The effect of *Ginkgo biloba* on memory in healthy male volunteers

Patricia L. Moulton*, Leon N. Boyko, Joan L. Fitzpatrick, Thomas V. Petros

Department of Psychology, University of North Dakota, P.O. Box 8380, Grand Forks, ND 58203-8380, USA

Received 20 November 2000; received in revised form 26 March 2001; accepted 19 April 2001

Abstract

The purpose of this study was to investigate possible effects of *Ginkgo biloba*, a widely used herbal extract, on memory. This study incorporated a double-blind, placebo-controlled design, which used 30 healthy male subjects in each of two groups. The treatment group received two 60-mg tablets of BioGinkgo (LI 1370) daily for 5 days, while the placebo group received a placebo. On the fifth day, after a 2-h waiting period, all subjects were given the Sternberg Memory Scanning Test [Q. J. Exp. Psychol. 27 (1975) 1.], a reaction time control test, the vocabulary and digit span subtests of the WAIS-R [Wechsler D. Manual for the Wechsler adult intelligence scale — revised. New York: Psychological Corporation, 1981.], a reading span test [J. Verbal Learn. Verbal Behav. 19 (1980) 450.] and a prose recall test [Discourse Proc. 13 (1990) 387.]. Blood pressure, heart rate and side effects were also monitored throughout the study. Nonsignificant results were found on all interactions involving treatment group on all tests except the Sternberg Memory Scanning Test. The extract appeared to be safe but largely ineffective in enhancing memory. © 2001 Elsevier Science Inc. All rights reserved.

Keywords: *Ginkgo biloba*; LI 1370; Memory

1. Introduction

*Ginkgo biloba* is a herbal supplement derived from the leaves and nuts of the *Ginkgo* or maidenhair tree. The leaves of the *Ginkgo* tree were prescribed in China for medical problems and were mentioned in major Chinese medical texts dating back to 1436 AD during the Ming dynasty [14]. Currently, it is approved for use as a medication by the German Health Department for cerebral dysfunction, hearing loss and peripheral arterial circulatory disturbances [30]. There is also some evidence that *G. biloba* may have some neuroprotective properties [27]. Advertisements have claimed that *G. biloba* can enhance concentration, improve memory and relieve symptoms of Alzheimer’s disease. However, there is very little research to support these claims. Despite a lack of systematic research, sales of *G. biloba* continue to increase with US$240 billion of *G. biloba* products sold in the United States in 1997 alone [23].

*G. biloba* is marketed under two standardized extracts. The first developed was EGb 761, which contains 24% flavonoid glycosides and 6% terpene lactones. The second extract is labeled LI 1370, which contains 27% flavonoid glycosides and 7% terpene lactones. The first active ingredient is the flavonoid glycosides, which are thought to be responsible for its free radical scavenging abilities. Free radicals are metabolites that are released as a result of tissue trauma and other physiological reactions. These metabolites have been implicated in the degeneration of nerve tissue. The second active ingredient is the terpene lactones, which may serve to antagonize platelet-activating factor receptors. The platelet-activating factors activate clotting mechanisms and also may be associated with toxic increases of glutamate release and increases in intracellular calcium concentrations during trauma. By antagonizing these platelet-activating factors, *G. biloba* may help to protect the brain tissue from damage during trauma [27]. Also, the LI 1370 extract was chosen for the present study due to the increased amount of the active constituents of the *Ginkgo* extract [11].

Several studies have examined the impact of *G. biloba* on cognitive performance in subjects with Alzheimer’s disease or other types of dementia (e.g., Refs. [2,9,18,19]). These studies administered 120 mg of EGb 761 per day [18,19], 160 mg of EGb 761 per day, 240 mg of EGb 761 per day [9] or 50 drops of a *Ginkgo* extract per day [2]. The results of these studies are complex; but, in general, it was
found that administration of G. biloba led to an improvement of cognitive performance. One study [32] found no overall effects on outcome measures after administering either 240 mg EGB 761 per day or 160 mg EGB 761 per day for 24 weeks to older individuals with dementia or age-associated memory impairment.

