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Enhancing Intellectual Performance in Well Functioning Elderly

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During the past decade there has been an increased focus in the study of adult intelligence on issues related to optimal or adaptive intellectual functioning. Researchers have attempted to address this issue in at least three major ways. First, there has been the search for new models of intellectual functioning uniquely characterizing cognition in adulthood. A second major thrust has been more microanalytic in nature and has sought to examine within the information processing approach components of intellectual performance which do and do not exhibit age differences.

A third major thrust has focused on the modifiability of adult intellectual performance through cognitive training procedures. Even well functioning older adults can be disadvantaged in at least two different ways. First, some age-related decline may occur through disuse, whether by personal choice or environmental restrictions. Second, other older adults may be disadvantaged because of rapid sociocultural and technological change. Our paper presents research designed to examine whether the behavior of well functioning adults can be enhanced via educational intervention techniques.

Prior cross-sectional cognitive training research has strongly suggested the modifiability of older adults' performance on a number of intelligence dimensions (see Willis, in press, for a review of training research). However, the cross-sectional nature of this

research made it impossible to examine one of the most fundamental questions. That is, to what extent did training procedures result in remediation of age-related decline vs the acquisition of new performance levels in subjects experiencing no decline? This issue must be addressed within the context of a longitudinal study, such that training improvement can be assessed for subjects with known intellectual histories.

Method

This paper represents a first report of a study currently in progress, which focuses on the above question. Subjects from the five oldest cohorts (age 60+) of the Seattle Longitudinal Study were classified on the basis of prior longitudinal data and pretest scores as having either remained stable or shown significant decline in performance on two of Thurstone's Primary Mental Abilities, Spatial Orientation and Inductive Reasoning. Significant decline was defined as equal to or greater than one standard error of measurement. Subjects showing decline on one of the two abilites were assigned to training on the declining ability. Subjects who either remained stable on both abilities or declined on both abilities were randomly assigned to training on one of the abilities.

The study involves a pre- posttest control group design. Subjects are pre- and posttested on an extensive battery of primary ability measures. Training subjects received five one-hour training sessions in their homes. Training procedures focus on strategies and skills shown in previous research to facilitate performance on the target ability. Approximately 90% of the longitudinal subjects

contacted have indicated a willingness to participate in the training. It is anticipated that approximately 200 subjects will receive training, 100 on Spatial Orientation and 100 on Inductive Reasoning. Approximately 200 additional control subjects will be tested. Two-thirds of the sample is female; one-third is male. Thus far, approximately one-third of the sample (N=166) has completed the study. Mean age of subjects (N=42) in Reasoning training is 72.9 years (Range=63-91); mean age for Space training subjects (N=49) is 73.2 years (Range=63-94).

Results

The results to be presented in this paper are based on one-third of the total sample to be studied. Thus, the findings must be interpreted with considerable caution. We will begin by examining the proportion of subjects showing significant training improvement. Secondly, we will report analyses of group comparisons of training effects. In this paper we will focus only on the Thurstonian PMA measures of Spatial Orientation and Inductive Reasoning, since these are the measures for which longitudinal data are available.

First, what percentage of subjects showed significant training gains? Training gains are defined as equal to or greater than one standard error of measurement. It appears that training procedures are particularly effective for subjects who exhibited prior decline. Figure 1 presents the percentage of decline subjects who showed significant training gain at posttest. Also shown is the percentage of decline subjects whose posttest score is equivalent to or greater than their 1970 score (the longitudinal data point prior to onset of

significant decline). This is the proportion of subjects whose performance decline was successfully remediated. Data are reported separately by sex, given pretraining sex differences in level of performance.

Figure 1

Of those subjects receiving Space training, eighty-one percent of the women and fifty-eight percent of the men showed significant training improvement at posttest. For seventy-one percent of the women and a third of the men training resulted in remediation to subjects' 1970 score level. With regard to subjects receiving training on Inductive Reasoning, sixty-three percent of the men and fifty-six percent of the women showed significant training improvement at posttest. Remediation of performance to their 1970 score level occurred for fifty percent of the men and forty percent of the women.

