

Zensel

Evidence in Support of the
"TAKE TEA AND SEE" - Campaign

prepared by the
Research Department of
Tea Bureau, Inc.

Data for
Supporting the Claims

TAKE TEA AND SEE,
WHETHER YOU DON'T FEEL BETTER, SLEEP BETTER

compiled by the
Research Department of
Tea Bureau, Inc.

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SUMMARY

1. The vast majority of Americans drink coffee. About 32 million people drink 4 cups or more per day; more than 12 million people drink 6 cups or more.. (Pages 4-6)

2. Coffee, because of its caffeine content, if consumed in too great amounts, has adverse effects on sleep and general well being. (pages 7-11)

3. Just what constitutes a "too great amount" of coffee varies from individual to individual and also by situations; there are indications that the unpleasantness-level starts on the average around 6 grains of caffeine(pages 12-14) Since one cup of coffee contains about $1\frac{1}{2}$ grains of caffeine, 4 cups approach the 6 grain level; yet 32 million people in the U. S. drink 4 cups of coffee or more per day. (pages 15-16)

4. Tea contains about 50 per cent less caffeine per cup than coffee; other circumstances remaining equal, by drinking tea people will remain farther from the unpleasantness-level, than by drinking coffee. (Pages 15 & 16)

5. Furthermore, tea contains a substance called ADENIN which considerably reduces the effectiveness of the caffeine in tea. Coffee does not contain adenin. In terms of "physiologically effective caffeine" the span between a cup of tea and a cup of coffee is therefore even greater than revealed by the chemical analysis. (Pages 17-19)

6. Reversing a belief of long standing recent studies established tea as a useful source of Vitamin B2 (Riboflavin and Pantothenic acid). This vitamin content might be an additional contribution to the consumer's well-being. (Page 18)

7. For any or all of these reasons tea is considered a pleasant, mild stimulant, the first beverage given to convalescents in need of "feeling better". (Pages 21-25)

CONCLUSION:

Because a cup of tea contains considerably less caffeine than a cup of coffee, and because, in addition, the caffeine in tea is less effective than that in coffee, many of the millions of regular coffee drinkers have a chance to feel better and sleep better by switching to tea. Tea, unlike coffee, has been found to be also a useful source of the vitamin B 2.

1. The Vast Majority of Americans Drink Coffee

The following statistics will corroborate the well known fact that coffee is the leading hot beverage on the U. S. market. In the year ending June 30, 1951 the U. S. consumed coffee at the rate of 2.77 cups per day per head of population 15 years and over. This figure is arrived at as follows:

Coffee imports during the 12 months ending June 30, 1951.....	21.2 mil. bags
Reduction in U. S. stocks during that period.....	<u>0.2 mil. bags</u>
CONSUMPTION.....	21.4 mil. bags
21.4 mil. bags at 132 lbs. each, equal.....	2,825 mil. bags
Taking the accepted average of 40 cups of coffee per one pound, one arrives at a per year consumption of.	113,000,000,000 cups
By dividing this amount by 365 we obtain a daily rate of.....	<u>309,000,000 cups</u>
Projected against the U. S. population of 15 years and older, as of January 1951 (the mid-point of the 12 month period).....	111.5 mil. people
one arrives at.....	<u>2.77 cups per day per</u> <u>head of the population</u> <u>15 years and older</u>

It is of interest, that a study sponsored by the Pan American Coffee Bureau arrives at a projection figure very close to this one. In that survey the U. S. population 8 years and over (129,000,000 on January 1, 1951) drank on the average 2.36 cups of coffee per day, which amounts to 3,040,000 cups per day, which is only 2 per cent below our estimate of 309,000,000 cups. Since some - although not much - coffee is consumed also by children under 8 years, the two estimates are quite close and corroborate each other.

The significance of the average of 2.77 cups per day per person is expanded by the following data from a survey of U. S. Beverage Drinking Habits made by Elmo Roper (Exhibit # 19).

Of the U. S. population 12 years and over

75.4% drink coffee almost every day
or oftener

3.9% drink it several times a week

Hence about 80% can be called regular.

coffee drinkers.

There are also some data available on the different amounts of cups of coffee drunk by different people. The following data are projected from the already quoted survey of the Pan American Coffee Bureau:

<u>Coffee drunk per day</u>	<u>Number of people in U. S.</u>
1 cup	21,100,000
2 cups	23,200,000
3 cups	18,400,000
4 cups	13,000,000
5 cups	6,700,000
6 or more	12,200,000

There are, therefore, more than 12 million people in the U. S. who drink 6 or more cups of coffee per day; 19 million drink 5 or more and 32 million drink 4 cups or more.

2. Caffeine Has Often an Adverse Effect on Sleep
and General Well Being.

Of the three effects exerted by caffeine

(a) on the central nervous system

(b) on muscles

(c) on the kidney

only the first interests us here.

The stimulating power of caffeine may go beyond the disirable level. "Caffeine acts as a stimulant producing a condition of wakefulness and increased mental activity....With larger doses..... the patient becomes at first restless and noisy, and later, may show convulsive movements" (British Pharmaceutical Codex).

In an experimental study on the effects of caffeine the unpleasant sensations caused by continous coffee drinking are described as follows:

"Influence on nervous system was pronounced and unfavorable. Lessening of period of sleep, bad dreams, inability to concentrate, tremors or nervousness, headache and dizziness. Less satisfaction in response to physiological tests. Prolongation of simple R.T. and loss of

accuracy in rapid calculating."
(P. B. Hawk, American Journal of
Physiology 1929, "A study of the
Physiological and Psychological
reactions of the human organism
to coffee drinking") (Exhibit # 4)

There is also no doubt about the sleep
disturbing powers of caffeine:

"It (caffeine) incontestably increases
resistance to sleep" (R. Crosnier,
Annales d'hygiene No. 3-4 (May-July)
1949 Paris ("Resistance to Sleep"))

It is undoubtedly on the evidence such
as this one that the manufacturers of Postum and
Sanka are able to make the following statements in
their current campaigns:

Save your nerves! No "Coffee Nerves"
from Postum

While lots of folks aren't bothered
by Caffeine in Coffee - others suffer
sleeplessness, nervousness, indiges-
tion.

(Saturday Evening Post 11/4/50)

Can "make-up" make up for coffee?

There's no hiding those tired little lines around the eyes that result from lost sleep. Nerves show, too, the day after a restless night.

Behind those lines, behind that edginess, could be the caffeine in coffee. For many women and men, caffeine is a sleep-stealing, nerve-tensing demon.

(Life 6/4/51)

Is coffee your Waterloo?

Have you surrendered nights of precious sleep to the caffeine in coffee? Toss and turn nights that leave you tense and jumpy the next day?

It's a losing battle for many men and women - the more coffee they drink, the more they feel the harmful effects of caffeine. Sleepless nights! Jittery days!

(Life 5/7/51)

Does tick...tick...tick...say lay...
off...coffee?

Two o'clock - and all is not well. Try as she will, she just can't get to sleep...every sound in the night is loud and clear. Eight O'clock - and another day starts off wrong. Often the caffeine in coffee is to blame. Sleep-stealing, nerve jangling caffeine!

(Saturday Evening Post 4/14/51)

Does coffee bring out the beast in you?

