pursuit tracking in children(Goldstein & Sabatina-Middleman, 1984), the results indicated that the transfer function of pursuit tracking performance was different for easy versus difficult tasks. This finding is interesting in that it suggests that the transfer function analysis of pursuit tracking performance may be a way of studying reorganization. The present study was aimed at following up on the previous finding and addressing the general issue of the utility of the transfer function approach of analyzing pursuit tracking performance.

METHOD

Description of Task: Subjects were seated in front of a monitor attached to a Commodore-64 computer and disc drive. On the screen there appeared a bar which was red on the ends and green in the middle. The computer moved the green part up and down. The subject had control over the up and down movements of red parts by means of a game paddle. The job of the subject was to keep the two red ends of the bar aligned with the green middle.

Description of Experimental Design: Each person was pretested with the Hypnotic Induction Profile(Spiegel & Spiegel, 1978). This test is theorized to measure the ability of a person to concentrate in a hypnotic way, that is to be hypnotized.

Then each person was given six trials of pursuit tracking. There were three trials done with the left hand and three trials done with the right hand. There were two trials of easiest task difficulty, two trials of medium task difficulty, and two trials of hardest task difficulty. The task difficulty was manipulated by the computer which changed how fast the green line was moving and the number of changes in direction. A computer program generated the three different difficulty levels. The movements of the green part of the line was random and the subject could not predict when it would change direction. Each person was given the easiest trials first, the medium trials second, and the most difficult trials last. If a person selected to use his right hand on the first trial, then the person was given the sequence: left, left, right, right, left. If a person elected to use his left hand on the first trial, then the person was given the sequence: right, right, left, left, right. The purpose of this was to allow comparisons of

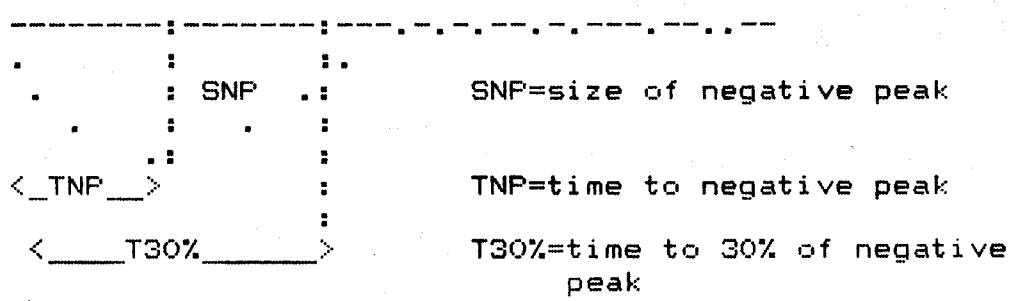
right versus left hand performance even if the person improved with practice. The comparison of task difficulty levels were confounded with practice trials. However, this would work in the direction of wiping out task difficulty effects.

Subjects who demonstrated high hypnotic ability on the pretest were given the Personality Assessment System which consists of the well known Wechsler Adult Intelligence Scale plus two additional tests. The PAS information results in classifying people into one of 120 possible reference groups. A prediction of pursuit tracking performance can be made from the PAS results. This allows us to better understand the nature of the pursuit tracking task in terms of cognitive style variables.

Subjects Thirteen adult subjects participated in the study. They were paid volunteers. Most of them became aware of the study by means of a newspaper advertisement which they answered. None of them were taking any medicine which could affect their concentaration. One of them was in counseling sessions with one of the authors(DMG). No other selection criteria was operating.

RESULTS

Description of Transfer Function and Dependent Measures: The transfer function in pursuit tracking is a curve which shows a person's handle response to a momentary disturbance. It is obtained by calculations made on the the first 210 actual data points (out of the 1000 available). The horizontal axis consists of time, the vertical axis consists of the person's handle response. Each transfer function in this study was formed from 70 points. The transfer functions looked like this:



In addition to the transfer function measures, the stability number was calculated. This number is a statistic which indicates how well a person was doing the job of tracking the line. Thus, there were four dependent measures in the study.

Transfer Functions Based on Proportional Model: It is possible to have the computer act as a subject in a pursuit tracking task and produce data. A transfer function can be calculated for the data. This approach was used in order to provide some guidlines for interpreting the real subject data. Using this approach, the following results were obtained. Stability number changed as a function of the model's gain but not the task difficulty. The larger the gain, the larger the absolute value of the stability number. The time to the negative peak showed a gain effect but not a task effect. The larger the gain, the longer the time to reach the negative peak. The time to the 30% point displayed a gain and task effect. The larger the gain, the longer the time to reach the 30% point. The more difficult the task, the shorter the time to reach the 30% point. The size of the negative peak was a function of gain and task difficulty. The more difficult the task, the larger the negative peak. The size of the negative peak increased, reached a maximum, and then decreased with an increase in gain.

Relationships Among Transfer Function Parameters: As mentioned above, each person in the study had six trials of pursuit tracking. The performance measures on the six trials were averaged for each person and then intercorrelated.

The correlation between time to the negative peak and size of the negative peak was .84, $p < .001$. In words, people who had bigger peaks had smaller times to the peak. Neither of these two parameters correlated with the 30% point measure.

The correlation between time to the negative peak and the stability number was .60, $p < .03$. In words, people who performed better in pursuit tracking had smaller times to the negative peak.

The correlation between the size of the negative peak and the stability number was .91, $p < .001$. In words, people who performed better in pursuit tracking had bigger peaks.

Pursuit Tracking And Left/Right And Task Difficulty: Each person's pursuit tracking performance was analyzed individually using ANOVA statistical techniques. The result was that transfer function parameters and stability number were not different for the left versus right hand. These measures did change with task difficulty. Stability number was larger with lower task difficulty. Time to the negative peak was smaller with higher task difficulty. Time to the 30% point was smaller with higher task difficulty. Size of the negative peak was not related to task difficulty.

Pursuit Tracking and Hypnotic Ability: The correlation between the HIP induction score and the time to the negative peak was .58, $p < .05$. In words, people who have higher hypnotic ability have longer times to the negative peak.

Pursuit Tracking and PAS: It is possible to use the PAS to make a prediction of pursuit tracking performance based on the PAS. There were only 7 out of 13 subjects whose HIP score qualified them for being given the PAS. Thus, the results must be considered only suggestive. The correlation between the predictor and the time to the negative peak was .48, $p < .30$.

DISCUSSION

The results of the present study with respect to task difficulty was the same as the former study. The new information was that pursuit tracking performance was the same with the left versus right hand.

We have learned a little more about the utility of the transfer function approach to analyzing pursuit tracking. The task difficulty results suggest that the subjects were decreasing their gain in order to cope with the faster moving target. The left/right hand results could be interpreted to mean that people do not change their gain when doing this task with the left versus right hand. This is a little surprising. Perhaps this is such an easy task in terms of motor requirements that no reorganization is needed.

The fact that persons high in hypnotic ability have longer times to the negative peak suggests that they have higher gains and therefore, more sensitivity to errors. This is supportive of Spiegel's interpretation of hypnosis as requiring a special kind of concentration style. The PAS results indicate that the cognitive style of field independence is related to pursuit tracking performance. People who are more field independent are better at pursuit tracking.

Is it worth the effort to do transfer function analyses of pursuit tracking? The answer is still unclear. Stability number correlated strongly with time to the negative peak and size of the negative peak. Thus, it is likely that stability number may serve just as well as the more complicated transfer function measures. Is it possible to obtain a result where the transfer function measures provide nonredundant information? More studies will tell. The next study will look at transfer function results for auditory pursuit tracking.

REFERENCES

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