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Psychological and Cardiovascular Effects of Guaraná and Yerba Mate: A Comparison with Coffee

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Abstract

An exploratory experiment was conducted to investigate the effects of coffee, guaraná, and yerba mate on mood and performance, and to determine any potential of these beverages to overcome the soporific effects of lunch. Seventy-one female students were assigned to four beverages, including a decaffeinated coffee control, and tested on two days (lunch/no lunch), over three sessions (prior to drinking the beverage, and again 60 and 150 minutes after drinking the beverages). Lunch had little effect other than to increase pulse. Guaraná increased systolic blood pressure and accuracy on a vigilance task; coffee increased accuracy on the vigilance task; but yerba mate had no significant effects. Further research is recommended before any definitive conclusions about the effects of guaraná and yerba mate are reached.
Keywords: Coffee; guaraná; yerba mate; performance.

Efectos Psicológicos y Cardiovasculares del Guaraná y de la Hierba Mate: Una Comparisión con el Café

Compendio

Se investigaron los efectos del café, guaraná y hierba mate en los estados de ánimo y funcionamiento mental, y también su potencial para aliviar los efectos soporíferos del almuerzo. Se distribuyeron estas tres bebidas citadas, además de café descafeinado, entre cuatro grupos de alumnas (N=71). Las participantes fueron controladas durante dos días (con/sin almuerzo), en tres sesiones respectivamente (antes de ingerir la bebida, y después, a los 60 y 150 minutos de su ingesta). El almuerzo no tuvo nigngún efecto importante, aparte de aumentar el pulso. El guaraná aumentó la tensión arterial sistólica; con el guaraná y el café ordinario se notó un incremento de la precisión en una prueba de vigilancia; sin embargo, la hierba mate no produjo ningún efecto. Siendo éste un experimento de carácter exploratorio, se recomienda realizar más estudios antes de llegar a conclusiones definitivas sobre los efectos del guaraná y la hierba mate.
Palabras clave: Café; guaraná; hierba mate; funcionamiento.

Caffeine, which occurs naturally in coffee and tea, is one of the xanthine stimulant drugs (Glanze, K. N. Anderson & L. E. Anderson, 1994). Although not fully understood, its action appears to inhibit the breakdown of neurotransmitters, so that neurons continue firing and maintain high central nervous system (CNS) arousal (Nehlig, Daval & Derby, 1992). This state of arousal is a common reason why people consume caffeine, most typically in the form of coffee. Extensive previous research has demonstrated the effects of caffeine-induced arousal on such cognitive activities as psychomotor vigilance and logical reasoning, as well as manual dexterity and subjective alertness (e.g., Bernstein et al., 1994; Brice & Smith, 2001; Smith, Rusted, Savory, Eaton-Williams & Hall, 1991; Van Dongen et al., 2001). For instance, caffeine tends to increase motor activity and speech rate, but reduce motor steadiness when taken by people who normally consume little or no coffee. It has also been suggested that caffeine improves the ability to maintain a person's focus of attention on a visual vigilance task, but reduces reaction times (Lamberg, 1999).

Most authors agree that small amounts of caffeine, such as two cups of coffee per day, do not affect healthy individuals adversely (Talalaj & Czechowicz, 1989). However, there is evidence that more than 600mg of caffeine per day may be hazardous for an adult of average height and weight (Gilbert, Marshman, Schwieder, & Berg, 1976). Given that a cup of coffee contains between 60-100mg of caffeine (Barrone & Roberts, 1996; Stavric et al., 1988) an adult consuming more than eight cups of average strength coffee per day could quite possibly show physical symptoms such as rapid pulse and breathing, nausea, diarrhea or muscle twitching, as well as nervousness, agitation, and confusion. Hence, those who suffer from hypertension, cardiovascular disease or anxiety may be advised to avoid caffeine (Lovallo et al., 2001; Upfal, 1991). To avoid caffeine, many people seek

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healthy alternatives to coffee and tea. Sometimes advocated for this purpose are the two South American herbs yerba mate (*ilex paraguarensis*) and guaraná (*paullinia cupana*). The central purpose of the present research was to investigate their effects, in the same way that those of caffeine have been studied, and to compare these beverages both with caffeine in its most familiar and popular form, namely coffee, and with a suitable control beverage.