Our data thus far suggest that significant training gains are achieved by fewer of the subjects exhibiting no prior decline in intellectual functioning on the target ability. One-third of the stable women and twenty percent of the stable men trained on Space showed significant training improvement. For Reasoning, one-third of the stable men and fourteen percent of the stable women showed significant training improvement at postest.

We will next report statistical analyses of group comparisons. We will begin with Space Training, focusing on improvement for stable vs decline subjects. A 2(Status - Stable,Decline) X 2(Sex) ANOVA on pre-posttest gain scores for training subjects resulted in a significant Status main effect, and a significant Sex main effect. As

shown graphically in Figure 2 (left side), both males and females showing prior decline demonstrated significant training effects when compared with stable training subjects. Secondly, females (stable and decline) demonstrated greater training gain than men.

Figure 2

In a second set of analyses training improvement was compared with performance of a control group receiving only pre- and posttests. A 2(Treatment - Training, Control) X 2(Status - Stable, Decline) X 2(Sex) ANOVA on pre-posttest gain scores resulted in a significant Status main effect ($p<.001$), a significant Training X Sex interaction ($p<.003$), and a trend toward a Training X Status interaction ($p<.09$). As shown graphically in Figure 2, training gain for both stable and decline females was significant when compared to performance of control females. Females exhibiting prior decline showed the largest training effect. However, training gain for men was not statistically significant when compared with control men.

The above findings were based on posttest performance under standard time conditions. Posttest performance under relaxed-time conditions (double the standard time) was also assessed, and a second gain score (Relaxed-time posttest score minus standard time posttest score) was computed. It was reasoned that subjects performing at a high level prior to training might require additional time at posttest in order to demonstrate training effects. A 2(Treatment) X 2(Status) X 2(Sex) ANOVA on Relaxed Time gain scores resulted in a significant Training X Status interaction ($p<.05$). Figure 3 graphically illustrates the finding that gain from timed to relaxed

time posttest scores was significantly greater for stable training subjects than for stable control subjects. Posthoc analyses indicated a significant difference between stable training males and stable control males.

Figure 3

We turn now to comparison of gains for stable vs decline subjects trained on Inductive Reasoning. A 2(Status - Stable,Decline) X 2(Sex) ANOVA on pre-posttest gain scores for training subjects resulted in a significant Status main effect ($p<.007$). As shown graphically in Figure 4(left side), subjects showing prior decline demonstrated significant training effects when compared with stable training subjects.

Figure 4

In a second set of analyses training improvement was compared with performance of a control group receiving only pre- and posttests. A 2(Treatment) X 2(Status) X 2(Sex) ANOVA on pre-posttest gain scores resulted in a significant Training X Status interaction ($p<.02$), a significant Training X Sex interaction ($p<.05$), and a significant Status X Sex interaction ($p<.008$). As shown in Figure 4, there was a significant training effect for both males and females showing prior decline, when compared with decline control subjects. Secondly, training males demonstrated significantly greater gain than control males. Post hoc analyses indicated that decline training males demonstrated greater gain than decline training females.

Finally, we examined gains from the timed to the relaxed time condition on the Reasoning measure. No effects were statistically significant.

Discussion

The objective of this study is to examine the enhancement of intellectual performance in well functioning elderly with known intellectual histories. It has been suggested that even well functioning elderly may experience some decline and/or disadvantage due to disuse or rapid sociocultural change. The effectiveness of training procedures in remediating intellectual performance decline vs the attainment of new performance levels is being examined.

Thus far, the data suggest the following trends. One, training on both Spatial Orientation and Inductive Reasoning abilities appears particularly beneficial for subjects showing prior decline on that ability. Training gain for decline subjects is significantly greater than gain for stable training subjects.

Second, training on each ability appears to benefit the sex showing an initially lower level of performance on that ability. This effect is most clearly demonstrated for Spatial Orientation, on which women usually score lower. Females demonstrated significantly greater training gain than men; decline females showed the greatest training gain. Indeed, after training there were no significant sex differences in level of performance. There is a similar trend for Inductive Reasoning, on which males initially score lower (although not significantly lower than females). The significant Training X Sex interaction indicated that training males achieved significantly greater gain than control males; this gain was not significant for training females compared with control females.