A man can be cross as a bear when he's affected by the caffeine in coffee. Jangled nerves make "hard days" harder - bring him home from work worn out, irritable and on edge!

He's an easy prey, at night, to every disturbing sound. And with many coffee-drinkers, it's the same story. Caffeine is the cause of restless, wakeful nights and tense, jittery days!

(Life 9/10/51)

Is coffee half the battle?

When folks flare up, it's often because they're losing out on precious sleep. As a result, they're tense....irritable.... jumpy!

And often back of men's and women's sleeplessness is the caffeine in the coffee they drink. Sleep-stealing, nerve jangling caffeine!

(Saturday Evening Post 3/17/51)

Each of these statements by the Sanka
advertisers is then followed by this consideration:

Should you cut down on the number of
cups of coffee - or give up your
favorite beverage entirely?

On the strength of both the direct medical
evidence, and the statements made by anti-coffee
advertisements there can be no doubt that many
people suffer from sleeplessness and nervous symptoms
due to too great an amount of caffeine consumed in
coffee.

3. How Much Coffee is Too Much?

"Small doses of caffeine act on the nervous system - stimulating. . .and relaxing. . .Excessive doses produce insomnia, nervousness, headache, palpitation and nausea, especially in susceptible persons". (From Useful Drugs, Published by The American Medical Association, Chicago 1938)
(Exhibit # 9)

The unpleasant effects of caffeine may appear on rather different levels of caffeine consumption. This level seems to depend among others on the following factors:

- a) physiological susceptibility of the individual
- b) mode and frequency of coffee consumption
- c) time of the day

(cf - H.L. Hollingworth's study on the Influence of Caffeine on Sleep in the American Journal of Psychiatry)
(Exhibit # 3)

All studies suggest, however, that - leaving other conditions equal - the physiological effects of caffeine consumption are related to the amount of

caffeine consumed. The studies furthermore suggest the existence of a distinct danger level, although this danger level may vary from individual to individual and from situation to situation.

Caffeine consumption below the danger level will cause none of the unpleasant effects, whereas caffeine consumption beyond that level will lead to unpleasant sensations.

Several studies have tried to determine such levels. In the already quoted study by H.L. Hollingworth 6 grains of caffeine were found to constitute such an average danger level. (Exhibit # 3)

In a study by N.R. Cooperman "The Effect of Caffeine on Body Temperature and Motility During Sleep" (Exhibit # 6) it was found "Large doses of caffeine, 4 to 6 grain, caused a distinct increase in motility....paralleled...by a rise in body temperature (during sleep)."

K.B. Lehmann (Archiv fuer Hygiene v. 92 123, p. 85) found the first signs of disturbance at a level of 5 grains. (Exhibit # 10).

Cooperman (American Journal of Physiology
V 105, 133, p24) found that with many adults 4.6
grains of caffeine started to produce increasing
restlessness (Exhibit # 10).

Thus the danger level causing unpleasant
reactions of caffeine stimulation, has been found
to vary around doses of 4 to 6 grains of caffeine.

4. The Amount of Caffeine in Tea and Coffee

Measurements of caffeine content in tea and coffee vary, of course, according to the type and amount of tea and coffee used and according to the method of preparation. Following are some of the authoritative measurements:

COFFEE

<u>Grains Per Cup</u>	<u>Authority</u>
1.2	Wilhelm Holdner, quoted in Oscar Eichler, Kaffee und kaffein, Vienna, Springer 1938 p. 10.
1.5	U. S. Dispensatory, Osol Farrar, 24th ed. 1947

Average 1.42 grains

TEA

0.78 - 0.95	Dr. Punnet (Depending on Water Temperature and Tea)
0.8	Wilhelm Holdner (see above under coffee)

Average 0.85 grains

From these data it appears that a cup of coffee contains about 60 to 70 percent more caffeine

than a cup of tea. From an expert who is with one of the companies packing tea and coffee comes this statement:

"We get in each cup of coffee from $1\frac{1}{2}$ to 2 grains of caffeine while in a cup of tea we get only $\frac{3}{4}$ to $\frac{9}{10}$ of a grain."

(George F. Mitchell - General Foods, Maxwell House Division - Tea & Coffee Trade Journal, September 1951)

This would indicate that a cup of coffee contains twice as much caffeine than a cup of tea.

Summarizing the available evidence, it appears that an average cup of tea contains at least 40 percent less caffeine than an average cup of coffee.

5. The Caffeine in Tea is Less Powerful

For a long time it has been a more or less accepted fact that tea is a more palatable beverage than coffee.

"It is a well-known fact, that coffee, even in small quantities, has rather unpleasant effects on many people who show no such effects if they drink tea." (David I. Macht and Hermann Schroeder, Baltimore, "A Pharmacological Study of the Effect of Caffeine Adenine Mixtures", Klin Wochenschrift, 9 Jahrg. No. 52, p. 2430 - 1929, Exhibit # 5)

Efforts to explain this "well-known fact" attributed it first to the presence of tannin in tea and to some volatile oils. None of these theories, however, transcended the level of conjecture. It was not until 1930 when the above mentioned Baltimore chemists Macht and Schroeder were able to explain this fact in a satisfactory way.

They were able to find in tea a product called adenine which is not present in coffee. Adenine came recently into the popular lime light when it was shown to be part of the necessary chemical constituents of all living cells. (Exhibit # 19)

In a series of experiments on animals as well as plants, Macht and Schroeder were able to show that the effects of caffeine were below the expected level if the caffeine was administered and mixed with adenine. The two products form what is called an antagonistic synergism: the one counteracting the effects of the other.

Thus it is established that even if equal amounts of caffeine were consumed in tea and coffee, the amount of caffeine consumed in tea would be less effective. Caffeine in tea could therefore, be consumed in greater quantities than caffeine in coffee, before the danger level is reached.

The public, incidentally, is well aware of this basic fact. This is shown by the following table from an Elmo Roper Survey on Beverage Drinking Habits, conducted in the Winter of 1948. It is based on a cross-section of 8016 respondents, representing the U. S. population of 12 years and over. Asked which of the phrases and words on a long list describe the respondent's feelings about

coffee and tea "particularly well" the following answers were received:

	<u>Coffee</u>	<u>Tea</u>
	% Respondents	
Keeps you awake	26.7	2.4
Makes you nervous	11.5	2.6
Harmful to health	9.1	2.8
Soothing	7.0	19.1
Mild	4.8	22.0

Note the percentages on "keeps you awake", "makes you nervous" and "harmful to health" - all high for coffee and very low for tea - and in contrast the percentage of people who associate "soothing" and "mild" with tea but not with coffee.

6. Tea is a Useful Source of Vitamin B₂

Until not so long ago it was a generally accepted belief that tea, in its infused form, does not contain any amounts of vitamins worth considering. One of the Tea Bureau's own publications pronounced some eight years ago: "There are only three important ingredients in tea - caffeine, vegetable tannin and certain essential oils."

Ukers' "All About Tea" concludes the presentation of the collected material by stating: "The evidence so far advanced concerning the vitamins in tea is not very definite."

