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AUTHOR Hines, Dwight; Martindale, Colin
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ABSTRACT

Thirty-two males were divided into high and low creative groups based on the Remote Associates Test and the Alternative Uses Tests. High creatives exhibited a lower basal alpha index, a higher basal theta index, differential amounts of alpha on creativity and intelligence tests, and were better at alpha control in a feedback situation than low creatives. (Author)

Creativity and the Operant Control of the Alpha Rhythm

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Dwight Hines and Colin Martindale

University of Maine

Abstract

Thirty-two males were divided into high and low creative groups based on the Remote Associates Test and the Alternate Uses Test. High creatives exhibited a lower basal alpha index, a higher basal theta index, differential amounts of alpha on creativity and intelligence tests, and were better at alpha control in a feedback situation than low creatives.

Key words: creativity, cortical activation, intelligence, brainwaves, operant control.

Several theories have been proposed which indicate that creativity is correlated with specific brain wave frequencies. Martindale (1969, 1972, in press) proposed that creativity is associated with variability in state of consciousness, which he paralleled with variability of cortical arousal as measured by EEG activity (beta waves correspond to high cortical activation, alpha waves to low cortical arousal). High creatives in Martindale's model are characterized by more access to low and high levels of activation or in Freudian terms, more access to primary and secondary process thought. Fischer (1969) associates creativity with beta waves and Green (1970) argues that it should be associated with theta waves. Recent reports in the popular press have emphasized the alpha wave as a mediator of creativity. However, Martindale and Armstrong (in press) found that high creatives actually possess a lower basal alpha index, and are better at alpha suppression as opposed to enhancement than low creatives.

In an attempt to replicate and extend the findings of Martindale and Armstrong (in press), the following questions were asked:

1) Do high and low creatives differ in alpha index under different baseline conditions (eyes open, eyes closed)?

2) Do high and low creatives differ in variability of the alpha index under different baseline conditions?

3) Do high and low creatives differ in the ability to focus differentially (as measured by the alpha index) during specific cognitive tasks?

4) Do high and low creatives differ in the ability to enhance

and suppress the presence of alpha during brainwave feedback?

Method

Subjects were thirty-two male students participating as a requirement for Introductory Psychology.

Raw EEG signals were picked up at positions 0_2-P_4 (occipital-parietal placements--International 10-20 system), amplified 200,000 times by a Grass P-511 amplifier, filtered through a Kron-Hite Model 3700 band pass filter (set at 8 and 13 Hz with an attenuation slope of 24 decibels per octave), and then rectified. The rectified signal was monitored by a level slicer set to operate when the voltage was in the desired frequency range. The level slicer output was fed to appropriate logic so that counts of amount of time in alpha during each 50 second period during the experiment were obtained on a counter.

Subjects were required to participate in two separate sessions. During the first session, basal alpha was recorded for ten minutes with eyes closed. Alpha activity was then monitored while they were given the Remote Associates Test (RAT), the Alternate Uses Test, and the IPAT Culture Fair Test (all tests were given in counterbalanced orders). During the second session, five minutes of basal alpha and five minutes of basal theta were recorded with eyes open. Subjects were then given five minutes of practice tone (900 Hz) which was activated by the presence of alpha and were told to determine what they did mentally to make the tone go on and off. Ten trials (100 seconds per trial) followed: five to keep the tone on alternating with five to keep the tone off. The conditions, tone off or tone on, were signalled to the subject via a red and a green light respectively.

Results

The analyses of variance reported below were performed on log transformed scores; however, for graphic purposes, these have been converted back to the original scores. The analyses of variance were performed on subjects first split into high and low Uses scorers and then split into high and low RAT scorers. There were eight subjects in each of the four resultant groups.

Creativity tended to correlate with amount of basal theta but not significantly. Figure 1 shows the differences in basal alpha between high and low creatives (based on Uses score) in the eyes

Insert Figure 1

closed and eyes open condition. High creatives had less basal alpha than low creatives: $\underline{F} = 2.96$ ($\underline{p} < .10$, $\underline{df} = 1, 28$).

As a measure of variability, we computed the intra-subject standard deviation based on the separate counts of time-in-alpha for each subject during the basal measures. As may be seen in Figure 2, high scorers on the Uses Test were found to have more variability in the eyes closed condition. The opposite pattern was found in low creatives: $F = 4.37$ ($p < .05$, $df = 1, 28$) for the Uses x basal condition interaction. No significant differences were found in basal alpha or in variability when subjects were divided on the basis of the RAT.

