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# Bisecting and behavior: Lateral inattention predicts 8-week academic performance

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**Abstract**

Converging evidence supports a left hemisphere role in defensive repression and sensation seeking. This led to the hypothesis that students with a relatively active left hemisphere would perform poorly during 8 weeks of a college class. The measure of relative hemispheric activation was the visual line-bisecting task given early in the course. The hypothesis was supported. Previous evidence that activation asymmetry is stable over time was supported because the single measurement of line bisecting was a longitudinal predictor of multiple behaviors. A temporal pattern of increasing correlation between the bisecting and performance measures favors a feedback repression model. Alternative explanations based on sensation seeking, subject-matter repression, and cooperation were considered but not eliminated. © 2002 Elsevier Science (USA). All rights reserved.

## 1. Introduction

Humans have a tendency to give preferential attention to pleasant over unpleasant information (Sedikides & Green, 2000; Skov & Sherman, 1986). This defensive repression involves regulatory processes that attempt to avoid the immediate experience of negative affect. Avoidance of uncongenial information and attention to congenial information is supportive of current beliefs and thus reduces the probability that a person will change.

Converging evidence shows that this self-enhancing cognitive style is stronger in persons whose left cerebral hemisphere is relatively more active than the right hemisphere. In one study, patients with lateral brain damage were given a card-sorting task during which the rules were changed without warning. Those with lesions such that only the left hemisphere remained intact were slow to notice the need to change. They retained their belief in the previous rule longer than did normal controls or other patients, even in the face of disconfirming evidence (Rausch, 1977).

This connection of a pattern of leftward brain activation with defensive repression has also been shown in healthy, intact individuals. Persons who have a repressive cognitive style are more likely to have relative left frontal activation as measured by electroencephalogram (EEG) (Tomarken & Davidson, 1994). Those results

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conceptually replicated research that showed that the left hemisphere is less attentive and reactive to stress and threat than is the right. For example, shyness is related to greater social anxiety and social restraint. Schmidt showed that self-identified shy individuals had relatively more active right frontal EEG (1999) than nonshy individuals. In other research, when threatening words were presented to normal subjects, they reacted more quickly to stimuli in their left visual hemispace, an indicator that these words caused greater right hemisphere activation (Van Strien & Heijt, 1995). Threatening faces produce the same effect (Jansari, Tranel, & Adolphs, 2000; Mogg & Bradley, 1999).

Defensive repression may boost self-esteem and enhance positive affect by ignoring or discounting negative information, but this self-serving cognitive style may be maladaptive in the long run (Robins & Beer, 2001; Tennen & Affleck, 1987). Especially in a learning situation, either or both of the following mechanisms may work to produce lower performance.

The first of these can occur with the rejection of unpleasant information to be learned. For example, in a college course there is often some material that seems unbelievable, that attacks one's conception of self or family, or that disagrees with current beliefs. When individuals were presented with both supportive and opposing arguments, those whose EEG indicated a greater activity in their left hemisphere reported a form of informational defensive repression (Cacioppo, Petty, & Quintanar, 1982). They said that they selectively attended to the agreeable arguments and paid less attention to statements with which they disagreed.

Goldberg and Costa (1981) also found a left hemisphere preference for the familiar and a right hemisphere preference for novelty. In an academic setting, the student who notices only what is already known or already preferred may ignore half of the material that will be on the next test. Even if a student is not engaged in selective attention, research has demonstrated that defensive repression mechanisms such as selective discounting of truth and relevance (Drake, 1993) and reduced recall of unpleasant information (Drake, 1991) become more prevalent during manipulated left hemisphere activation.

A second way that greater defensive repression may produce poor academic performance is through a motivational function. Successful repressors, who ignore, discount, or forget unpleasant information, will not know when things are going wrong. Even if they allow themselves to know, effective repressors will underestimate the importance of bad news. Tomarken and Davidson (1994) described defensive repressors as having attentional avoidance of threatening cues and an impaired memory for negative self-relevant feedback. These self-enhancing processes can become central to a lack of effort toward the academic task (Robins & Beer, 2001).

Another possible cause of poor academic performance is tonic sensation seeking. A college student must choose among competing activities such as reading, homework, class attendance, television, social events, participatory recreation, spectator sports, and so on. Research has shown that a preference for highly stimulating activities is associated with relatively greater left hemisphere activation. For example, in one study German medical students performed the line-bisecting task and completed Zuckerman's (1979) Sensation Seeking Scale. Those scoring higher on the scale made visual errors indicating a more active left hemisphere (Drake & Ulrich, 1992). Their higher scores represented a tendency toward being easily bored, having an attraction toward experimenting with drugs, and a liking for wild parties. These preferences do not necessarily exclude good academic performance, but in excess they may conflict with the time needed for learning.