Derived from the leaf of an evergreen tree in semi-tropical parts of Brazil and Argentina, yerba mate is promoted in the health food industry as a mild stimulant, which supposedly improves mood, psychomotor performance and concentration. Although reportedly harmless in moderate doses, it has been claimed that mate can cause insomnia, anxiety and increased heart rate with excessive use, and that it should be avoided by people with conditions such as peptic ulcer, hypertension, and tachycardia (Talalaj & Czechowicz, 1989). In addition, research suggests that yerba mate should be considered as one of the risk factors for oral and oropharyngeal cancer (Goldenberg, 2002).

Guaraná comes from the seeds of a vine native to the Amazon basin (Müller, 1996). Because the seeds are fatty and not readily water-soluble, guaraná is released slowly into the body and for this reason is commercially promoted as a powerful, long-acting stimulant, allegedly improving alertness and quickening perception (Mowrey, 1996). It is, however, claimed that exceeding the recommended dosage may induce insomnia, irritability, nervousness, palpitations and elevated blood pressure. As with caffeine and mate, individuals with high blood pressure or heart conditions are advised to avoid guaraná (Cannon, Cooke & McCarthy, 2001).

It is well established that the active ingredient in coffee is caffeine. There seems to be some confusion, however, whether guaraná and yerba mate contain actual caffeine, or only caffeine-like substances. Most advertising material reports that these herbs contain substances with similar chemical constituency to caffeine, referred to as mateine (Mowrey, n.d.), and guaranine ('Guaraná', n.d.), but that the active ingredient is not caffeine. Advocates of yerba mate claim that it is a natural stimulant, devoid of the side effects of caffeine (Mowrey, n.d.), and guaraná is similarly reported to have stimulant properties without the tension and stress associated with caffeine (Symmetry, n.d.). On the other hand, published scientific literature claims that yerba mate does contain caffeine, at a level (between one and two percent) comparable to that of coffee beans (Vazquez & Moyna, 1986). Guaraná is also reported to contain 3 to 5% percent caffeine by dry weight, which is two to three times as much as coffee beans (Weiner, 1990).

Previous Research on Yerba Mate and Guaraná

Research on the effects of yerba mate and guaraná is very limited. There have been studies of the mineral content (Vera-Garcia, Basualdo, Peralta, de Herebia & Caballero, 1997) and chemical composition (Vazquez & Moyna, 1986) of yerba mate, but we have found no scientific studies of its effects on cognitive performance, mood, or physiological functioning. We found only two scientific studies of the effects of guaraná on cognitive functioning. One concerned its immediate effects on young people (Galduroz & Carlini, 1994), and the other studied long-term effects on the elderly (Galduroz & Carlini, 1996). Because of its relevance to the present study, we now discuss the latter.

Galduroz and Carlini (1994) found no significant effects of guaraná on cognitive performance. A possible explanation is that their psychological tests may have been too insensitive to detect any changes. They used a battery of tests, including digit span, free recall, digit symbol, cancellation tests and the Mosaic Test (Lowenfeld, 1952), which, although designed to evaluate a range of cognitive aspects, do not measure sustained attention (for general information about these types of tests see Lezak, 1995). Given the reported effects of caffeine, the inclusion of a vigilance task would appear to be desirable in any such research.

Another possible explanation for their results is that a relatively low dosage of guaraná was used in their experiment: two capsules each containing 500mg of guaraná were administered. Each capsule contained 12.5mg of caffeine, so the total amount of caffeine (or guaranine) administered was only 25mg. The authors report that this quantity was based upon laboratory recommendations, but such an amount of caffeine would be so low as to have little, if any, effects.

A further consideration is that participants were tested only one hour after ingestion of guaraná. Given the claims of slow release properties, it is possible that any effects of guaraná would have been detected more easily later.