Across all tests, high scorers on the Uses Test tended to operate at a high percentage of basal alpha during the tests, while high RAT scorers tended to operate at a lower percent of basal alpha during tests (See Figures 3 and 4). The correlation between Uses Score

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Insert Figure 3

Insert Figure 4

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and percent of basal alpha during all tests was $r_s = .32$ ($p < .05$, $N = 32$). The correlation between the RAT and percent of basal alpha during all tests was $r_s = -.24$ ($p < .10$, $N = 32$). The amount of percent of basal alpha during tests decreases as we move from Uses to RAT to IPAT for all subjects: $F = 3.09$ ($p < .10$, $df = 2,56$). Dividing the subjects into high and low RAT scorers and looking at percent of basal during tests we find that high RAT scorers do focus differentially as a function of cognitive task while low RAT scorers do not: $F = 3.74$ ($p < .05$, $df = 2, 56$) for the RAT x tests interaction. High RAT scorers operate at the highest percentage of basal alpha on the Uses test, at the lowest on the IPAT, and at an intermediate percentage on the RAT.

There was not a significant creativity effect for the Feedback condition. However, there was a significant difference in the amount of alpha if subjects were told to keep the tone on or off: $F = 21.28$ ($p < .01$, $df = 1, 28$). In addition, the amount of alpha over trials increased regardless of instruction: $F = 2.46$ ($p < .10$, $df = 4, 112$). Looking at the instructions x trials interaction, the amount of alpha increased over on trials but did not decrease over off trials: $F = 2.61$ ($p < .05$, $df = 4, 112$). Low Uses scorers enhanced alpha over on trials but High Uses scorers did not: $F = 2.53$ ($p < .10$, $df = 4, 112$) for the Uses x instructions x trials interaction. However if we examine partial correlations, controlling for amount of basal alpha, between RAT and Uses and mean amount of alpha during on and off trials we find that the RAT is correlated with ability to suppress alpha and the Uses test with ability to enhance it. The partial correlation between RAT and alpha during off trial is -.32 ($p < .05$) while the analogous correlation between the Uses and alpha during on trials is .27 ($p < .10$).

Considering only extreme scorers (obtained by summing the ranks of the Uses and the RAT to yield a composite creativity score [CCS] and dividing into upper and lower quartiles), we find that high creatives can control alpha better than low creatives: $F = 3.99$ ($p < .10$, $df = 1, 14$) for the instructions x creativity interaction. This difference is due mainly to their ability to suppress alpha (see Fig. 5).

Insert Figure 5

Discussion

The earlier findings that high creatives have a lower basal alpha index (Martindale and Armstrong, in press) and are better at alpha suppression than low creatives were replicated. In addition, high creatives as measured by the Uses test were found to be more variable in basal alpha during the eyes closed than the eyes open conditions. This suggests that high creatives do exhibit a greater fluctuation in cortical activation than low creatives.

The ability of high creatives as measured by the RAT to focus differentially on different cognitive tasks implies that high creatives have greater access to different modes of processing information. If we equate amount of alpha with breadth of focus of attention, the finding makes a good deal of theoretical sense. High RAT scorers have most alpha on the Uses test, an intermediate amount on the RAT, and least on the IPAT. Theoretically, (Martindale and Armstrong, in press; Martindale and Greenough, in press) creative activity requires broad, unfocussed attention and intellectual functioning requires more narrowly focussed attention. The Uses test is a relatively pure measure of creativity since it shows no correlation with measures of intelligence while the RAT has consistently shown fairly substantial correlations with intelligence tests (Wallach, 1970). Thus, especially for high RAT scorers, the more a test calls for intellectual as opposed to creative functioning, the less alpha subjects exhibit while taking the test, hypothetically because of increasing focussing of attention. The finding that alpha may be due to focusing of eye muscles (Mulholland & Peper, 1970), leads us to believe that alpha might be viewed as an indication of an individual's ability to focus inward, in contrast to attending to external cues. This internal focusing would seem to be under better control in high creatives than in low creatives.

References

Fischer, R. On creative, psychotic, and ecstatic states. In I. Jakab (Ed.), Psychiatry and Art, Vol. 2. New York: Karger, 1969.