Any one of these three mechanisms—subject-matter repression, feedback repression, or sensation seeking—is sufficient to predict weak academic performance. Because the empirical evidence finds each of these to be associated with left hemispheric relative activation, the research hypothesis is that students with greater left hemisphere activation as measured by visual line bisecting will perform less well than those with a more active right hemisphere.

## 2. Method

### 2.1. Participants

Participants were thirty-seven right-handed students (21 females) with a handedness score greater than +60. Their ages ranged from 18 to 24 years, with a mean of 19.7.

### 2.2. Measures

The measure of relative hemisphere activation was visual line bisecting. Originally designed to measure lateral inattention due to brain damage (Hjaltason & Tegner, 1997), it is frequently used with intact participants to measure the balance of activation between the two cerebral hemispheres (Bradshaw, Nathan, Nettleton, Wilson, & Pierson, 1987). Like EEG measures of lateral asymmetry of activation, it appears to be stable over time (Drake & Myers, 2002; Tomarken, Davidson, Wheeler, & Doss, 1992). Jewell and McCourt (2000) have provided a meta-analytic review of 73 studies of line bisecting.

Eight horizontal lines between 4 in. (10.16 cm) and 6 in. (15.24 cm) in length were presented on a single page, with their centers offset from a common center. The participants were asked to make a small mark through the center of each line, to divide it into two equal segments without measuring or folding. Respondents directed their gaze freely over the page, taking as long as they wanted, usually less than 1 min. Bisecting a line to the right of its true center represents more attention toward the smaller (right) line segment, a sign of relatively greater contralateral (left) activation. In other research using these stimuli, a Cronbach's $\alpha$ of. 75 was found (Carlstedt, 2002).

The measurement of academic performance was based on four routine measures from the course. Two of these measured in-class performance. In nearly every class there was a written quiz and several students were called upon by name and graded for their oral response. In about half of the 10 classes leading to a large exam there was a short typed assignment due. For those who missed a class, alternative assignments were available to earn points. The scores earned for these tasks were part of the normal course, and comprised approximately 25% of the grade for the first 8 weeks.

There were two 50-question multiple-choice exams, given during the 11th and 22nd class periods. Together they accounted for 75% of the 8-week (midterm) grade.

### 2.3. Procedure

Near the end of the fourth class period students in two introductory psychology courses were invited to leave early if they wished or to stay to participate in a research project. Each read and signed an informed consent that was approved by the Institutional Review Board for Human Research. They then spent about 10 min completing a personality inventory, bisecting eight horizontal lines, and filling out the Edinburgh Handedness Inventory (Oldfield, 1971; Ransil & Schacter, 1994).

As part of their informed consent, the participants agreed that their course performance could be used as part of this research. At no time were they identified or treated differently from other students. The course met three times per week for 50 min each session.

## 3. Results

The direction and extent of errors from the true center of each line were measured to the nearest 32nd of an inch (0.79 mm) with a ruler. The mean error was +1.12 mm right of the true center with a standard deviation of 14.17. Each participant was assigned an Index score based on a ratio of the frequency of rightward to leftward errors using the formula $100 \times (R - L)/(R + L)$. The index scores varied from −100 to +100 with a mean of +7 and standard deviation of 63. Positive numbers indicated rightward errors, representing a relatively more active left hemisphere. There were no significant gender differences for either the bisecting measure or class performance.

The long-term behavior of interest was academic performance during an 8-week period. This was measured by the points earned in the course toward the midterm grade. Because of different possible points in the two classes, a standardized score was calculated for each student, $z =$ (score−mean)/*SD*, based on scores within that class. The standardized midterm score correlated significantly with the index measure of line bisecting, $r(28) = -.49,\ p < .01$. This relationship, represented in Fig. 1, was the result of higher midterm scores for those students who had made more line bisecting errors to the left of the true center of the line.

A further analysis was performed by an ANOVA of the standardized midterm scores as a function of line bisecting index scores blocked into thirds. As shown in Fig. 2, the means were respectively +.54, +.17, and −.50 for participants who made leftward, middle, and rightward bisecting errors. These means were significantly different from each other $[F(2, 27) = 3.52,\ p < .05]$. A Tukey HSD comparison of means showed that only the leftward and rightward groups differed significantly from each other at the. 05 level. Please see Fig. 2.