In 1946, however, it was definitely established that tea not only in its dry form but also in its infused form contains appreciable amounts of Riboflavin (Vitamin B₂) and of Pantothenic Acid, a substance regularly associated with Riboflavin. An ordinary cup of black tea contains about 25 mg. Riboflavin and 75 mg. of Pantothenic Acid. As the authors put it: "These quantities are appreciable and tea may therefore be considered a useful source of these two products." (Exhibit 20)

7. The Beneficial Effects of Theine (Caffeine)

So far we have talked primarily of the unpleasant effects of caffeine (since it is also called THEINE, we might consider using this name) if too much of it is used.

By switching from coffee to tea, as we have shown, the danger of reaching the unpleasantness-level is considerably removed. For most tea drinkers only the pleasant effects of theine will become apparent.

Any discussion of these effects should probably start with the well known rule of dietetics that tea is the first beverage given to convalescents and to people who have any diseases of the digestive tracts.

"With respect to diet, tea is being used as the beverage most becoming in case of any disease of the digestive system." (W. Heupke, Dietetic, Leipsig 1942, p. 66)

The diet for children, healthy and sick, recommends tea but warns expressly against coffee:

"Childhood diet (6 years) Beverages:
Water, tea, cocoa, chocolate. Avoid
all alcoholic drinks and coffee.

"Children in disease: water abundantly,
weak tea, no coffee."

(Sanford Blum, Applied Dietetics,
Philadelphia pp. 326,334,336)

The best investigated effect of tea is its
stimulation of muscles and the nervous system. A few
quotations follow:

"The administration of caffeine improved
strength, dexterity and mental ability of
a test group, as compared with elaborate
controls. The mental performance under
caffeine was even better than that of the
rested (non-fatigued) group which did
not receive any drug."

(Untersuchungen uber die Wirkungen von
Coramin, Caffeine und Pervitine auf
psychische und physische leistungen
des er mudeten und nicht ermudeten
menschen - B. Pellmont - Archiv fur
Experimentelle, Pathologie und Phar-
macology, 1942, v. 199, pp. 274-291)
(Exhibit #12)

Here is the summary of two other series of
experiments:

"Caffeine increases work output of non-
fatigued subjects; it also enhances the
rate of recovery from fatigue."

(E. E. Foltz, A. C. Ivy, C. J. Barborka -
The Influence of Amphitamine (Benzedrine)
sulfate, d-desoxyephedrine hydrochloride
(pervitin), and caffeine upon output and

recovery when rapidly exhausting work is done by subjects."

Journal of Lab. and Clinical
Medicine, Feb. 1943, p. 603-606)
(Exhibit #13)

"Animal experiments indicate that the effect of caffeine against fatigue is achieved by direct affection of the muscle, not through a central mechanism. Caffeine can produce tension in normal as well as denervated muscles."

(F. Huidobro and E. Amenbar -
Effectiveness of Caffeine (1, 3,
7 Trimethylxanthine) Against
Fatigue. J1. of Pharmacology &
Exper. Therap., Baltimore 84:82,
1945 (May))
(Exhibit #14)

In view of the controversy started in the old FTC complaint as to whether the stimulating effects of tea are only transitory and compensated for by subsequent reaction, the following findings will be of interest, although it comes from a rather old study:

"Caffeine has a twofold effect: one, to diminish the effects of fatigue and the other, merely in the nature of a transitory stimulation, followed by so great a reaction, that one could call the effect one of acceleration of fatigue."

(W. H. R. Rivers and H. N. Weber - The
action of Caffeine on the Capacity for
Muscular Work - J. Physiol. London, 1907,
XXXVI, 33-47)
(Exhibit #2)

Here, there is a clear differentiation between the effect with reaction and the one which does not have such a reaction.

The following quote will be useful in documenting the "feel better" claim because it uses almost the identical expression:

"These (caffeine-containing) beverages... (are)...generators of sensations of vigor"

(R. Crosnier - Resistance to Sleep - Annales d'hygiene No. 3-4 (May-July) Paris 1949)
(Exhibit #15)

A recent German study provides evidence that:

"Caffeine reduced high blood pressure for as long as two hours after administration"

(I. Seboeck - Effect of Caffeine in Hypertension - Deutsche Med. Wschr. 75:33-34 August 25, 1950)
(Exhibit #17)

By way of conclusion, then, the following two findings will round out the medical evidence on tea:

"Good tea, brewed for five minutes, produces mild and pleasant stimulation, in no sense

corresponding with the violent, unpleasant action of its main components, caffeine and tannin, when these are given separately or in combination."

(The Effects of Tea Drinking -
G. W. Halpenny and H. E. McDermot -
The Canadian Medical Association
Journal Nov. 1939 pp. 449-453)
(Exhibit #11)

and

"I may then conclude that tea... affords a wholesome source of fluid for the body, while at the same time it gives, on account of its aromatic flavor and slightly stimulating properties a pleasure to its users which makes it worthy of a far more extended use among us that it has yet reached."

(Frank B. Wade - "Some Scientific Aspects of Tea Drinking" - Indiana Acad. of Science, 1905)
(Exhibit #1)

"The Riboflavin Content of Tea and some Results for
the Pantothenic Acid Content"

E. A. M. Bradford and E. B. Hughes

"The Analyst" (Cambridge, Eng.) Vol. 70 Pg. 2-5 1945

Summary: -- An ordinary cup of black tea contains about 25 μ g. of riboflavin and 75 mg of pantothenic acid. "These quantities are appreciable and tea may therefore be considered a useful source of these two products."

Table IV

Tea No.	Country of Origin	Type [!]	Riboflavin μ g per g	Pantothenic Acid μ g per g
1	N. India	B.P.S.	10	26
2	" "	B.P.	10	29
3	" "	B.O.P.	9	31
4	" "	P.F.	10	36
5	" "	D.O.P.	7	28
6	" "	O.F.	8	36
*7	" "	—	9	20
*8	" "	—	7	19
*9	India	—	11	21
10	Ceylon	B.O.P.	10	40
11	"	"	7	—
12	S. India	"	8	—
13	" "	"	7	—
14	Kenya	"	9	—
15	Nyasaland	B.P.	9	—
*16	"	—	11	14
17	China	Keemun	7	—
18	"	Lapsang	6	—
*19	"	Gunpowder (green)	6	15

! B = Broken F = Fannings O = Orange P = Pekoe S = Souchong

* These samples were four years old.

It is of interest to note that practically the whole of the riboflavin passes into tea infusion prepared as tea is usually "made" for drinking; for example, a sample of finely ground tea extracted by boiling for 1 hour under a reflux gave about the same result (11 μ g) as was obtained from the ordinary infusion (10 μ g).

Results: -- In Table IV (last column) are the results found for the pantothenic acid content of twelve of the teas listed in the Table. These quantities are appreciable, and tea may therefore be considered a useful source of riboflavin and of pantothenic acid. For example, on the common basis of 1 teaspoonful of tea (2 to 2.5 g) plus a little "for the pot" -- say 1/4th -- for a cup of tea (generally about 5-6 oz. of infusion) the amounts of these vitamins so supplied are about 25 μ g and 75 μ g respectively. These quantities are exclusive of amounts derived from the milk added.