Green, E.E., Green, A.M., Walters, E.D. Voluntary control of internal states: Psychological and physiological. Journal of Transpersonal Psychology, 1970, 2, 1-26.

Martindale, C. The psychology of literary change. Unpublished doctoral dissertation, Harvard University, 1969.

Martindale, C. Femininity, alienation, and arousal in the creative personality. Psychology, 1972, 9, 3-15.

Martindale, C. and Armstrong, J. The relationship of creativity to cortical activation and its operant control. Journal of Genetic Psychology (in press).

Martindale, C. and Greenough, J. The differential effect of increased arousal on creative and intellectual performance. Journal of Genetic Psychology (in press).

Mednick, S.A. The associative basis of the creative process. Psychological Review, 1962, 69, 220-232.

Mulholland, T.B. and Peper, E. Occipital alpha and accommodative vergence, pursuit tracking, and fast eye movements. Psychophysiology, 1971, 8, 556-575.

Wallach, M.A. Creativity, In P.H. Mussen (Ed.), Manual of child psychology, Vol I. New York: Wiley, 1970.

Fig. 1. Basal alpha indices of high and low Uses scorers in eyes closed and eyes open conditions

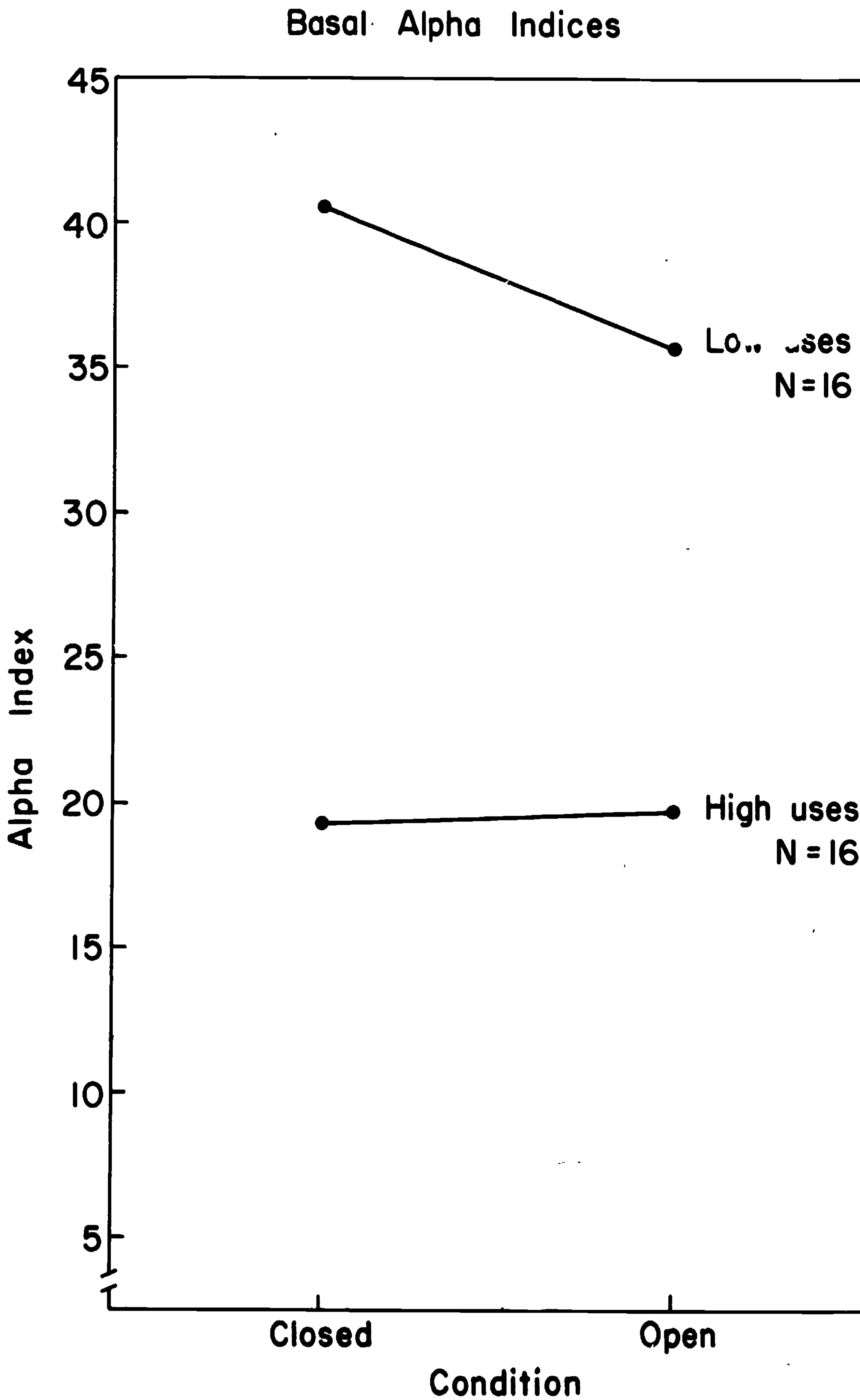

Basal Alpha Indices
45
40
35
30
25
20
15
10
5
Alpha Index
Lo.. .ses
N=16
High uses
N=16
Closed
Open
Condition

Fig. 2. Within-subject standard deviations of high and low Uses scorers in eyes closed and eyes open basal conditions.