Two recent studies have examined the effects of G. biloba on healthy middle-aged and older adults. Mix and Crews [21] administered either EGB 761 or a placebo daily for 6 weeks to male and female participants between 55 and 86 years of age. Neuropsychological functioning was assessed both prior to and after cessation of treatment with G. biloba. Significant improvement was found on the color-naming task of the Stroop Color and Word test and on subjective rating of memory abilities. No effect of G. biloba was observed on memory for short stories and memory for old). The extracts were given for 14 weeks with cognitive testing occurring at 0, 4, 8, 12 and 14 weeks. Significant improvement was found on an index of Memory Quality, which included long- and short-term memory tasks at the 12-week testing. The effects of the combination of extracts make this study difficult to compare with the other two studies on older adults. Very little research has been done with healthy, young participants in order to characterize the actions of the extract independently of disease states or the confounding effects of aging.

Three studies have examined the effects of the extract on EEG measurements of brain wave activity in healthy, young volunteers. Kunkel [16] administered 40, 80 and 160 mg of EGB 761 or a placebo to 12 healthy male volunteers. After 3 days of administration, five hourly EEG recordings were taken between 0800 and 1300 h. Twenty-five parameters of the EEG wave were computed, including total power, dominant frequency and whole spectrum difference. A significant difference between placebo and Ginkgo groups was found on 15 of 25 parameters. Kunkel concluded that the Ginkgo extract appeared to have a positive effect on EEG waves, but that a study examining event-related potentials would be a more sensitive measure.

In another EEG study, doses of 0, 120, 240 and 600 mg of EGB 761 were administered by Krauskopf (Schwabe Industries internal report as cited in Ref. [6]) to 12 healthy volunteers for 7 days. The 120-mg dose was found to increase the alpha spectrum in all areas except for the frontal lobe along with decreased beta-1 activity in the occipital areas. An increase of the alpha waves, which are associated with decreased mental activity and a decrease in the active beta waves, indicates that G. biloba may induce relaxation.

Itil and Martorano [11] compared three commercial preparations of G. biloba extract on 12 healthy male volunteers from 18 to 65 years of age. The extracts were all EGB 761 and included the brands Ginkgo Power (40 mg), Ginkgold (60 mg) and SuperGinkgo (40 mg) and were given once followed by an assessment of EEG at 1 and 3 h after the extract was given. Ginkgold showed the most increase in alpha wave activity after 1 h. However, at 3 h, SuperGinkgo demonstrated more of an increase in alpha wave activity than the other two extracts. The increase in alpha waves in both Itil and Martorano and in Krauskopf’s study suggests that G. biloba may increase relaxation.

Since the G. biloba extract has shown significant effects on brain wave activity, it would be interesting to examine its effects in cognitive functioning. Three studies have examined the acute effects of G. biloba, using cognitive tests in healthy volunteers. Subhan and Hindmarsh [31] examined the effects of Ginkgo with eight healthy female volunteers who were given one dose of G. biloba extract (either 0, 120, 240 or 600 mg) 1 h before testing. Several memory and performance measures were obtained including a critical flicker fusion test, a reaction time task, the Sternberg Memory Scanning Test and the LARS scale for perceived drug effects. Administration of Ginkgo enhanced the rate of memory scanning (Sternberg) only with a dose of 600 mg. No other effects of Ginkgo were observed.

Warot et al. [34] also examined the acute effects of a 600-mg dose of two different brands of G. biloba extract on
12 healthy female volunteers. Cognitive measures included critical flicker frequency, reaction time, a picture memory task, the Sternberg Memory Scanning task and subjective rating scales of drug effects. Testing of the participants occurred before administration of Ginkgo and again 1 h after administration. However, no effects of treatment with Ginkgo were found on the Sternberg task, but improvements in performance were found for the free picture recall task for one of the Ginkgo extracts. This study also incorporated the repeated-measures design with testing occurring at 1 h after dosing.

Kennedy et al. [12] also examined acute effects of 0, 120, 240 and 360 mg of G. biloba on measures of cognitive functioning using 18 female and 2 male volunteers. Measurements on a computerized cognitive assessment battery (Cognitive Drug Research, CDR, battery) were accessed at baseline, 1, 2.5, 4 and 6 h after dosing in a repeated-measures research design. The CDR battery accesses speed and accuracy of attention and the speed and quality of memory. Significant increased speed of performance was found on the attention tasks at the 240 and 360 mg doses of G. biloba and at 2.5, 4 and 6 h after dosing. Essentially, improvement was found on a highly skilled, automatic task involving the response to a stimuli by quickly pressing a key — a task which may reflect just an improvement in simple reaction time. This study also incorporated a repeated-measures task leaving open the possible confounding effect of practice.