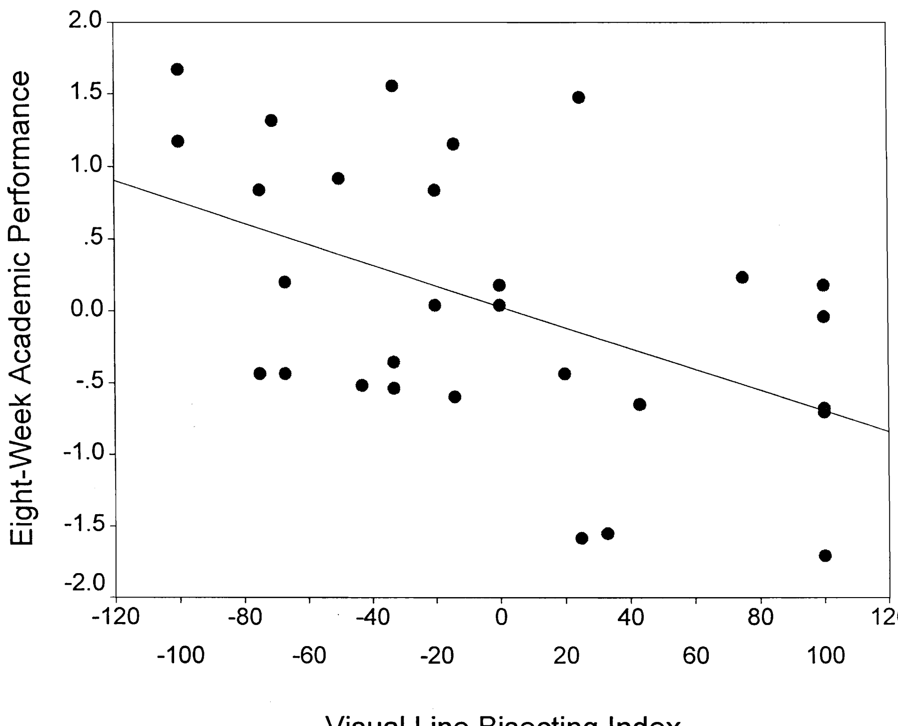


Fig. 1. Scatterplot of 8-week academic standardized performance scores as a function of the visual line-bisecting index.

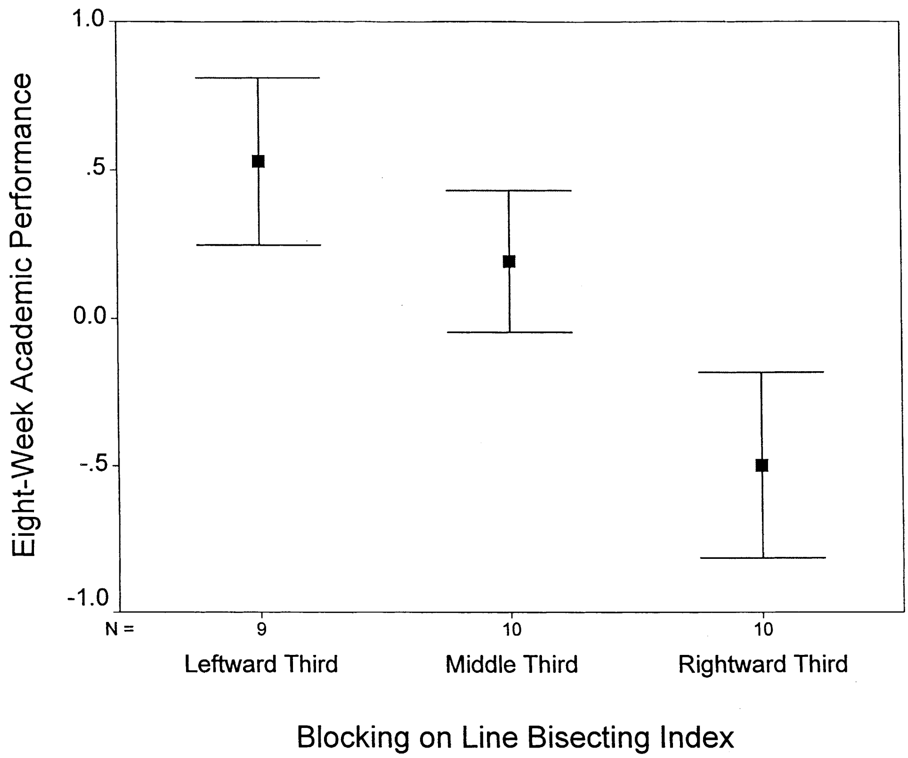


Fig. 2. Means and standard deviations of 8-week academic standardized performance scores based on statistical blocking on the visual line-bisecting index.

The midterm score was the sum of graded homework and quizzes in 20 classes plus the points earned in two scheduled examinations. As seen in Table 1, the line bisecting measure did not significantly predict the earlier (first 10 classes and Exam 1) components of the midterm grade. The planned comparison of the original hypothesis, that 8-week performance to the middle of the academic term would be predicted by the visual bisecting measure, was supported. In addition, both of the latter two components of the score were significantly correlated with visual line bisecting.