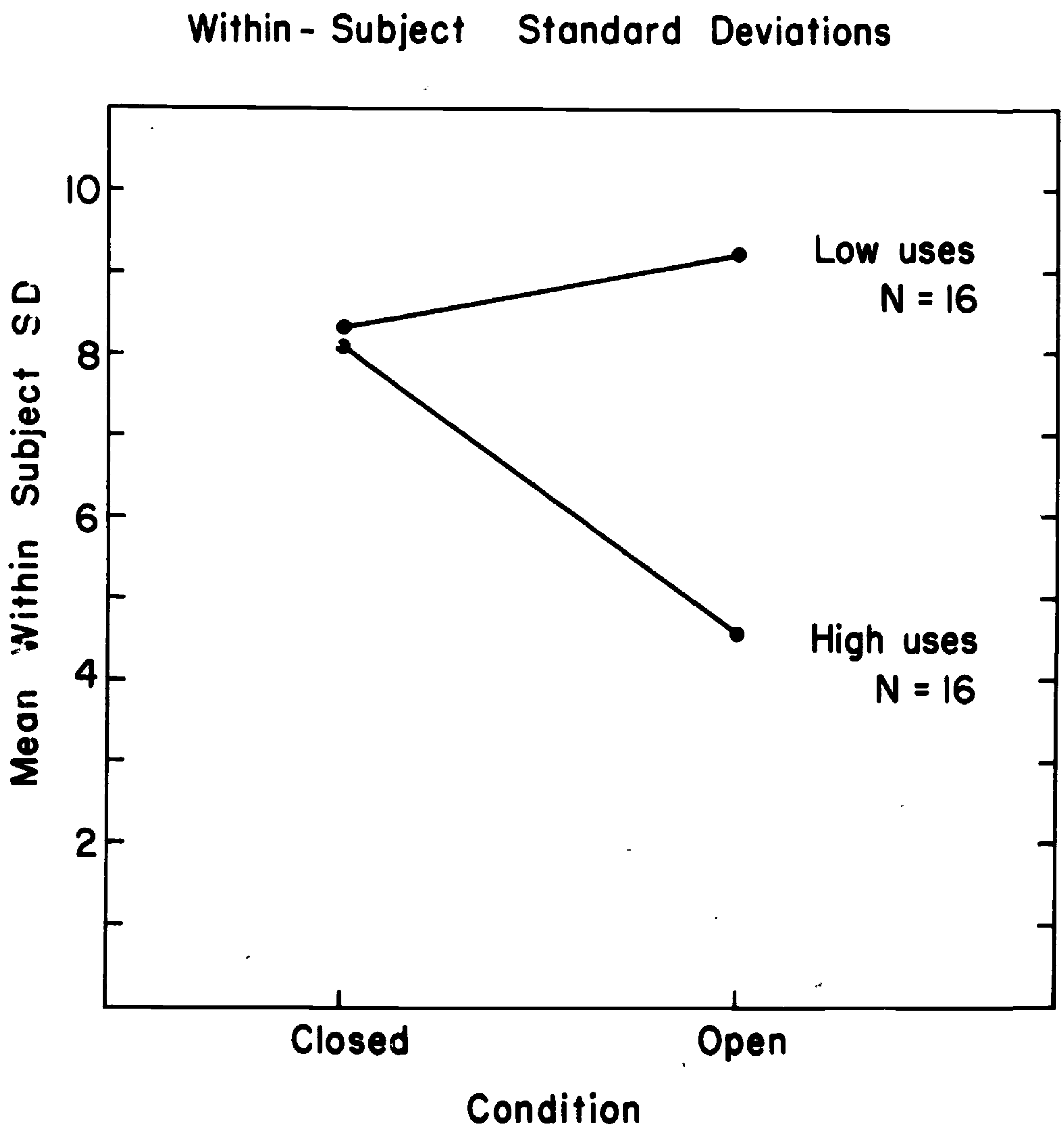

Within-Subject Standard Deviations
Mean Within Subject SD
10
8
6
4
2
Low uses
N = 16
High uses
N = 16
Closed
Open
Condition

Fig. 3. Percent of basal alpha during tests.