Previous examination of the impact of G. biloba on cognitive performance in healthy, young volunteers is inconclusive due to many methodological concerns of these studies. Significant effects of the extract have been found for memory scanning [31], picture free recall [34] and on speed of performance on attention-related tasks [12]. However, these studies found these results using doses of 240 and 360 mg [12] or 600 mg [31,34], which are larger than the recommended daily dose (120 mg), placing participants at a higher risk for side effects and limiting the relevance of the results. In the present study, cognitive testing was done following 5 days of the recommended daily dose of the extract (120 mg).

Another concern surrounding these studies [12,31,34] is that they employed a repeated-measures design in which cognitive testing was given multiple times within the same day (five times [12]) or repeated cognitive testing for each subject across several different dosages in a within-subjects design (four dosages [31]; three dosages [34]). Repeated administrations of cognitive tests present a problem with interpretation regarding the potential for practice effects or for an interaction of practice with the effects of the G. biloba extract. The present study employed a between-subjects design in order to avoid this problem.

These studies [12,31,34] also examined only acute effects of the extract, performing cognitive testing within the same day. Previous studies have indicated significant effects on EEG measurements when the extract was administered for a longer period of time (e.g., 3 days [16]; 7 days [6]). Due to these studies, it is of interest to discover what the effects the extract may have in healthy volunteers over a longer period of dosing in order to potentially reach steady blood concentrations of the extract. The present study administered the extract for 5 days in order to test this.

Another potential limitation of the studies on the impact of G. biloba on cognitive performance in healthy, young volunteers is the fact that only female subjects were administered tests of cognitive function. Studies have shown that there are variations in memory across phases of the menstrual cycle [8,13]. None of these studies controlled for this potential problem by administering cognitive tests at a consistent time of month across female subjects. Also, the studies which demonstrated an effect on EEG waves [6,11,16] all used male subjects. The present study is the first study to examine cognitive effects in healthy, young male subjects.

Several tests of short-term memory were also used in the present study, including the Sternberg task, to provide a broad-based assessment. In addition, we examined the impact of administration of Ginkgo on prose memory, a task sensitive to the effects of vasopressin [3], caffeine [20] and alcohol [17,25].

2. Methods

2.1. Participants

This study incorporated a double-blind, placebo-controlled design with healthy male participants divided into two groups of 30. Male participants were used in order to exclude any confounding effect of the menstrual cycle with female participants. The participants were screened prior to starting the study and those participants who had a chronic health condition, hypertension, blood clotting disorders, drug and alcohol abuse problems, were regular smokers, had hypersensitivity to G. biloba or with recurring gastrointestinal problems were eliminated from the study. The Wahler Physical Symptom Inventory [33] was also given and those participants who reported experiencing headache, intestinal or stomach trouble, heart trouble, abnormal blood pressure, skin trouble, bowel trouble or chest pains at least once a week were also excluded from the study. In addition, those participants with blood pressure above 130/80 were dismissed.

2.2. Materials

The treatment group received two 60-mg tablets of BioGinkgo 27/7 (LI 1370) per day while the placebo group received identical tablets containing only fillers. Both the BioGinkgo and the placebo were donated by Pharmanex Inc. The dosage of 120 mg/day is the recommended daily amount listed in the PDR for BioGinkgo. The tablets were
The number of sentences in each set increased. Carpenter [4] was also administered. In the task, subjects were asked to read at their own rate sets of sentences and were asked to read one practice and four experimental stories from a computer at their own rate. Immediately after reading each story, subjects were asked to recall each story in as much detail as possible [24]. The digit span subtest of the WAIS-R [25] consisted of four, short expository stories with approximately 401–423 words in each. Two stories were of seventh to eighth grade Dale–Chall readability (easy passages) and two were of ninth to 10th grade Dale–Chall readability (difficult passages).