In summary, these preliminary data from subjects with known intellectual histories supports the promising findings of previous cross-sectional training research, and further clarifies the nature of the training effects achieved. Again, given the small sample sizes, representing only one-third of the final sample, these findings must be interpretted with caution. Hopefully, at next year's meeting we can present such positive effects with increased confidence.

FIGURE 1

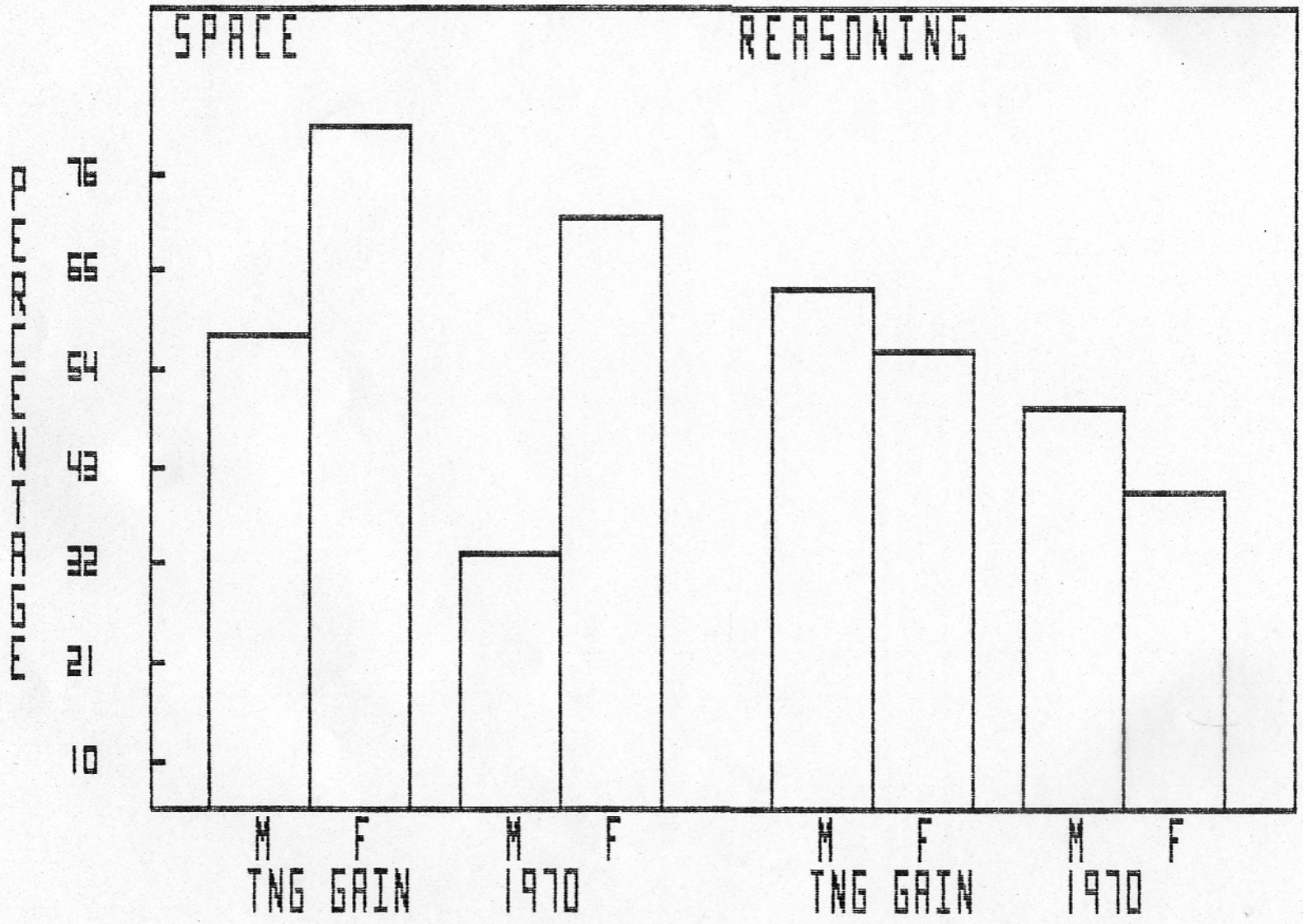
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FIGURE 2