Effects of Lunch

It is known that alertness and cognitive performance often decline following consumption of lunch – so-called "post-lunch dip" (Smith & Kendrick, 1992; Smith & Miles, 1986). This impairment can be alleviated by administering caffeine after the meal (Smith, Brockman, Flynn, Maben, & Thomas, 1993; Smith, Rusted, Eaton-

Williams, Savory, & Leathwood, 1990). High doses of caffeine (3mg/kg of body weight) improve sustained attention and self-reported alertness, and are reported to increase systolic and diastolic blood pressure (Brice & Smith, 2001; Smith et al.., 1993, 1990). Effects are also found with smaller doses (Smith, Sturgess, & Gallagher, 1999) but they are less extensive. On a logical reasoning task, 1.5mg/kg of body weight dosage of caffeine improved accuracy but not speed, and participants receiving caffeine rated themselves more alert than controls. Thus, notwithstanding differences in the findings for the two dosage levels, even a low dose of caffeine can apparently improve mood and cognitive performance.

The Present Study

The first aim of this study was to investigate the effects of guaraná and yerba mate on cardiovascular functioning, mood, and cognitive performance. The second aim was to determine the potential of these herbal beverages to overcome post-lunch dip, in comparison with caffeine in coffee.

Given previous indications that high doses of caffeine are not necessary to eliminate post-lunch dip (Smith & Phillips, 1993), a dosage of 100mg of caffeine was used, approximately equivalent to one cup of brewed coffee or 1.5mg/kg for a 70kg person. It was hypothesised that coffee with caffeine would have a beneficial effect on mood and performance, reducing the post-lunch dip in alertness and sustained attention.

Owing to the limited previous psychological research on yerba mate and guaraná, this was an exploratory study. Thus, the only specific predictions made about these beverages were that they would have similar effects to those of a low dose of caffeine and that, unlike those of caffeine or mate, any effects of guaraná would still be detectable 150 minutes after ingestion because of its alleged slow release properties.

Although significant cardiovascular functioning effects from low doses of caffeine have not previously been reported (Smith & Phillips, 1993), given the known effects of higher levels of caffeine, it was hypothesised that coffee with caffeine would, if anything, increase blood pressure and pulse. We extended this prediction to yerba mate and guaraná.

Method

Design

The experiment had a between groups [4 (beverage: coffee with caffeine/ guaraná/ yerba mate/ control)] x 2 (meal condition: lunch/ no lunch) x 3 (test session: baseline/ 60min after beverage/ 150min after beverage) repeated measures design. Dependent variables were blood pressure and pulse readings, mood ratings, and the reaction times and number of correct responses on two performance tasks.

Participants

Seventy-one female participants, between 17 and 35 years of age (*M*=19.51 years, *SD*=3.50), were recruited from an introductory psychology course at the University of Tasmania, Australia. They volunteered for this study, as one of several alternative activities for which they could receive course credit, and they also obtained a standard free lunch as part of the experiment. Participants provided informed consent and were reassured that taking part in the study was entirely voluntary and that they could withdraw at any stage. The experiment was approved by the University of Tasmania Human Research Ethics Committee.

Participants initially completed a simple screening questionnaire designed to elicit information about habitual caffeine consumption, smoking habits, allergies, current medication, and medical conditions. Those who normally consumed more than 250mg of caffeine per day were excluded, as were any who typically smoked more than 50 cigarettes per day, since caffeine is more quickly eliminated from the body in smokers (Lieberman et al., 1987). Participants taking medication likely to alter their reaction time on the performance tasks, such as stimulants or depressants, were also excluded from participating in the experiement. In addition, participants suffering from diabetes, heart-related problems, peptic ulcer, epilepsy, or frequent migraine were excluded, as were those who were either pregnant or currently breast-feeding, in order to reduce the likelihood of any adverse health effects on the individual.

Instruments

The following substances were involved: decaffeinated coffee, *No Doz* caffeine tablets, *Nature's Own* guaraná capsules, and *Summit Health Products* yerba mate tea. An *Omron HEM-403C* digital monitor was used to measure blood pressure and pulse rate, and eighteen bipolar visual analogue rating scales (VASs) were used to assess mood (Herbert, Johns, & Dore, 1976). The performance tasks were a Logical Reasoning task (Baddeley, 1968), and a Repeated Numbers vigilance task (Smith & Miles 1986), and both were run using a 486 PC with a standard keyboard for response input and a monitor for stimulus presentation. The mood scales and performance tasks are described in detail below.