2.3. Procedure

The vocabulary subtest of the WAIS-R [35] was given on day 1. All of the participants received either G. biloba or placebo tablets for five consecutive days. All dosages were administered in our laboratory for all 5 days and the participants took the tablets in the presence of a trained research assistant. Dosages were given at the same time each day (± 1 h). Blood pressure and heart rate were assessed on each day of the study and participants were asked about side effects each day to monitor the safety of the treatment. On the fifth day, 2 h after receiving the dose of G. biloba or a placebo, a series of memory tests was administered. Nieder [22] found the half-life for the ginkgole component of the LI 1370 extract to be between 2 and 4 h and for this reason, testing was done after 2 h. Participants were asked to refrain from ingesting caffeine or nicotine for 2 h before the memory testing began. One memory test (Sternberg Memory Scanning Test) required subjects on each trial to memorize a set of two, four or six memory set. The prose memory task required subjects to read one practice and four experimental stories from a computer at their own rate. Immediately after reading each story, subjects were asked to recall each story in as much detail as possible [24]. The digit span subtest of the WAIS-R [35] was given according to standardized instructions. Finally, a reading span test introduced by Daneman and Carpenter [4] was also administered. In the task, subjects read at their own rate sets of sentences and were asked to recall in order of presentation the last word of each sentence. The number of sentences in each set increased. After testing, participants were debriefed and blood pressure taken. The participants were compensated with research extra credit to be used in their Psychology classes. One week after testing, the participants were called and asked if they had noticed any side effect or change in memory since treatment. This study was approved by the Institutional Review Board and informed consent was obtained from each participant prior to beginning the study.

2.4. Statistical analysis

Independent t tests were done on the demographic variables including age, year in college, vocabulary score and the use of multiple vitamins in order to determine any underlying difference between groups. Independent t tests were also used with the digit span and the reading span tests. Mixed analyses of variance (ANOVA) were used with the seven blood pressure and heart rate measurements. Mixed ANOVA was also used for the Sternberg Memory Scanning Test and the prose recall test. Any significant result in the ANOVA was followed by Tukey’s analysis.

3. Results

The average age, year in college, vocabulary score and the number of participants who used multiple vitamins are presented in Table 1. A series of independent sample t tests revealed no significant differences between groups on any of the measures.

Blood pressure and heart rate were measured daily during the study and a 2 (Group) × 7 (Time) mixed ANOVA was calculated separately for the systolic and diastolic components of blood pressure and also for heart rate. A significant main effect of day was found for systolic blood pressure [F(6,282) = 4.90, P < .01] and for heart rate [F(6,282) = 14.41, P < .01]. A subsequent Tukey’s analysis of this main effect revealed that systolic blood pressure was significantly higher on days 3 and 4 than on the day 5 pre-test measurement. The day 3 reading was also significantly greater than the day 5 post-test reading. A subsequent Tukey’s analysis of the main effect of heart rate revealed that heart rate for days 1 through 5 did not differ significantly, but all of these measures were significantly higher than day 5 pre- and post-test readings.

No side effects were reported by 86.7% of the participants. Of those who did report side effects, they included minor headaches, heartburn and indigestion. Twenty-five percent of the participants believed that they had received a placebo component of the LI 1370 extract to be between 2 and 4 h. One week after testing, the participants were called and asked if they had noticed any side effect or change in memory since treatment. This study was approved by the Institutional Review Board and informed consent was obtained from each participant prior to beginning the study. Independent t tests were done on the demographic variables including age, year in college, vocabulary score and the use of multiple vitamins in order to determine any underlying difference between groups. Independent t tests were also used with the digit span and the reading span tests. Mixed analyses of variance (ANOVA) were used with the seven blood pressure and heart rate measurements. Mixed ANOVA was also used for the Sternberg Memory Scanning Test and the prose recall test. Any significant result in the ANOVA was followed by Tukey’s analysis.

3. Results

The average age, year in college, vocabulary score and the number of participants who used multiple vitamins are presented in Table 1. A series of independent sample t tests revealed no significant differences between groups on any of the measures.

Blood pressure and heart rate were measured daily during the study and a 2 (Group) × 7 (Time) mixed ANOVA was calculated separately for the systolic and diastolic components of blood pressure and also for heart rate. A significant main effect of day was found for systolic blood pressure [F(6,282) = 4.90, P < .01] and for heart rate [F(6,282) = 14.41, P < .01]. A subsequent Tukey’s analysis of this main effect revealed that systolic blood pressure was significantly higher on days 3 and 4 than on the day 5 pre-test measurement. The day 3 reading was also significantly greater than the day 5 post-test reading. A subsequent Tukey’s analysis of the main effect of heart rate revealed that heart rate for days 1 through 5 did not differ significantly, but all of these measures were significantly higher than day 5 pre- and post-test readings.