From the Elmo Roper Survey on Beverage Drinking Habits conducted in the winter of 1948 with a cross-section of 8016 interviews, representing the U. S. population of 12 years and older, the following pertinent data are quoted:

Question 2a - How many times a week during the winter would you say you drink coffee?

Almost every day 75.4%

Several times a week 3.9%

Question 5 - What one thing about coffee do you think is better than tea? *

First two items mentioned:

Better taste 26.7%

More stimulating 24.3%

Question 5 - What one thing about tea do you think is better than coffee?*

First two items mentioned:

More relaxing 11.4%

Better for health 9.3%

* Asked of all who drink coffee and tea

Question 7a - Here is a card with a list of words and phrases on it. I wonder if you could find three or four words or phrases on this list that are particularly good for describing your feelings about coffee and tea?

(The following 5 of the 32 items of the list are pertinent for our problem)

	<u>Coffee</u>	<u>Tea</u>
	% Respondents	
Keeps you awake	26.7	2.4
Makes you nervous	11.5	2.6
Harmful to health	9.1	2.8
Soothing	7.0	19.1
Mild	4.8	22.0

"Has Science Found The Spark of Life".
Collier's, September 1, 1951
John Lear

Summary -- Adenosine-5-TriPhosphate, one of the chemical prerequisites of life contains adenine, a substance found in tea but not in coffee.

Thousands of experiments, both peaceful and warlike, are being tried with a mysterious substance which gives all living things - at least all those that have been put to the test, and they are myriad - the power to move, breathe and grow.

Without this precious stuff, seeds will not burst forth with life in the darkness of the earth; flowers and vegetables and trees cannot absorb the minerals required for survival; animals are helpless to digest the plants they forage on; nor can man convert the meat of animals into amino acid building blocks for the protein frame in which he dwells.

Fireflies cannot make their light in the summer air without its power. Electric eels cannot discharge their current through the water. Beetles scuttling underground cannot employ their feelers as direction finders. No human being anywhere can walk or run or jump or crawl across the land because none of his multitude of muscles can move without it. The heart cannot beat. The lungs cannot breathe. The brain cannot transmit intelligence-it cannot even think.

The potent spark without which life would cease is Adenosine-5-TriPhosphate, known to science as ATP. It is literally loaded with get-up-and-go. In it are sugar, which is concentrated energy; adenine, a drug related to the caffeine in coffee*, the breakfasttime lift with which we launch the day; nitrogen, the pick-me-up which earth gives to all green growth; and phosphorus, which strikes fire from common matches.

*Mr. Lear, the author of this article, has been advised by the Tea Bureau that he erred here: adenine is associated with the caffeine in tea - not in coffee.

"Effect of Caffeine in Hypertension"

Seboeck I. Deutsche Med. Wschr. 75:33-34 August 25, 1950.

Summary — Caffeine reduces high blood pressure for as long as two hours after administration.

Before and after the peroral administration of 0.05 and 0.10 grams of caffeine respectively, the systolic and diastolic blood pressure of 43 bedridden patients chosen at random, was measured auscultatedly with the Boulitt tonometer, at intervals of ten minutes for two or three hours. Attention was also paid to the rate of the pulse, in addition to the blood pressure.

In these analyses, instead of the expected rise in blood pressure after the administration of caffeine, all 32 cases showed a more or less marked decline in blood pressure. The least decline of the systolic pressure was 10 mm Hg., the greatest 80 mm Hg. The average decline, based on the 32 cases, was 37 mm Hg.

The moment of maximum decline came, in three cases, after ten minutes, in one case after 150 minutes, the average for the 32 cases was 45 minutes. In most cases the maximum decline occurred 40-45 minutes after the administration of caffeine.

In one case blood pressure returned to its original height after 50 minutes, in the overwhelming majority of cases not even after two or three hours.

No relationship was found between the height of the original measurements and the maximum decline.

There was, among the cases with relatively low original blood pressure, low (10 mm Hg.) as well as considerable (35 mm Hg.) decline, and the same variations were found among cases with higher original pressure (for example from 250 to only 240 = 10, and from 270 to 225 = 35 mm Hg.). The greatest decline (80 mm Hg.) was observed from an original pressure of 215 mm Hg. Fig. 2 represents graphically the case with the greatest observed decline (80 mm Hg.) as well as the average decline calculated from the 32 cases (coordinating each ten-minute observation interval).

It appears from this that the decline in blood pressure caused by the administration of caffeine ceases, on the average, after 100 minutes, giving way to a new rise in pressure. But even after two hours the original pressure is, on the average, not reached.

(transl. from German)

"Action of Caffeine and Aminophylline as Respiratory Stimulants in Man."
Journal of Applied Physiology. July 1949 No 1 Vol. 2
Richmond, Glenn H.

Summary -- Caffeine acts on the respiratory center by increasing its sensitivity to carbondioxide; it causes no change in the electro cardiogram.

The present study was undertaken to determine whether or not the action of CAFFEINE and Aminophylline on respiration is that of altering the sensitivity of the respiratory center to carbondioxide.

The subjects for the experiments with caffeine were 6 normal white males varying in age from 20-32 years. All of the subjects except No. 1 were coffee drinkers.

Both caffeine and Aminophylline caused slowing of the cardiac rate. Neither carbondioxide, CAFFEINE, nor combination caused any significant change in the ELECTROCARDIOGRAM. NO SIGNIFICANT CHANGE IN ELECTROCARDIOGRAM was observed following the administration of aminophylline. In general caffeine and aminophylline caused an increase in respiratory rate.

It is concluded from this study that CAFFEINE ACTS ON THE RESPIRATORY CENTER by INCREASING ITS SENSITIVITY TO CARBONDIOXIDE. The mechanism of the action of aminophylline in the dose used in this study does not appear to be similar to that of caffeine.

"Resistance to Sleep"

Annales d'Hygiene No. 3-4 (May-July) Paris 1949
Crosnier R.

Summary -- 1. Caffeine beverages generate sensations of vigor.
2. Caffeine increases resistance to sleep; doses of 1.5 gram and over may harm sustained effort.

Caffeine: This substance possesses well-known stimulant properties, as effective for physical as for intellectual work (athletic and cerebral effects).

It incontestably increases resistance to sleep. It is advantageous to divide doses of between 0.5 grams and 1.0 gram into fractions of 0.25 grams, to avoid the use of the maximum dose, i.e. 1.5 grams - capable of being a serious handicap to subjects forced to make an extraordinary physical effort but who must preserve a satisfying neuro-muscular equilibrium and at the same time a sustained state of tension.

This is the essential principle contained in the Kola; it is also the specifically active factor which exists: in coffee (1 gr., 2gr., 5%), tea (2.3%) and mate' (1.3%). But the efficacy of these beverages which stimulate the nervous system, generators of sensations of vigor, is not rapid enough to enable them to be advantageously substituted for the active substances themselves.

(transl from French)

"Effectiveness of Caffeine (1,3,7 Trimethylxanthine) Against Fatigue."
Jl. of Pharmacology & Exper. Therap., Baltimore 84:82, 1945(May)

Huidobro, F. and Amenbar, E.

Summary --- Animal experiments indicate that the effect of caffeine against fatigue is achieved by direct affection of the muscle, not through a central mechanism. Caffeine can produce tension in normal as well as in denervated muscles.