Eighteen bipolar visual analogue rating scales. Participants were required to indicate how they were feeling at each test session on 18 100 mm lines, each line anchored by two adjectives (e.g. 'alert' and 'drowsy' or 'energetic' and 'lethargic'). In order to prevent response stereotypy, these VASs were administered in a different order at each session. The ratings were recorded as the distance in millimeters from the left-hand pole to the participant's response.

A factor analysis of these 18 visual analogue rating scales reported by Herbert et al.. (1976) yielded two factors accounting for 72% of the variance. Factor 1, termed 'alertness,' accounted for 62% of the variance, with high loadings for the following scales: 'quick-witted'(0.878), 'alert' (0.865), 'attentive' (0.864), 'energetic' (0.856), and 'proficient' (0.826). In the present study, the ratings from the above scales were therefore summed to form a composite alertness score. The second factor identified by Herbert et al. was termed 'tranquillity'. Because it accounted for only 10% of the variance, this factor was not analysed in the present study.

Logical reasoning task. This task indexes working memory (Baddeley, 1968) and each trial involves the presentation of a short statement about the order of the letters A and B, followed by the letters AB or BA (e.g. "A follows B": BA). The participants were required to read each statement and indicate whether it truly described the letter-pair, pressing the T (true) or the F (false) key accordingly. The statements vary in complexity from active affirmative (e.g. "A follows B"), to passive negative (e.g. "A is not followed by B"). Fifty trials were involved, with a maximum trial duration of 10000 msec and a 1000 msec inter-trial interval. Reaction time and the number of correct responses were recorded.

Repeated numbers vigilance task. This task measures ability to sustain and focus attention (Smith & Miles, 1986). In the present experiment, the stimuli were 600 three digit numbers each displayed for 500 msec with an interstimulus interval of 500 msec. Normally each stimulus differed from its predecessor by only one digit, but in a randomly distributed 10% of instances all three digits were repeated. Participants were required to respond as quickly as possible to such repetitions by pressing the space bar. Reaction time and the number of correct hits were recorded.

Nature of the Lunch

The lunch consisted of a salad roll, a small tub of yogurt, a muesli bar and an orange fruit drink. Participants were allowed half an hour to eat the meal, before drinking one of the four experimental beverages.

Nature of the Beverages

As in numerous previous studies involving caffeine (e.g., Brice & Smith, 2001; Smith et al., 1990, 1991), decaffeinated coffee was used to mask the identity of the different beverages administered. Participants in the control condition received a 150 ml cup of decaffeinated coffee. For those in the coffee with caffeine condition, a *No Doz* tablet containing 100 mg of caffeine was added to a 150 ml cup of decaffeinated coffee. *No Doz* tablets were used in the present experiment, instead of caffeinated coffee, so that we could control the amount of caffeine ingested by the participants.

The manufacturers of *Nature's Own* guaraná claim that it is standardised to contain 40 mg of naturally occurring caffeine or guaranine per capsule and advice on the packaging recommends two capsules per day, equivalent to approximately one cup of coffee. In the present study, a dosage of two and a half capsules of guaraná (equivalent to 100 mg of caffeine) was adopted as a safe level for healthy adults, and equivalent to the caffeine content in the coffee with caffeine condition. As for that condition, the guaraná was added to a 150 ml cup of decaffeinated coffee.

Yerba mate tea and coffee beans are both reported to contain between one and two percent of caffeine ('The Yerba Mate Page', n.d.). In the mate condition, one tablespoon of yerba mate tea leaves (similar to the amount contained in a standard size tea-bag) were steeped in the decaffeinated coffee drink (using a tea leaf infuser) to extract its soluble constituents.

Each beverage had a slightly different, but coffee-like, taste, all were similar in appearance and participants were unaware of which condition they had been assigned to, or indeed of what all the conditions were.

Procedure

Participants were randomly assigned to one of the four beverage groups; coffee with caffeine (n=18), decaffeinated coffee (n=17), guarana (n=18), and yerba mate (n=18), and were tested on two separate days, one week apart. On one day participants received lunch, and on the other day they did not eat from the first session until completion of the day's testing. The order of the lunch and no-lunch conditions was counterbalanced. On both days, participants attended three sessions, in the late morning (baseline testing), early afternoon (60 minutes after drinking the beverage), and later in the afternoon (150 minutes after drinking the beverage).

