Rapid communication

Acta Neurobiol. Exp. 2000, 60: 511

Acute *Ginkgo biloba* facilitates decision-making in a working memory task in rats

W. Jeffrey Wilson, Julia A. Ogg and **Kami Z. Marsack**

Psychology Department, Albion College, 611 E. Porter St., Albion, MI, 49224 USA, Email: wjwilson@albion.edu

INTRODUCTION AND METHODS. Ginkgo improves memory in memory-impaired (2, 3, 6, 9, 14) and in healthy (5, 8, 10, 12, 13, 16) human and nonhuman subjects. In most studies (3, 5, 6, 8, 9, 10, 12, 16) ginkgo is administered chronically, but acute administration (2, 13, 14) also yields mnemonic improvement. Two human studies, examining P300 latencies (11) and the dual-coding of verbal and pictoral material (1), suggest that ginkgo accelerates decision-making. We examined decision-making speed and accuracy in a working memory task in rats following acute ginkgo administration. Ten 70- to 100-day old female Sprague-Dawley rats (Charles River Laboratories) were pair-housed in stainless steel cages on a reversed 12-h: 12-h light:dark cycle. Water was freely available; food was available 1-h daily, after the behavioral session. Rats were tested in the phi-maze (15), an automated T-maze with arms returning from choice point to start box, where 45-mg Noyes sucrose pellets were delivered as reinforcers. After rats were acclimated to the laboratory and magazine-trained (see 15 for details) daily continuous reinforcement sessions were conducted. A trial began when the door to the central alley opened, and ended with reinforcement when the rat returned to the start box *via* either arm. The next trial began 5 s later. CRF sessions continued until rats completed 40 trials in 30 min or less on 2 successive days. Spatial alternation sessions followed: after the first trial reinforcement occurred only if the rat returned to the start box *via* the arm not used on the prior trial. A session lasted until 40 alternations had occurred. After the first session, 1-s and 8-s delays were imposed between trials; each block of 4 trials contained two of each, randomly ordered. Ginkgo testing (*Ginkgo biloba* extract gelcaps: 40 mg ginkgo leaf extract, 9.6 mg flavone glycosides, plus soybean oil, gelatin, glycerin, water, yellow beeswax, lecithin oil; Nature Made, Mission Hills, CA, USA) began on the eighth spatial alternation session. Rats received three exposures each to 0, 1, and 2 gelcaps of ginkgo delivered according to individual random schedules, constrained such that no dose occurred three times in succession. Gelcap contents were squeezed onto dry cereal (Malt-O-Meal Honey Buzzers), which the rat consumed 30 min before the session. We measured accuracy of alternation, and latency to start a trial, run down the central alley, choose an arm, and return to the start box. Median latencies from each session were averaged across the three exposures to each dose for each rat. Data were analyzed *via* a nonparametric bootstrap procedure (4, 7).

RESULTS AND DISCUSSION. Accuracy of alternation with a 1-s delay (86%, 88%, 88% correct for Doses 0, 1, 2) was significantly better ($P<0.0001$) than with the 8-s delay (79%, 79%, 82%). Ginkgo's effect was not significant (0 v 1, $P=0.66$; 0 v 2, $P=0.30$); a longer, more difficult, delay might reveal ginkgo's facilitative effect. Start, Run, Choice, and Goal latencies were all reduced by the 8-s delay (all *P's*<0.003), perhaps reflecting frustration of delay. Ginkgo significantly reduced both latencies involving decisions: Choice time (1-s delay: 0.66 s, 0.60 s, 0.56 s; 8-s delay: 0.58 s, 0.53 s, 0.52 s; 0 v 1, $P=0.06$, 0 v 2: $P=0.01$), and Start time (1-s delay: 1.28 s, 1.08 s, 1.16 s; 8-s delay: 1.02 s, 0.92 s, 1.07 s; 0 v 1, $P=0.02$, 0 v 2, $P=0.64$). Run time and goal time, less reflective of decision processes, were not significantly affected by the ginkgo. Acute exposure to ginkgo reduced the time necessary for rats to make decisions, but did not increase the accuracy of the decisions. Thus in rats as in humans (1, 11) ginkgo can speed processing time. The mechanism responsible for this effect is as yet undetermined. (Supported by Albion College's Foundation for Undergraduate Research, Scholarship, and Creative Activity.)

1. Allain H., Raoul P., Lieury A., LeCoz F., Gandon J.M., d'Arbigny P. (1993) Clin. Ther. 15: 549-558.
2. Chopin P., Briley M. (1992) Psychopharmacology (Berl.) 106: 26-30.
3. Cohen-Salmon C., Venault P., Martin B., Raffalli-Sebille M. J., Barkats M., Clostre F., Pardon M.C., Christen Y., 4. Chapouthier G. (1997) J. Physiol. Paris 91: 291-300.
4. Efrom B. (1981) Biometrika 68: 589-599.
5. Gajewski A., Hensch S.A. (1999) Psychol. Rep. 84: 481-484.
6. Maurer K., Ihl R., Dierks T., Frolich L. (1997) J. Psychiatr. Res. 31: 645-655.
7. Péladeau N., Lacouture Y. (1993) Behav. Res. Methods Instr. Comp. 25: 410-413.
8. Petkov V.D., Kehayov R., Belcheva S., Konstantinova E., Petkov V.V., Getova D., Markovska V. (1993) Planta Med. 59: 106-114.
9. Rai G.S., Shovlin C., Wesnes K.A. (1991) Curr. Med. Res. Opin. 12: 350-355.
10. Rigney U., Kimber S., Hindmarch I. (1999) Phytother. Res. 13: 408-415.
11. Semlitsch H.V., Anderer P., Saletu B., Binder G.A., Decker K.A.. (1995) Pharmacopsychiatry 28: 134-142.
12. Stoll S., Scheuer K., Pohl O., Muller W.E. (1996) Pharmacopsychiatry 29:144-149.
13. Subhan Z., Hindmarch I. (1984) Int. J. Clin. Pharmacol. Res. 4:89-93.
14. Tadano T., Nakagawasai O., Tan-no K., Morikawa Y., Takahashi N., Kisara K. (1998) Am J. Chin. Med. 26: 127-132.
15. Wilson W.J. (1996) Behav. Res. Methods Inst. Comp. 28: 360-364.
16. Winter E. (1991) Pharmacol. Biochem. Behav. 38: 109-114.

Accepted 11 September 2000