Huidobro and Amenbar point out that Foltz and his co-workers have demonstrated that caffeine increases in human subjects not only the capacity for muscular work in rested persons but also the speed of muscular recuperation in fatigued persons. In human experiments it is impossible to determine whether the caffeine achieves its effect through a central mechanism, through action on the neuromuscular junction or through stimulation of the muscle directly. Experiments on frogs indicate that the xanthine derivatives have a direct action on muscle itself and that they are even capable of producing an increase of muscular contraction when a muscle is stimulated indirectly through its nerve. Studies were made by the authors on cats anesthetized with dial or pentobarbital sodium or on cats which had undergone decerebration to determine the effect of caffeine injected intra-arterially in doses of 0.007 to 0.035 Gm. Observations were made on the contractions of skeletal muscles, on the neuromuscular synaptic mechanism and on the superior cervical ganglion stimulated by acetylcholine. It was found that caffeine produces an increase in the tension developed by muscle which is being stimulated indirectly. Caffeine can produce tension in normal muscle as well as in denervated muscle. When denervated muscle is stimulated directly, caffeine can also increase the amplitude of contractions. Caffeine is able to augment not only the amplitude of contractions of a muscle stimulated by means of acetylcholine but also those of the nictitating membrane similarly stimulated by the latter drug. The enhancing action of caffeine on the contractions of the nictitating membrane stimulated by acetylcholine is due to the effect the caffeine exerts on the ganglion. Caffeine augments the action of neostigmine. The mechanism of the action of caffeine on the neuromuscular junction consists in lowering the excitatory threshold of acetylcholine.

"The influence of amphetamine (Benzedrine) sulfate, d-desoxyephedrine hydrochloride (pervitin), and caffeine upon output and recovery when rapidly exhausting work is done by trained subjects."

J. of Lab. and Clinical Medicine, Feb. 1943, p. 603-606
Foltz, E. E. Ivy, A. C., Barborka, C. J.

SUMMARY -- Caffeine increases work output of non-fatigued subjects; it also enhances the rate of recovery from fatigue.

Subjects -- 4 medical students.

Procedure -- Subjects were provided with room near laboratory. Food intake was controlled. Worked on bicycle ergometer described by Kelso and Hellebrandt. Worked at rate of 1,235 kilogrammeters per minute, with a pedaling rate of 54 r. p. m. Periods of training prior to performance of tests varied from 3-16 minutes. Subjects worked to complete fatigue, rested 10 minutes, then worked until fatigued again. End point of fatigue was when they could no longer hold the needle on dial at rate of 54 r. p. m. Amphetamine (10-15mg.) desoxyephedrine (5mg.) and Caffeine sodium benzoate (0.56 m.) were administered intravenously. They were given at various times (30 sec. to 30 min.) prior to first work period and amphetamine and desoxyephedrine were given immediately after first work period to determine their effect upon recovery. Placebo injections (sodium chloride solution) were given at random as controls.

Results -- 2 felt keyed up after amphetamine other 2 reacted same to placebo amphetamine. Desoxyephedrine seemed to increase leg pain in one case and decrease it in another and to cause insomnia in 3 subjects. In 1 case when given immediately after 1st. period it seemed to dispel fatigue -- rested feeling lasted until he worked about 10 seconds in 2 period when he felt tired again and his recovery was not enhanced. This was in contrast to 0.56m of caffeine given. This stimulated subject and it lasted throughout second period and greatly increased his recovery. After being given desoxyephedrine or caffeine for rest of day subject felt extremely alert and experienced difficulty in going to sleep at night. All subjects reported stronger immediate subjective sensations from caffeine and desoxyephedrine when drugs were given before 1st period than when given after first. Amphetamine had no significant effect. Desoxyephedrine and caffeine definitely increased work output. With the increase of work done in 1st period, there was a

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decrease in % recovery.

Conclusions -- (1) $\frac{1}{2}$ gr. of caffeine benzoate injected intravenously into non fatigued subjects increased work output. (2) neither 10 mg. of amphetamine nor 5 mg. of desoxyephedrine injected intravenously into fatigued subjects enhanced rate of recovery from heavy work carried to point of exhaustion; caffeine in adequate doses does. (3) When stimulants are employed, should be chosen according to whether it is desired to increase work output of unfatigued subjects or to enhance recovery of fatigued subjects.

" Untersuchungen über die Wirkungen von Coramin, Caffeine und Pervitine auf psychische und physische Leistungen des ermüdeten und nicht ermüdeten Menschen."

Pellmont, Bela, Vergleichende.

Archiv für experimentelle, Pathologie und Pharmacology, 1942, v. 199, pp. 274 - 291.

SUMMARY - - The administration of Caffeine improved strength, dexterity and mental ability of a test group, as compared with elaborate controls. The mental performance under caffeine was even better than that of the rested (non-fatigued) group which did not receive any drug.

The influence of Coramine, Caffeine and Pervitine was tested against two control groups, one received a placebo pill (containing ineffective ingredients), the other being well rested. The subjects were given a series of tests relating to (a) strength, (b) dexterity and (c) mental ability.

Following are the results of these tests:

Percent improvement over the performance in the fatigued state.

<u>Tests of</u>	<u>Rested (no pill)</u>	<u>Ineffective Pill (Placebo)</u>	<u>Coramine</u>	<u>Caffeine</u>	<u>Pervitine</u>
Strength	+ 24%	+ 4 %	+ 26%	+ 21%	+ 24%
Dexterity	+ 6%	+ 1%	+ 12%	+ 8%	+ 7%
Mental Ability	+ 19%	+ 12%	+ 18%	+ 28%	+ 22%
Total performance	+ 15%	+ 6%	+ 17%	+ 20%	+ 17%
Improvement of total performance minus suggestion effect from taking "a" pill (6%)		+ 9%	+ 11%	+ 14%	+ 11%

"The Effects of Tea Drinking"

Halpenny, G. W. and MacDermot, H. E.

The Canadian Medical Association Journal Nov. 1939 pp.449-453

Summary -- Good tea, brewed for five minutes, produces mild and pleasant stimulation, in no sense corresponding with the violent, unpleasant action of its main components, caffeine and tannin, when these are given separately or in combination.

Strong tea, brewed 10 minutes, may produce some mild discomfort, but the addition of milk nullifies this.

Cheap tea, weak, may suit some palates, and has no objective effects, but in strong infusion is apt to be unpleasant.

The effects of tea on gastric acidity and peptic activity are slight and variable. Tea does not increase acidity.

Tea does not seem to alter the basal metabolic rate.

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The following investigation was undertaken to find out just what effects tea does produce in the average human being. We had in mind only the drinking of tea as it is ordinarily done in Canada. Excessive consumption of strong tea was not considered. Nor have we tried to establish any special claims for the value of tea.

Clinical Effects -- Cups of cold and hot water, respectively, had no effects on the pulse, temperature, blood pressure and urinary output.

Good tea, clear, 5-minute brew, produced pleasurable effects in all the patients; a few perspired slightly, but there was no change in any of the objective findings. Four were given the tea cooled, with no different effects. With milk and sugar added, the same pleasurable effects were noted, and no changes otherwise. With lemon juice added, there were, similarly, no particular effects.