On the lunch day, participants ate their lunch half an hour after completing Session 1, and then returned to the laboratory for the assigned beverage. Beverages were ingested at the corresponding time in the no-lunch condition.

At each session, participants' blood pressure and pulse were measured, the mood scales were completed, and the performance tasks were administered. During the initial session, of approximately 30 minutes duration, participants also completed a consent form and were familiarized with the computer tasks. The remaining sessions each lasted approximately 20 minutes.

Participants were instructed not to ingest food and to drink no caffeinated beverages from one hour before the pre-meal session until the day's testing was complete, except what was provided as part of the experiment.

Analysis

Each dependent variable was subjected to three-way analysis of variance (ANOVA), with alpha set at $p<.05$ after Greenhouse-Geisser correction (Greenhouse & Geisser, 1959). We were interested in possible interactions between the beverages factor and either or both of the other two factors (session and lunch). Such interactions would indicate that the four drinks differentially affected the measures obtained in relation to manipulations of the other factors. Hence, we focussed on these statistical effects, largely disregarding any main effects as being of no practical concern. There were no three-way interactions.

Results

Blood Pressure and Pulse

Systolic blood pressure. There was a significant session x beverage interaction, $F(6,130)=3.084$, $p=.009$, which is highlighted in Figure 1. Further analyses comparing the individual beverages with decaffeinated coffee at each session, revealed no significant individual interactions for caffeine, $F(2,66)=.924$, $p=.398$, or yerba mate $F(2,64)=2.205$., $p=.120$, but the interaction for guaraná was significant $F(2,64)=3.827$, $p=.028$.

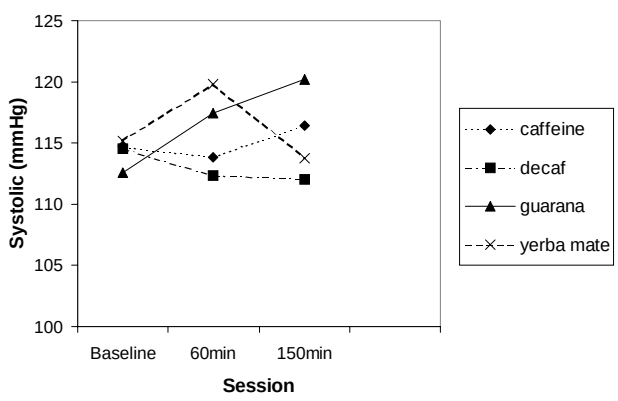

Figure 1. Mean systolic blood pressure for the session x beverage interaction

Diastolic blood pressure. The session x beverage interaction was non-significant $F(6,130)=.375$, $p=.894$, as was the session x lunch interaction $F(2,130)=.561$, $p=.642$. These results indicate that beverage type and lunch condition did not significantly influence diastolic blood pressure over the sessions.

Pulse rate. The session x beverage interaction was non-significant $F(6,130)=.850$, $p=.532$, indicating that pulse rate was not differentially influenced by beverage type after 60 minutes or 150 minutes compared with baseline. However, there was a significant lunch x session interaction $F(2,130)=7.570$, $p=.001$, indicating that pulse rate rose following the consumption of lunch, and later declined, while in the no-meal condition there was a decline in pulse rate, followed by a slight recovery. This is illustrated in Figure 2.