Eight weeks of academic performance was preselected as the behavior of interest based on a judgment that there would be adequate academic performance behavior by then to allow a powerful test of the research hypothesis. An additional consideration was to leave enough time for educational feedback to the students about the hypothesis and the results. An informal look at the remainder of the term suggested that missed examinations and withdrawal from the course by those with lower grades

Table 1
Correlation between measures of academic performance and the Index measure of visual line bisecting

| | *n* | *r* | *p* |
|---|---|---|---|
| Classes 1 to 10 | 37 | .27 | n.s. |
| Exam 1 | 36 | −.29 | n.s. |
| Classes 12 to 21 | 35 | −.41 | <.02 |
| Exam 2 | 31 | −.36 | <.05 |
| Total (Midterm) | 30 | −.49 | <.01 |

*Note.* The Index measure is negative when the line bisection error is made to the left of the true center of the line, reflecting a relatively more active right hemisphere. Therefore a negative correlation represents higher academic scores being associated with relative right hemisphere activation.

greatly reduced the statistical power of possible analyses due to fewer participants and restriction of range.

## 4. Discussion

The hypothesis was supported. In a between-subjects study, a relatively active left hemisphere was a significant predictor of lower academic performance for 8 weeks in an introductory psychology course. The results do not differentiate among subject-matter repression, feedback repression, or sensation-seeking models, from which the hypothesis was derived.

It is possible that all three mechanisms combined to create the observed effect. Students high in sensation seeking, who are likely to have a more active left hemisphere (Drake & Ulrich, 1992), may have begun the term with good intentions and then discovered a large number of highly stimulating distractions. This explanation is supported by the evidence that the points earned in classes 12 through 21 (see Table 1) were significantly negatively correlated with relative left hemisphere activation as measured by the visual line-bisecting task.

Students with a relatively more active left hemisphere may have used defensive repression to avoid learning unpleasant information from the course material and also to ignore, discount, or forget unpleasant feedback about their performance in the course. There is more support for the latter explanation because the strength of the predicted association between relative hemisphere activation and academic performance increased after feedback on course performance was given in Class 12, following the first examination.

The assumption of the stability of relative hemispheric activation was supported. The findings of stable prefrontal EEG asymmetry within subjects over time (Tomarken et al., 1992) were not studied by a test–retest method in this research. Instead a visual measure of asymmetry was made at one time, which served as a valid predictor of multiple academic behaviors over an 8-week period. This implies that the neurobiological substrate that influenced those behaviors was present during all or most of that time period.

An alternative explanation for the results of this study is offered by recent research on academic performance by Caprara, Barbaranelli, Pastorelli, Bandura, and Zimbardo (2000). They measured prosocial behavior in children in third grade and found it to be a positive predictor of academic performance 5 years later. Prosocial behavior was evaluated on the basis of ratings of cooperation, helping, sharing, and consoling. One of their explanations for these findings was that learning is a cooperative endeavor. Their results may provide an explanation for the present results because of earlier research showing that college students who made a stronger endorsement of the word *cooperative* to describe themselves were significantly more likely than others to make leftward errors in line bisecting, an indicator of a relatively more active right hemisphere (Drake & Myers, 2002).

### *4.1. Possible manipulation*

Several methods are available for the induction of relative hemisphere activation. One is biofeedback, which has been demonstrated to be effective for the voluntary control of the asymmetry of regional cerebral activation (Rosenfeld, Cha, Blair, & Gotlib, 1995; Schwartz, Davidson, & Pugash, 1976). It is unknown whether the control of selective activation learned in the laboratory can be applied to the classroom, studying, or doing assignments. A further problem is that Pulvermuller, Mohr, Schleichert, and Veit (2000) found that even in the laboratory they were able to successfully train only half of their participants in this task.

Another way to consciously manipulate relative hemisphere activation is with the induction of lateral attention. This method produces contralateral increases in direct measures of brain activity (Wright, Geffen, & Geffen, 1995). Predictable effects on functionally lateralized behaviors (Lempert & Kinsbourne, 1982) support these physiological findings. The induction of attentional orientation is effective whether the sensory modality is auditory, visual, or tactile (Bassel & Schiff, 2001). Most research has looked at the immediate effects of this manipulation, but of more practical use might be long-term strategies such as the chronic use of monaural earplugs (Green, 1983). Lack of parametric experiments on latency, duration, and habituation to the biofeedback and attentional manipulations leave open to empirical test the efficacy of these methods for selecting a neurobiological pattern of activation associated with better academic performance.

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