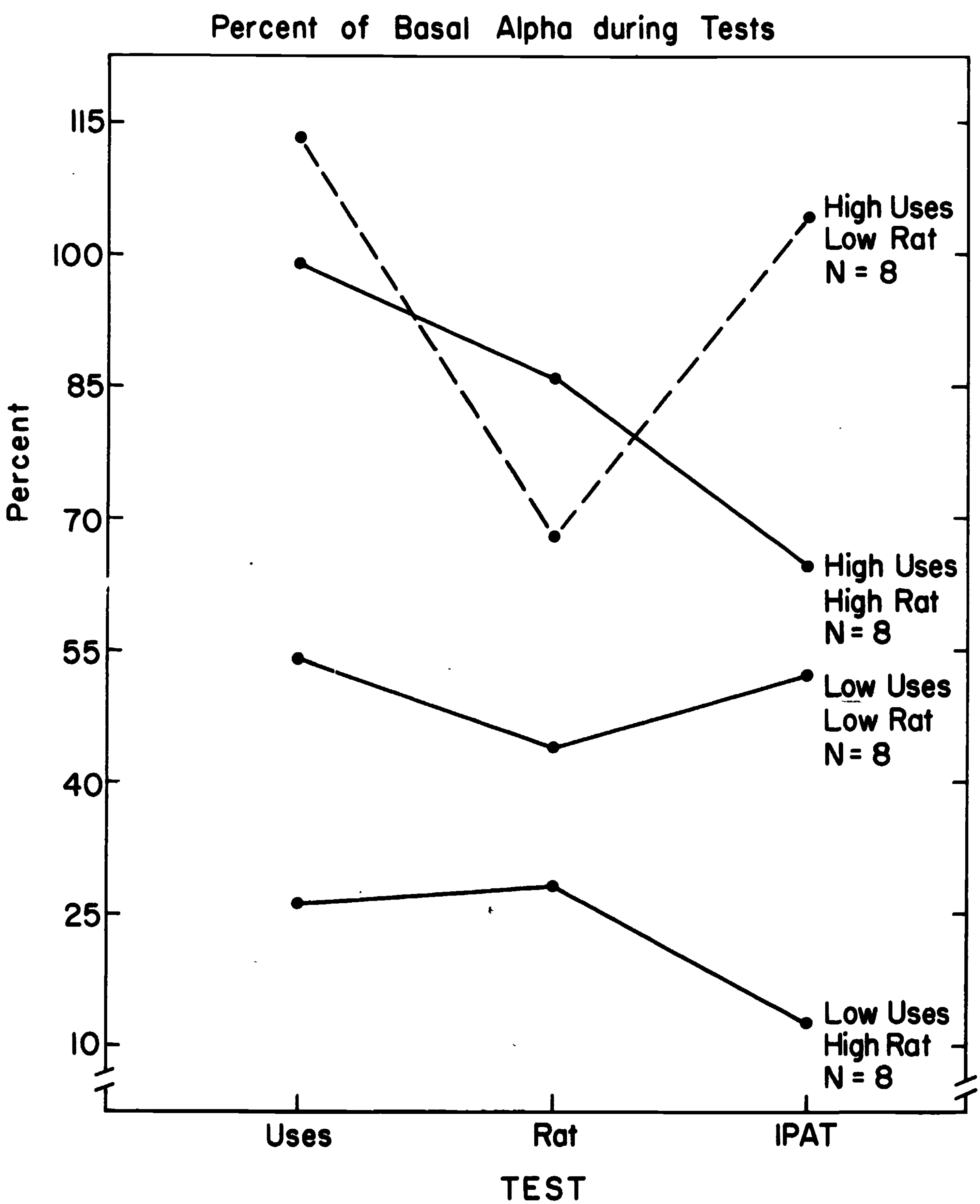

Percent of Basal Alpha during Tests
Percent
115
100
85
70
55
40
25
10
Uses
Rat
IPAT
TEST
High Uses
Low Rat
N = 8
High Uses
High Rat
N = 8
Low Uses
Low Rat
N = 8
Low Uses
High Rat
N = 8