No side effects were reported by 86.7% of the participants. Of those who did report side effects, they included minor headaches, heartburn and indigestion. Twenty-five percent of the participants believed that they had received a placebo component of the LI 1370 extract to be between 2 and 4 h. One week after testing, the participants were called and asked if they had noticed any side effect or change in memory since treatment. This study was approved by the Institutional Review Board and informed consent was obtained from each participant prior to beginning the study. Independent t tests were done on the demographic variables including age, year in college, vocabulary score and the use of multiple vitamins in order to determine any underlying difference between groups. Independent t tests were also used with the digit span and the reading span tests. Mixed analyses of variance (ANOVA) were used with the seven blood pressure and heart rate measurements. Mixed ANOVA was also used for the Sternberg Memory Scanning Test and the prose recall test. Any significant result in the ANOVA was followed by Tukey’s analysis.

3. Results

The average age, year in college, vocabulary score and the number of participants who used multiple vitamins are presented in Table 1. A series of independent sample t tests revealed no significant differences between groups on any of the measures.

Blood pressure and heart rate were measured daily during the study and a 2 (Group) × 7 (Time) mixed ANOVA was calculated separately for the systolic and diastolic components of blood pressure and also for heart rate. A significant main effect of day was found for systolic blood pressure [F(6,282) = 4.90, P < .01] and for heart rate [F(6,282) = 14.41, P < .01]. A subsequent Tukey’s analysis of this main effect revealed that systolic blood pressure was significantly higher on days 3 and 4 than on the day 5 pre-test measurement. The day 3 reading was also significantly greater than the day 5 post-test reading. A subsequent Tukey’s analysis of the main effect of heart rate revealed that heart rate for days 1 through 5 did not differ significantly, but all of these measures were significantly higher than day 5 pre- and post-test readings.

No side effects were reported by 86.7% of the participants. Of those who did report side effects, they included minor headaches, heartburn and indigestion. Twenty-five percent of the participants believed that they had received

### Table 1
Subject characteristics as a function of treatment group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ginkgo</th>
<th>Placebo</th>
<th>t</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>20.57 (1.89)</td>
<td>20.40 (1.77)</td>
<td>0.36</td>
<td>.72</td>
</tr>
<tr>
<td>Year in college</td>
<td>2.34 (1.17)</td>
<td>2.37 (1.16)</td>
<td>−0.07</td>
<td>.94</td>
</tr>
<tr>
<td>Vocabulary score</td>
<td>43.73 (8.31)</td>
<td>43.07 (7.04)</td>
<td>0.34</td>
<td>.74</td>
</tr>
<tr>
<td>Multivitamin use</td>
<td>1.87 (0.35)</td>
<td>1.83 (0.38)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digit forward</td>
<td>9.57 (2.06)</td>
<td>9.37 (2.01)</td>
<td>0.38</td>
<td>.71</td>
</tr>
<tr>
<td>Digit backward</td>
<td>8.93 (2.13)</td>
<td>7.87 (2.32)</td>
<td>1.86</td>
<td>.07</td>
</tr>
<tr>
<td>Reading span</td>
<td>3.00 (0.96)</td>
<td>3.30 (1.06)</td>
<td>−1.14</td>
<td>.26</td>
</tr>
</tbody>
</table>

Parentheses indicate standard deviations.

### Table 2
Sternberg Memory Scanning Test: mean response latency

<table>
<thead>
<tr>
<th>Group</th>
<th>Set size</th>
<th>Ginkgo</th>
<th>Placebo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>580.3 (175.5)</td>
<td>736.3 (255)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>572.0 (131)</td>
<td>695.6 (173)</td>
</tr>
</tbody>
</table>

Parentheses indicate standard deviations.
the G. biloba extract. Five percent of the participants reported seeing a difference in memory although two thirds of these participants actually received the placebo.

The reading span measure for each subject was the trial with at least two perfectly recalled sets of words (out of a possible three sets). The digit span raw scores were computed for each subject. No significant group differences were found on the reading span measure and the digit span forward test. The analysis of the digit span backward test approached conventional levels of significance (P<0.07) with a higher mean observed in the Ginkgo group relative to the placebo group (see Table 1).

The median response latency was computed for each set size by decision condition for every subject for the Sternberg Memory Scanning Test, and response times associated with errors were removed from these calculations. A 2 (Group) x 3 (Set Size) x 2 (Decision) mixed ANOVA conducted on these latencies revealed significant main effects of set size [F(2,116)=54.89, P<.01] and decision [F(1,58)=31.91, P<.01]. The main effect of decision indicated that positive decisions (M=706 ms) were significantly slower than negative decisions (M=783 ms). A subsequent analysis (Tukey’s) indicated that response latency significantly increased with each increase in memory set size, with mean latencies of 576, 715 and 853 ms for set sizes 2, 4 and 6, respectively. Error rates also increased significantly for positive decisions (M=0.07) as compared to negative decisions (M=0.04). Significant interactions of Group x Size [F(2,116)=4.46, P<.01], Size x Decision [F(2,116)=7.61, P<.01] and Group x Size x Decision [F(2,116)=3.40, P<.05] were found. A subsequent Tukey’s analysis of the three-way interaction indicated that for the positive decision, the Ginkgo group showed significantly fewer errors than the placebo group for set size two and no differences for set size four while the Ginkgo group had significantly more errors than the placebo group for set size six. No group differences in error rates were found for any set size for the negative decisions.