A 10-minute brew of the same brand of tea, clear, produced definite symptoms of distaste, with slight nausea and some abdominal discomfort in three cases. With milk and sugar added, these unpleasant effects were replaced by the pleasurable stimulation of the weaker brew.

Cheap tea, clear. -- With the 5-minute brew some patients thought the taste was even better than the good brand, whilst others thought it bitter and less palatable. Four complained of some abdominal discomfort, and one was slightly nauseated with the last cup. With milk and sugar added, the bitterness was removed, and all found it pleasant enough, with no other effects.

The 10-minute brew of this brand, clear, was definitely too strong and bitter. Nearly all of the patients were nauseated, and many complained of abdominal discomfort. When milk and sugar were added, this strength was found to be more palatable, but it still produced some abdominal discomfort.

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"The Effects of Tea Drinking"

Coffee.-- Here the results were roughly similar, in that a 7-minute brew (the ordinary length of percolation) gave pleasurable effects, and the stronger, 10-minute brew was found to be more bitter, although producing no special symptoms.

Gastric Analyses -- Four analyses were carried out on each patient. These were done at the first of each week, the patients reporting without breakfast. A No. 14 French Levine tube was passed, and after the fasting contents were aspirated and the testing fluid given, samples were taken at 15-minute intervals for 75 minutes -- six specimens in all.

Effects on Peptic Activity in Vitro -- The next step was the testing of the effects on peptic activity in vitro. This was done by incubating on c.c. of the gastric juice and 15 c.c. of N/20 HCl in a 50 c.c. Erlenmeyer flask, which served as a control. To this the various fluids were added. Peptic activity was estimated by measuring the digestion at both ends of the Metts tube and taking an average.

Gastroscopic Examination -- Three patients were examined with the gastroscope immediately after completion of the experiments. All showed a mild superficial gastritis, non-symptomatic, which consisted of slight reddening of the gastric mucosa, with occasional adherent patches of mucus. One of the examinations was repeated two weeks later, when no trace of gastritis could be found. It was probably due to the doses of tannin and caffeine which had been given, and the four gastric analyses done on each patient should also be taken into account.

"Coffee and Caffeine"

Eichler, Oscar - Berlin Springer 1938

Summary — Caffeine affects non-fatigued and fatigued persons differently. Whether caffeine is sleep disturbing depends primarily on the amount of caffeine.

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Tiredness — Very different effects can be reached in normal and tired nervous systems. The influence of caffeine is specially useful to fight tiredness, although the effect of caffeine is much weaker in a tired person.

Sleep — Coffee with 0.6 g. of caffeine does not affect the sleeping chart.

It depends on the amount of caffeine. Giddings (J. Amer. Med. Assoc. 1934, p. 525) has registered profoundness of sleep in 12 children, who had taken 0.04 g. of caffeine in cold drinks. He transcribed the movements during the night electrically. None of the children showed any effect. Due to the fact that smaller quantities do not produce disturbances, in some beverages without comparing the contents a sleep disturbing action is not noticeable, (Tscherning, R. Arch. Verdauungskrankh., Bd. 33, P. 332). Lehmann (Lehmann K. B. Arch. Hyg. Bd. 92, 1923, p. 85) has proved, that 0.325 g. of caffeine produced the first signs of disturbances in a person, who was, supposedly, not sensible against tea. Tests made by Cooperman (Amer. J. Physiolog., 105, 1933, p. 24) that in many adults only doses of 0.3 g. started to produce increasing restlessness. Although the observations vary sometimes (Dreikurs, R. Dtsch. Z. Nervenheilk., 107, 1928, p. 184) (Winternitz, Med. Klinik 1934, No. 38) it is generally accepted that the effect of caffeine and beverages containing caffeine are apt to ban tiredness and sleep.

"Science Studies Claims for Tea Presented at Merchandising Forum on Tea."
N. Y. Univ. 1938 Auspices of Tea Association
of United States of America p. 23-26.

Eddy, Walter H.

Summary -- Caffeine in small doses stimulating various body functions.

Let me be technical for a few minutes and quote what I found about
caffeine in a little book entitled "Useful Drugs" published by the
American Medical Association:

"Small doses of caffeine act on the nervous system stimulating the
psychic centers, the respiratory and vasomotor centers and the reflexes.
It modifies the circulation by stimulating the heart and relaxing the
muscles and by direct action. The flow of urine is increased, muscular
contraction is facilitated and fatigue lessened.

Excessive doses produce insomnia, nervousness, headache, palpitation,
and nausea, especially in susceptible persons."

Source -- "Useful Drugs" American Medical Association. 1938

Quoted from Oscar Eichler Coffee and Caffeine, Berlin Springer 1938
(Paneth L., Allg. Automobil Zeitung, Vienna 1935, No. 29).

Summary --- Caffeine beverage tends to sober intoxicated driver.

"A cup of a beverage containing caffeine will have a good effect on a driver who just had taken liquor. For that reason it is necessary that the cafeterias should have beverages containing caffeine available and always on easy reach."

(transl. from German)

"Child's Sleep - Effect of Certain Foods and Beverages on Sleep Motility,"
Giddings, Glenville, - Amer. J. Publ. Health, 24, (6) 609-614, 1934

Summary

Children who have 0.6 grains caffeine in sugared beverage before retiring showed only very minor effect on sleep, identical with effect of orange juice and sugar.

Subjects -- 42 children ages 9-14 years - equally divided as to sex.

Procedure -- Children were at first observed by nurse who recorded changes in position while sleeping - since by this means only gross changes could be noted, authors changed to electrical recording hypnograph.

Study of Normal Sleep Pattern -- 15 consecutive nights 24 children followed normal daily routine. No two children had same sleep curve. First hr. is most active and next most active is last regular hour of sleep. In most cases the 2nd 30 to 60 min. after going to bed is the quietest. Aside from these 2 facts generalities cease and what may happen to one may not happen to other. No sex diff.

Found that as a sex females are sounder sleepers, than males, not only do they get to sleep more quickly but sleep more quietly throughout the night.

Effect of certain Beverages on Sleep -- Beverage was given at 8:15 P. M. and children went to bed at 8:30. Experiment was done on 5 consecutive nights.

Warm Water -- Difference in movements before and after - in 83.3% case had no effect on sleep.

Warm Milk -- 41.7% showed decreased activity - slept more quietly.

A further experiment on 12 children each receiving 6 oz. cold water upon retiring for 5 nights. Found decrease in 16.7% children, increase in 25% and no effect on 58.3%.

Compared results of above to results of drinking cold milk for 5 nights (same children) 16.7% showed diminished activity, 8.3% increased, 75% no effect.

Another experiment on 12 normal children who received 6 oz. of cold beverage containing about 0.6 gr. caffeine and 20 gm. sucrose. Found less activity in none, increase in 18.2% and 81.8% no effect. Comparison experiment using 6 oz. orangeade containing 20 gm. sucrose was given to 12 normal children. Also found less activity in none, increase in 18.2% and no effect on 81.8%.

Conclusions -- (1) A child has a definite sleep pattern. (2) 6oz. warm milk at bedtime seems to produce quieter sleep in normal children. (3) 0.6 gr. caffeine and 20 gm. sucrose proved to be identical in effect with 6 oz. orange juice containing same amount of sugar.