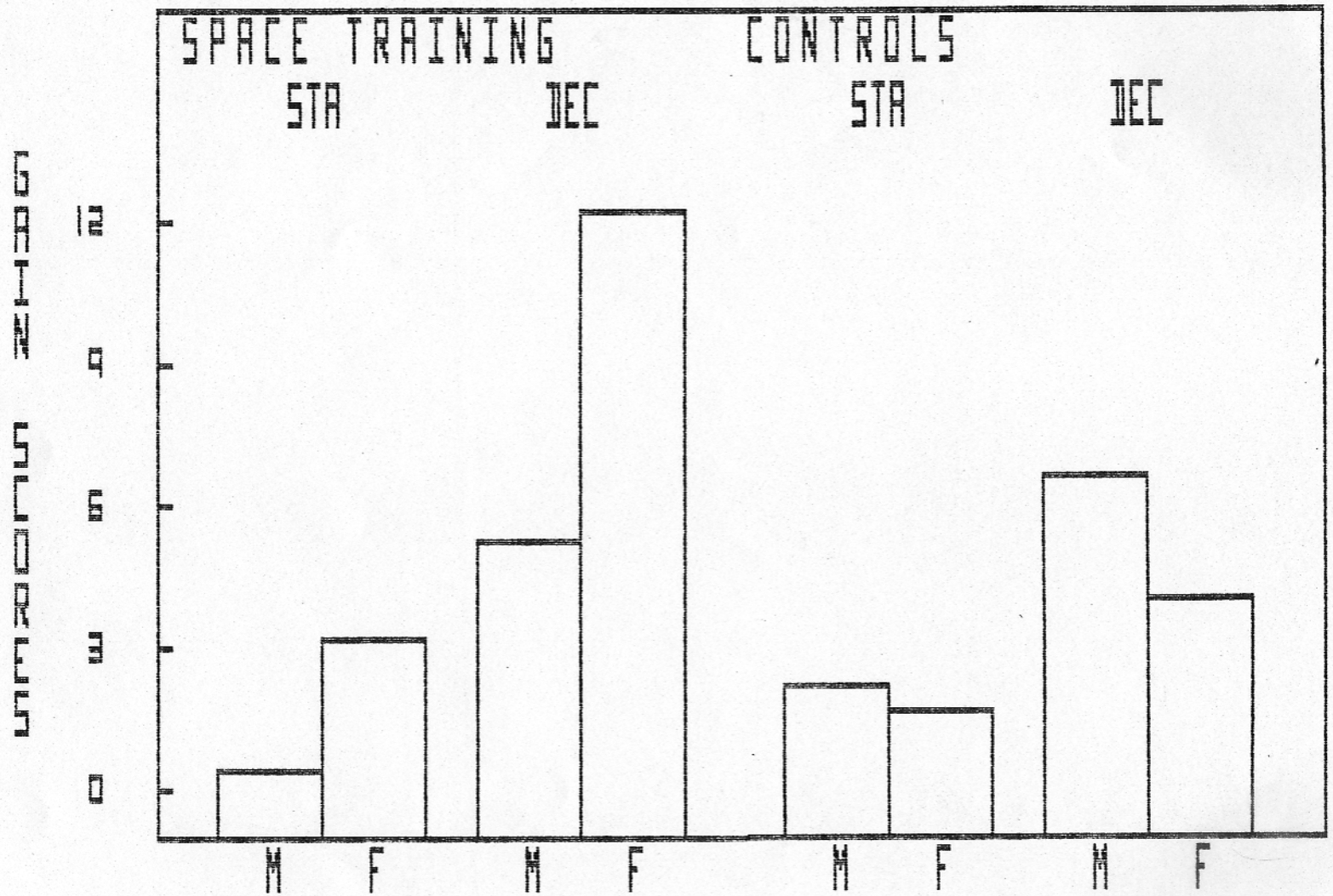
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FIGURE 3