Fig. 4. Percent of basal alpha during tests for high and low RAT scorers

Percent of Basal Alpha during Tests

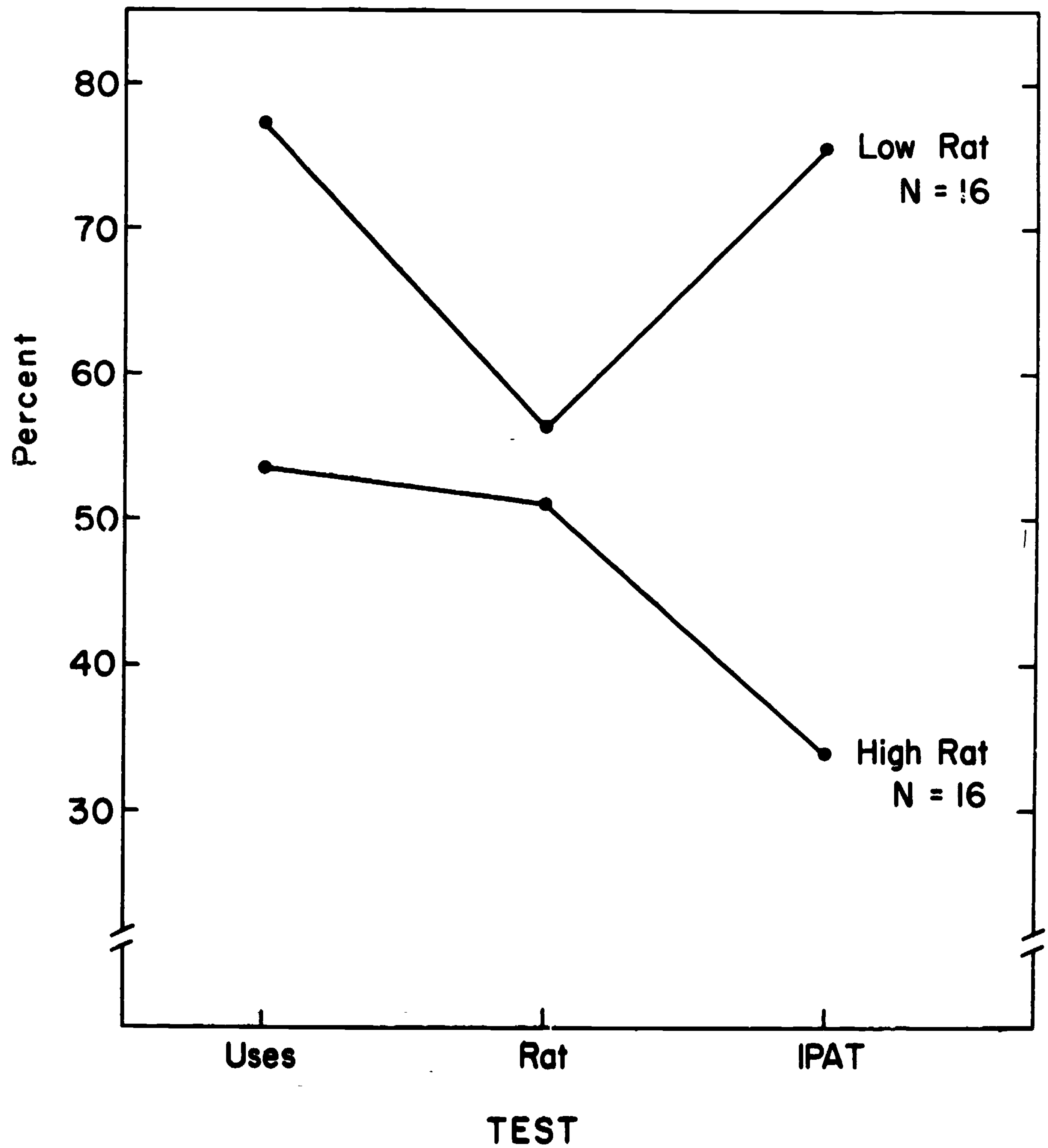
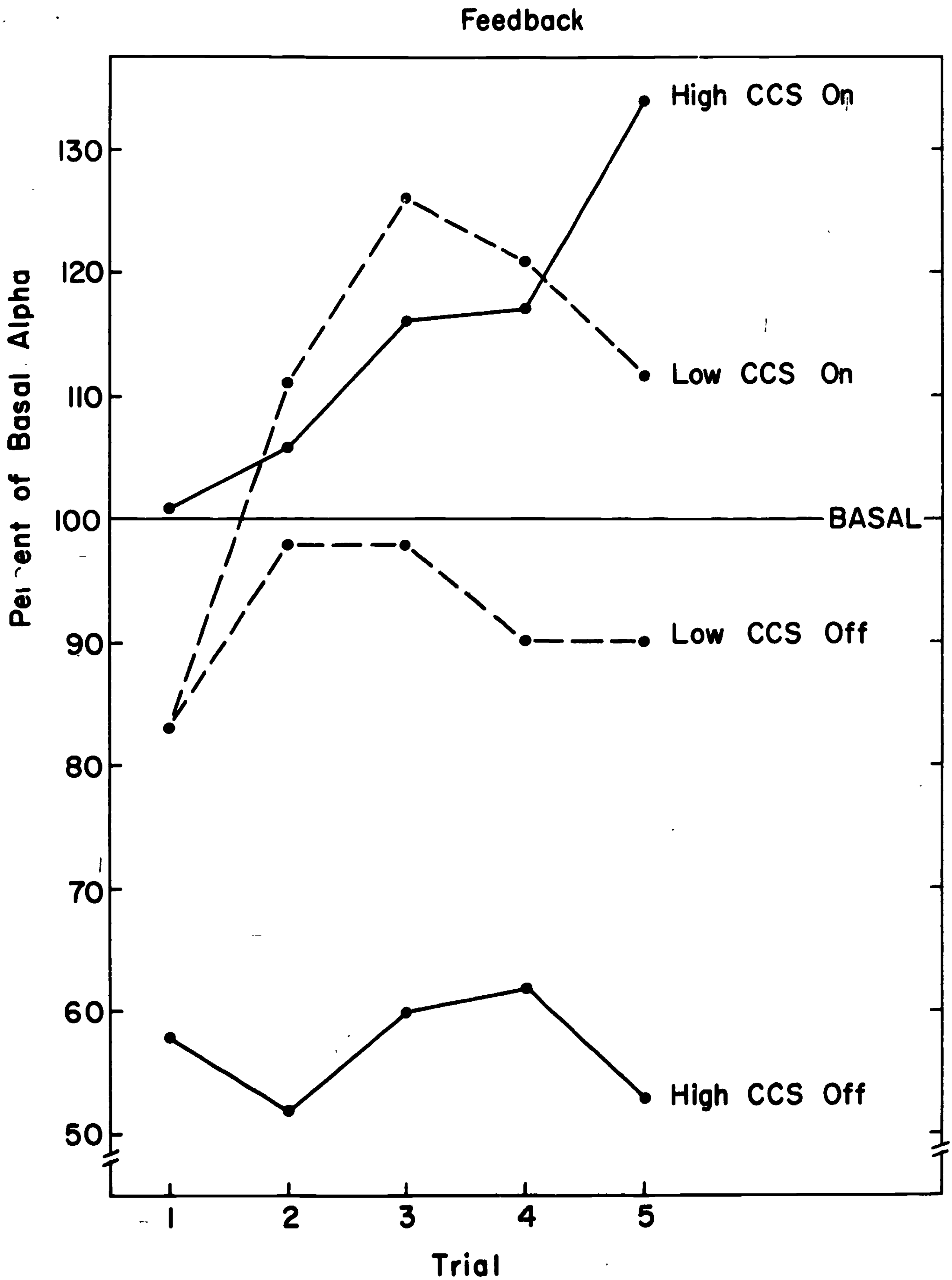


Fig. 5. Percent of basal alpha across on and off trials for high and low Composite Creativity Score quartiles.



Feedback
High CCS On
Low CCS On
BASAL
Low CCS Off
High CCS Off
130
120
110
100
90
80
70
60
50
1
2
3
4
5
Trial
Percent of Basal Alpha