The mean response latency for the reaction time control test was computed for each participant on the task separately for each decision. Response latencies associated with errors were deleted from these computations. A 2 (Group) x 2 (Decision) mixed ANOVA computed on these data revealed no significant differences for the response latencies across groups.

Each recall protocol was scored blind for the presence or absence of the gist of each idea unit. A second rater independently scored (blind to condition) 10% of the recalls with a resulting agreement that ranged from 0.81 to 1.00 with an average of 0.92. Memory for each passage was expressed as the proportion of idea units recalled at each of three levels of importance. The mean recall as a function of group, difficulty and importance level is presented in Table 4. A 2 (Group) x 2 (Passage Difficulty) x 3 (Importance Level) mixed ANOVA revealed significant main effects of Passage Difficulty [F(1,57)=46.37, P<.01] and Importance Level [F(2,144)=333.53, P<.01] along with a significant interaction of Passage Difficulty x Importance Level [F(2,114)=20.69, P<.01]. Subsequent Tukey’s analysis indicated that for each level of passage difficulty, recall declined as a function of importance. However, the source

Table 3
Sternberg Memory Scanning Test: mean error rates as a function of decision and set size

<table>
<thead>
<tr>
<th>Decision type</th>
<th>Positive</th>
<th></th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Set size</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ginkgo</td>
<td>0.03 (0.05)</td>
<td>0.07 (0.06)</td>
<td>0.12 (0.11)</td>
</tr>
<tr>
<td>Placebo</td>
<td>0.06 (0.07)</td>
<td>0.07 (0.09)</td>
<td>0.08 (0.05)</td>
</tr>
</tbody>
</table>

Parentheses indicate standard deviations.

Table 4
Prose recall mean recall rates as a function of difficulty, importance level and group

<table>
<thead>
<tr>
<th>Difficulty</th>
<th>Easy</th>
<th></th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Importance level</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ginkgo</td>
<td>0.56 (0.11)</td>
<td>0.30 (0.12)</td>
<td>0.24 (0.08)</td>
</tr>
<tr>
<td>Placebo</td>
<td>0.54 (0.15)</td>
<td>0.32 (0.13)</td>
<td>0.26 (0.12)</td>
</tr>
</tbody>
</table>

Parentheses indicate standard deviations.
of the interaction was that recall of easy passages was significantly higher than difficult passages for idea units of medium and high importance but not low importance.

4. Discussion

A primary result of the present study is the complete absence of any effect of G. biloba on any of the memory measures. Although the digit span backwards results were in the predicted direction, G. biloba failed to significantly improve memory performance on any of the memory measures.

One possible reason for the absence of any Ginkgo effects is that the participants were young and healthy and that the enhancement of cognitive performance by the administration of Ginkgo may best be observed in participants where some cognitive decline would have occurred. In addition, it may be argued that no differences were found in the present study due to a “ceiling effect” on the cognitive tests because healthy, young volunteers were used. However, the results of several studies suggest that a “ceiling effect” is an unlikely explanation for the negative results observed in the present study. For example, significant improvements have been found on the Sternberg Memory Scanning Task for subjects who received 120 mg of Ginkgo. Although hourly administration of the Sternberg task complicates the interpretation of their findings, the results at 120 mg were observed nonetheless. The dose of G. biloba used in the present study (120 mg), in addition to being motivated by the above research, is also the recommended daily dosage suggested by the manufacturer of the Ginkgo extract used. Using the recommended dosage would allow a more realistic picture of the effects of the extract in the general population, which would allow a greater generalization of the results of this study.

However, clearly more empirical work is needed to examine the impact of G. biloba on cognitive function. The popularity of the extract dictates the need to systematically examine its effects in a controlled research environment to determine its impact on memory function. In addition, subsequent work will need to explore the effect of G. biloba on community dwelling elderly, for whom memory concerns are typical and for whom benefits of the extract might be the greatest.

References