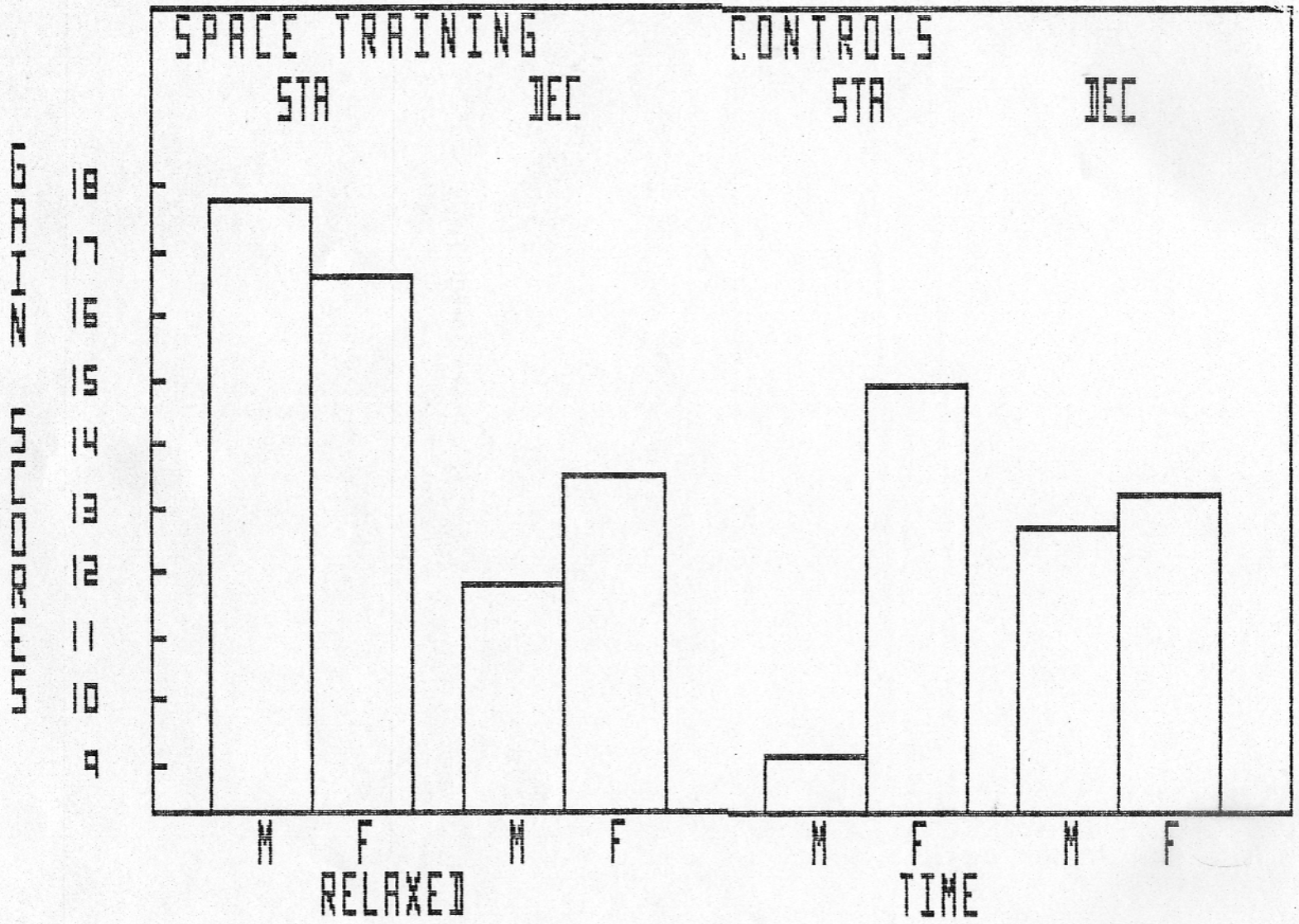
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