"The effect of Caffein on body temperature and motility during sleep."

.Dpt. of Physiology Univ. of Chicago

American Journal of Physiology 1933 v. 105 p. 24

Cooperman N. R.

Summary: Larger doses of caffeine (4 to 6 grains) cause distinct increase in motility and body temperature during sleep.

Doses of caffeine varying from 0-6 grains were taken by four subjects forty-five minutes to one hour before going to bed. The subjects were usually ignorant as to the amount of caffeine administered since three capsules were taken nightly which may have contained either caffeine, lactose or a combination of both. Rectal temperature was recorded continuously by means of an electrical resistance thermometer and the movements of the bed springs by a pulley lever system. The sum total of all such movements was obtained by means of a Harvard work adder and the time spent in performing such movements was also measured.

The large doses of caffeine, 4-6 grain, caused a distinct increase in motility which was paralleled for the most part by a rise in body temperature. That is to say, the most increases of motility as compared to normal were found to correspond to the most marked increase of body temperature. There was also an increase in the time spent in such motility. Both major movements such as turning over, and minor ones were increased.

"A Pharmacological Study of the Effect of Caffeine Adenin Mixtures."
 Macht, David I. and Schroeder, Hermann.
 Klin. Wochenschrift, 9 Jahrg. No. 52 p. 2430. - 1929

Summary: -- Tea, unlike coffee - contains a substance called Adenin. This substance has the effect of reducing the power of caffeine. Mixtures of caffeine and adenin, in plant and animal experiments, showed less of the expected caffeine effect, than a smaller dose of caffeine administered without adenin.

It is a well known fact, that coffee, even in small quantities, has rather unpleasant effects on many people who show no such effects if they drink tea. People who from 2 or 3 cups of tea experience only mild and pleasant stimulation, complain already after half a cup of black coffee about sleeplessness, nervous excitement and unpleasant palpitations of the heart. The different interpretations given to this well known phenomenon are not satisfactory.

Experimental Results: -- The pharmacological test of caffeine-adenin mixtures was conducted on phytopharmacological and zoopharmacological testing objects. In this test it was found that, in solutions of 1:5000, both caffeine and adenin had a toxic effect on vegetable protoplasm. The method used was that described in earlier papers, the influencing of the growth of lupinus albus seeds. Both caffeine and adenin exhibited a growth-hindering tendency. But solutions of adeninsulfate, 1:5000, were in every case more toxic than caffeine in the same concentration. Most interesting, however, was the observation that combinations of caffeine and adenin in equal parts and also in varied proportions exhibited a distinctly antagonistic effect. Thus, in our case, the mixture did not prove to be as growth-hindering as either substance alone. In other words, a combination of caffeine and adenin exhibited what might be called an antagonistic synergism.

It is well known that the reflex reactions of the frog are slowed down by greater quantities of caffeine, so that, for example, the reflex contraction of the legs, when immersed in a solution of diluted acid, occurs later than is customary. Adenin produces little or no effect, in any case it has no slowing-down effect. Here, too, a solution of adenin and coffee produced an antagonistic effect in that adenin was able to neutralize the effect of irritability.

Furthermore, experiments which demonstrate the stimulating effect of caffeine on the brain have been conducted with rats. The rats were narcotized with Urethan so that a complete but light narcosis was achieved (80-100 mg pro 100g. weight). Then injections of caffeine and adenin, both alone and combined, were given.

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"A Pharmacological Study of the Effect of Caffeine Adenin Mixtures."

Here also we found that a combination of caffeine and adenin did not have as stimulating an effect as the same quantity of caffeine alone. In these experiments pure adenin produced no effect.

Similar experiments were conducted with rabbits, to study the awakening attributes of caffeine. The rabbits received a chloralhydratic narcosis and here also the stimulating effect of caffeine was reduced by adenin. The results of the analysis were very interesting with respect to the effect of caffeine and adenin on the respiration of cats and rabbits both in and out of narcosis. We found that the respiration of both animals in ether narcosis was stimulated by caffeine. Adenin alone (20 mg. pro. Kg) had no influence. If, on the contrary, a stronger dose of caffeine together with adenin (20 mg.) was given, the effect of the mixture was not as great as a smaller dose of caffeine (10 mg) alone.

Experiments on non-anesthetized rabbits, conducted according to a special method of one of the authors, had the same result. Still underway are experiments on the psychological effect of adenin and caffeine on the behavior of trained rats in a labyrinth, also following the above method, and, finally, others which are occupied with the effect of caffeine and adenin on the heart and diuresis.

" A Study of the physiological and psychological reactions of the human organism to coffee drinking."

Hawk, P. B. Amer. J. Physiol. 1929, 90, 380-381.

Summary -- Effects of 2-6 cups of coffee daily: unfavorable effects on nervous system, shortening of sleep, bad dreams, nervousness, dizziness etc.

Subjects -- 100 normal young men.

Procedure -- Coffee given 1-3 times per day over a prolonged period. Physiological and psychological responses of subject were determined at beginning. After period of time on coffee were subjected to same physiological and psychological tests. Studied gastric digestion, kidney function, heart action and number of standardized tests in experimental psychology.

Results -- 2-6 cups daily for weeks or months by men unaccustomed to its use had no injurious action on heart and circulatory system. Increased pulse in sev. cases and cardiac palpitation and increased blood pressure in a few. No outstanding or permanent interference with gastrointestinal functions. Indications of gas formation, indigestion, diarrhea or constipation in 50% cases. Kidney function not deranged to any degree. Mild diuresis in sev. cases. The effect on blood urea and uric acid was variable.

Influence on nervous system was pronounced and unfavorable. Lessening of period of sleep, bad dreams, inability to concentrate, tremors or nervousness, headache and dizziness. Less satisfaction in response to psychological tests. Prolongation of simple R. T. and loss of accuracy in rapid calculating.

"The Influence of Caffeine Alkaloid on the Quality and Amount of Sleep."
 Hollingworth, H.L. - American Journal of Psychiatry, 1912 v.23,
 pp 98-100

Summary

On the average, sleep disturbing effects became noticeable after 6 grains of caffeine have been administered.

However, of 11 individuals, 3 were affected already by small amounts; 3 were not even affected by 6 grains.

Susceptibility to caffeine's sleep disturbing effect varies by individuals and situation. The following factors favor susceptibility:

lower body weight
 if taken without food
 regular daily intake

Subjects -- 10 men; 6 women.

Procedure -- Subjects abstained from coffee, tea, chocolate, cocoa, alcohol, nicotine, and all other drugs - also soda fountain drinks.

Influence of Caffeine on Sleep -- Recorded whether he slept better than usual, ordinary, worse than usual. Assigned values to reports. 200 indicated normal sleep, less than 200 sleep judged unusually good and more than 200 indicated impaired sleep. Statements were made as to no. of hours slept. 7.5 average for group before caffeine administered.

Records of sleep fall into 2 general categories (1) covering 28 days of caffeine alkaloid experiments (2) covering 7 days of experiments with syrups and carbonated water, with and without caffeine contents.