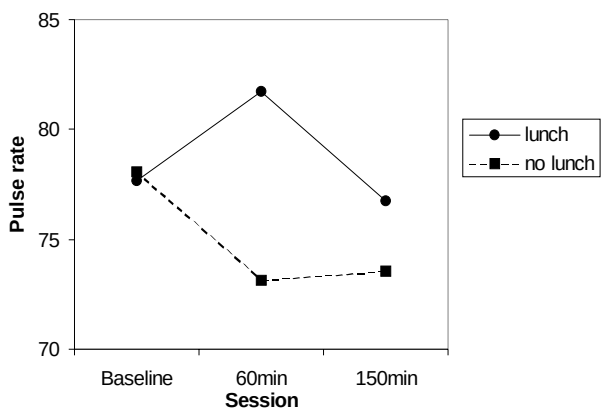

Figure 2. Mean pulse rate for the session x lunch interaction

Mood Ratings

For the composite alertness score, the lunch x session interaction was non-significant $F(2,128)=1.496$, $p=.229$, indicating that subjective ratings of alertness, in Sessions 2 and 3, were not significantly influenced by the consumption of lunch. Nor were significant interactions or main effects for beverage type obtained, but a trend toward a significant session x beverage interaction was observed $F(6,128)=2.136$, $p=.067$, as illustrated in Figure 3. Although the interaction was non-significant, post hoc testing using Tukey's HSD method (Howell, 2002), which computes the minimum difference between means that may count as significant, revealed that the difference between the guaraná and caffeine beverages was significant at 150 minutes ($p=.023$).

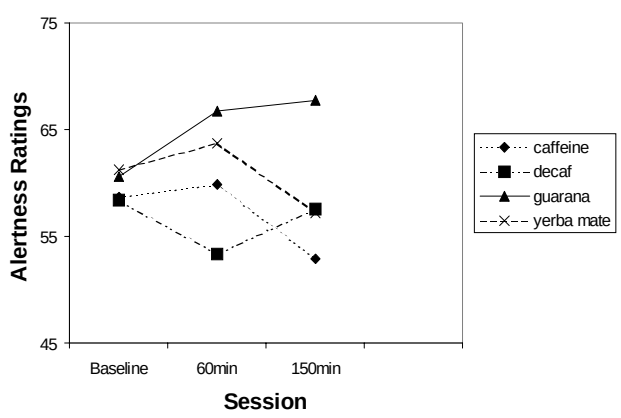

Figure 3. Mean alertness scores for the session x beverage interaction

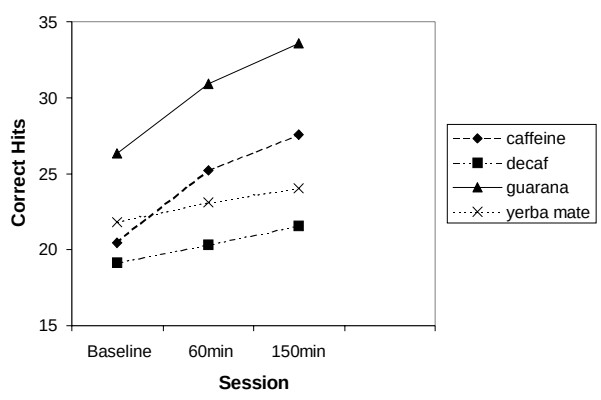

Figure 4. Mean number of correct hits for the vigilance task, for the session x beverage interaction

Logical Reasoning Task

Two participants had missing data so analyses were performed with data of the remainder (*N*=69).

Reaction time. Both the session x beverage interaction, $F(6,126)=.662$, $p=.652$, and the session x lunch interaction, $F(2,126)=.106$, $p=.875$, were non-significant, suggesting that neither lunch nor beverage type influenced speed on this task.

Correct detections. Again the session x beverage interaction, $F(6,126)=1.842$, $p=.103$, and the session x lunch interaction, $F(2,126)=1.214$, $p=.296$ were non-significant, suggesting that lunch or beverage type did not influence accuracy on this task.

Repeated Numbers Vigilance Task

Four participants had missing data so the analyses were with complete data of the 67 remaining.

Reaction time. No significant interactions among beverage type, session or meal condition were observed for speed on this task.

Correct hits. There was a significant session x beverage interaction $F(6,124)=2.546$, $p=.036$, which is highlighted in Figure 4. Further analyses comparing the individual beverages with decaffeinated coffee at each session revealed a significant interaction for guaraná $F(2,64)=3.800$, $p=.041$ and coffee with caffeine $F(2,64)=4.667$, $p=.019$, indicating that accuracy improved over the sessions after consumption of these beverages. There was no significant individual interaction for yerba mate $F(2,44)=4.313$, $p=.766$. Post hoc tests (Tukey's HSD) revealed that the differences between the decaffeinated coffee and the guaraná beverages were significant after 60 minutes ($p=.045$) and after 150 minutes ($p=.029$), while there were no significant differences between decaffeinated coffee and coffee with caffeine at particular sessions.