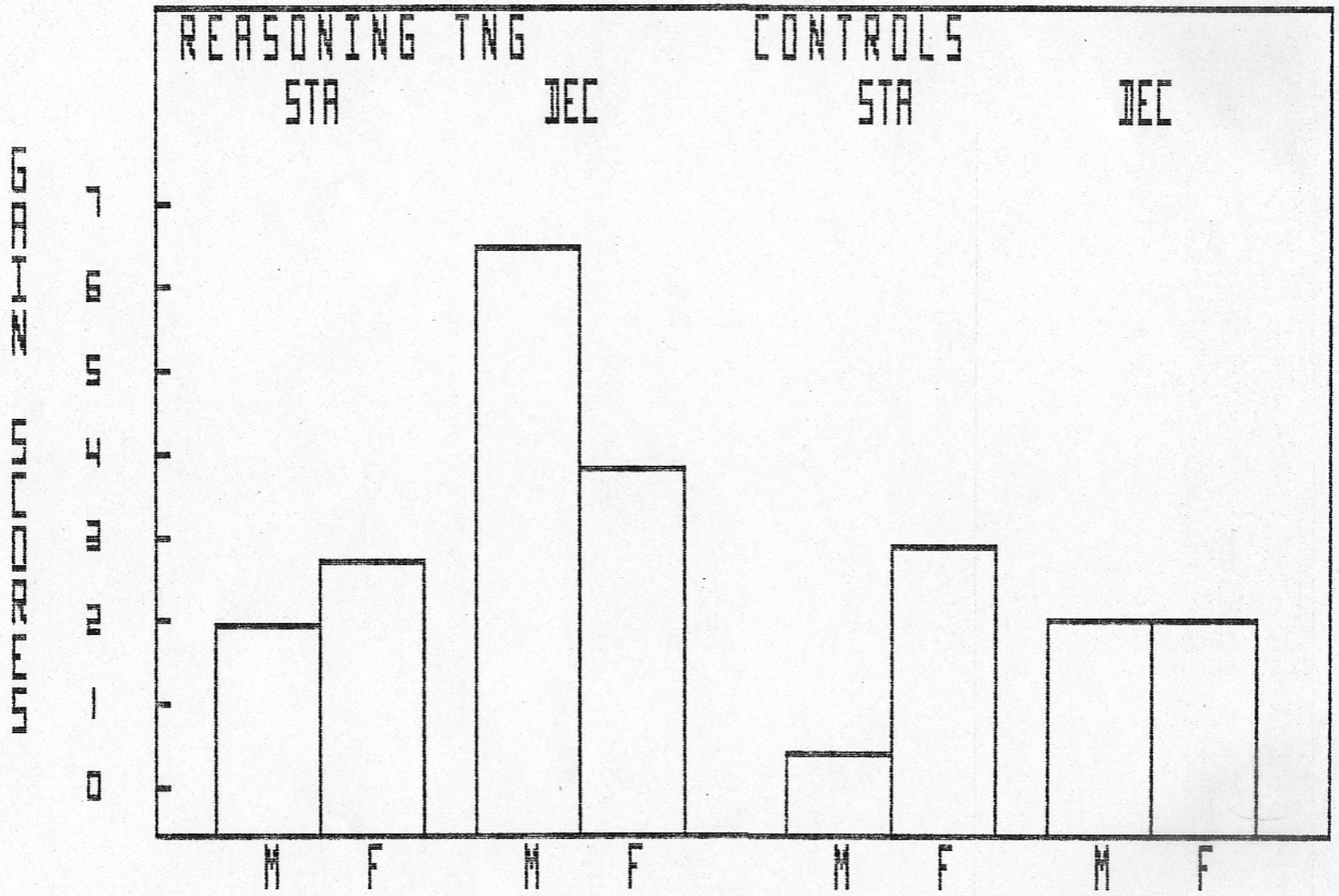
FIGURE 4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