Discussion

The purpose of the present experiment was to investigate the effects of caffeine, guaraná, and yerba mate on cardiovascular functioning, mood, and cognitive performance, and to further determine the potential of these beverages to reduce post-lunch dip. The results confirm that a low dose of caffeine does not affect cardiovascular functioning significantly, as was also the case for yerba mate, and these findings can be viewed as favourable for the two beverages. Guaraná, however, increased systolic blood pressure, and its components were apparently still active in the body after 150 minutes. Further research is recommended to investigate any other extended or delayed effects of a physiological or psychological nature.

Systolic blood pressure also rose after lunch, which does not confirm previous findings (Smith et al.., 1990), but might reflect the different nature of the meal used in the present experiment. For instance, in the Smith, et al. (1990) experiment, both male and female participants were instructed to eat their usual lunch, which would have resulted in a variety of types and sizes of meals. In this investigation, all participants were female and all ate a standard lunch. It should also be noted that, while no quantitative analysis was performed, most participants reported that the meal was either very filling or more than they would normally eat, so these factors could have influenced blood pressure.

The results do not uphold the hypothesis that a low dose of caffeine, guaraná, or yerba mate has any significant effect on subjective ratings of alertness. One possible explanation for this result is that ratings of alertness are simply insensitive to the dosages used in this study. Interestingly, however, there was a significant difference between the caffeine and guaraná groups after 150 minutes, suggesting that participants in the caffeine group may be experiencing a 'post-caffeine dip' in alertness. This finding is consistent

with literature that suggests that "caffeine reaches peak plasma levels within 30 minutes" (Revelle, Humphreys, Simon, & Gilliland, 1980, p.5), and also provides some support for the hypothesis that guaraná has slow release properties.

The results also suggest that the three beverages produce different effects on cognitive performance. For instance, yerba mate had no significant effects on either task, while there were significant effects of caffeine and guaraná for accuracy on the vigilance task. Although participants in the guaraná group were performing more accurately than participants in the other groups on the vigilance task, even prior to receiving the beverage, the significant session x beverage interaction for guaraná nevertheless indicates an increase in this advantage over successive sessions. As participants were randomly assigned to the four beverages, it is assumed that the difference between the baseline scores is, therefore, a chance result of individual differences.

Given the small body of previous relevant research, it would be premature to propose definitive conclusions about the effects of either yerba mate or guaraná until further investigations provide more detailed evidence. In the present study, participants were tested 60 and 150 minutes after taking the beverages, but it is conceivable that effects of caffeine and yerba mate might be observable within half an hour after ingestion, while effects of guaraná might be observable beyond 150 minutes. In addition, it is possible that the dose of yerba mate administered in the present study contained insufficient caffeine to have any effect on participants and, therefore, further research regarding this issue is warranted.

It is not unreasonable that the level of scrutiny that has been given to caffeine over recent years should also be applied to guaraná and yerba mate, particularly when one considers the claims made for these herbal beverages and their rising popularity. Until such research is conducted, it should be borne in mind that any product used in excess or over a prolonged period may cause adverse health effects. It is important, therefore, that basic information about herbal products should be clearly labelled on the packaging, including not only information about recommended dosage, but also specific information about the ingredients. Clearly, this is a matter or some importance for the two herbs investigated in the present experiment, as conflicting information is presently in circulation about whether or not they contain caffeine. Furthermore, any potential health risks should be acknowledged. This is particularly relevant to pregnant women, as well as to people with conditions such as peptic ulcer or hypertension, both of which may be aggravated by prolonged use of many herbs (Talalaj & Czechowicz, 1989).

In summary, this exploratory study helps redress the absence of scientific literature with respect to guaraná and yerba mate by investigating the effects of caffeine and caffeine-like substances on mood and performance, and the potential of these substances to overcome the soporific effects of lunch. The experiment has demonstrated a significant effect of guaraná upon systolic blood pressure and upon accuracy on the vigilance task, as well as a trend towards significance for subjective ratings of alertness. Just as there is a need to investigate the potential curative medical properties of traditional herbal preparations, their potential psychological and behavioral effects also need to be studied and recorded, because of their possible positive or negative impact on workplace performance and safety, on affective states, or even perhaps on social functioning. The present findings will contribute to this enterprise.

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