Subjects were divided into squads. Squad 1 consisting of 4 subjects ran throughout 4 weeks on sugar doses only. Squad 2 (3s) took caffeine 3 days and sugar on following 3 days, then again 3 days on caffeine etc. throughout entire experiments. Doses ranged from 1 g. to 6 g. (10:30 A.M.). Squad 3 (3s) took caffeine and sugar doses on alternate days throughout exp. and doses ranged from 1-6 g. and were taken at 1 o'clock lunch hour. Squad 4 (5s) alternated caffeine and sugar throughout exper. with some distribution of days as in case of Squad 3, but dose was taken in mid-afternoon.

Conclusions -- based on M.V. computed.

1. Doses smaller than 6 g. do not cause impairment of sleep, so far as squad averages indicate.

Squad 2 indicate sleeplessness for 6 g. doses.

Squad 3 no sleeplessness

Squad 4 no sleeplessness or deterioration in sleep until 6 g. dose is reached.

Up to 4 g. sleep quality remains quite constant but at 6 g. there is an abrupt falling off.

2. Influence of caffeine depends on conditions under which dose is taken, especially on time of day, contents of stomach and frequency with which dose is taken. Greatest impairment shown by those taking doses on successive days although dose was taken early morning.

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"The Influence of Caffeine Alkaloid on the Quality and Amount of Sleep."

Next greatest impairment in group taking caffeine late afternoon, between meals on an empty stomach.

Squad 3 (caffeine at same time as food), showed no sign of sleeplessness. Presence of food in stomach seems to weaken or completely neutralize its effect.

3. These results are confirmed by a more detailed study of records of individuals making up various squads. Three subjects were not affected even by 6g. 5 remain unaffected until 6g. reached. Only 3 showed signs of disturbance before 6g. reached - affected immediately by small amounts and show increasing impairment with larger doses.

4. Age of individual (21-39 years) does not influence susceptibility to sleep - disturbing effects of caffeine.

5. Previous caffeine habits do not seem to modify individuals susceptibility during experiment. Individuals who were accustomed to regular use of caffeine containing beverages are to be found in each group along with those who have never used coffee, nor tea, or who have used them only occasionally.

6. No sex difference found.

7. Only factor which correlates closely with susceptibility is weight. Average weight of those who are affected by the minimal doses is only 120 pounds. Av. weight of those affected by maximal dose is 149 lbs. while average weight of 3 not affected is 176 lbs.

(Relation between body-weight and action of drugs in a medicinal way is a well recognized principle of pharmacology.)

Influence of Syrups, with and without Caffeine on the Quality of Sleep.

Experiment took one week. On two days no dose was given. Two days given soda fountain syrup containing no caffeine but with carbonated water. Remaining three days, (scattered throughout week) varying amts. of syrup were given, served with carbonated water but containing caffeine alkaloid (1.2gr. per glass) On 1 day 1 glass was taken, on another 3 and on 3rd day 5 glasses. Drink always taken in middle of afternoon. When large amounts were taken drinks were distributed over 2 or 2.5 hours. Small amounts were taken at 3 o'clock.

Subjects: - - 12 from previous experiment.

Confirm conclusions of first experiment. Blank days have a good average quality but no better than for day on which dose consisted of one glass of syrup containing 1.2 g. caffeine. 3.6g. caffeine resulted in poorer quality of sleep than on blank days but no poorer than that reported on days on which same amount of plain syrup was taken.

When 6g. given there is marked signs of sleep disturbance.

Blank days, 1.2 gr. caffeine and plain syrup days all yield 7.5 normal hours of sleep. 3.6 gr. yielded 7.16 hours but after 6g. doses average falls to 6.75 hours.

Subjects didn't know what they were taking; knew only that they received a capsule (or a soft drink was administered).

"The action of Caffeine on the capacity for muscular work "
 J. Physiol. London, 1907, XXXVI, 33-47
 Rivers, W. H. R. and H. N. Webber.

Summary -- Caffeine has a double effect; One, to diminish the effects of fatigue and the other, merely in the nature of a transitory stimulation, followed by so great a reaction, that one could call the effect one of acceleration of fatigue.

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Subjects - 2 - Rand U

Apparatus - improved form of Mosso's ergograph devised by Kraepelin and made by Runne.

Experiment of U -- Lasted 8 days, three sets, each of six ergograms were recorded on morning of each day. On 4 days right hand used, and other 4 days left hand. Weight lifted was 4.5 kg. - interval between ergograms was 2 minutes; the interval between successive lifts two seconds. Between sets there was an interval of $\frac{1}{2}$ hour during which time other subject was performing experiment.

Dose of citrate of caffeine was 0.3 gm. was taken on 4 days 10 minutes before beginning of second set of ergograms, while control dose (mixture of gentian and citric acid) was taken at the corresponding period of work of four normal days.

Recorded: - (1) work in kgm; (2) number of contractions; (3) average heights of contractions obtained by dividing total height through which the weight was lifted by the number of contractions.

Results -- On first ergogram of 4 caffeine days average work was 5 kgm., while control was 4 kgm. This was before caffeine and control doses were given therefore, they differed in absolute amount and this tends to obscure the effects of drug. The dose whether caffeine or control mixture was not taken till the interval between first and second sets, the work of the first set was done under the same conditions in each group of days and the two curves for these sets should, therefore, show a close correspondence. "The closeness of the actual correspondence seems to provide evidence of the satis-

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factory nature of our method and seems to justify the device of expressing the results in percentages of the first ergogram."

The total work of each set seems to show a distinct drug effect - a greater diminution on control than on caffeine days, however difference is not very great.

"The constancy of the difference between the caffeine and the control curves justifies the conclusion that the data show a real though only a slight effect of the drug, for if the difference had been due to chance variations we should have expected the relations between the two curves to be less regular."

Curves for height and number of contractions show that effect on work of first ergogram of each set is due to an increase in number of contractions, while the effect throughout the whole course of sets show itself chiefly in increase in height.

Experiment was carried out in early part of training.

After 6 months a second experiment along same lines but with several important differences was conducted. Five sets of ergograms were recorded. To each of third set intervals were $\frac{1}{2}$ hour but last 2 were 1 hour. Each day experiment took $4\frac{1}{2}$ hours and dose was taken 10 minutes before second set was started. In first two intervals light work was done in connection with tracings third light reading and a few biscuits were eaten; 4th calculations of % etc. Dose was increased to 0.5 gm.. Left arm was now completely trained because subject was a subject in alcohol experiment. Therefore, weight for left hand was increased 5 kg.

Results -- Caffeine taken 10 minutes before 2nd set seems to have produced a remarkably constant increase. Increase is perhaps rather greater at beginning of set but predominance of effect in 1st ergogram is not so striking as in earlier experiment. P. E. are much smaller than difference. Curves agree with those of first experiment.

Experiment on R -- Only 3 sets of ergograms for 4 days - each consisted of 4 ergograms only, 2 with each hand otherwise conditions were same. Even in this experiment several ergograms were incomplete because of pain.

Results -- On normal days total work of 2nd and 3rd sets as compared with first decreased by 25.0 and 16.7 respectively the work of 2nd set on caffeine days only decreased by 3.2% while 3rd set increased 16.4%.

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2nd experiment with same dose lasted 8 days on 4 contractions of finger carried out, while on other 4 contraction was only allowed to reach 2/3 of its usual extent. 2 ergograms with each hand in each set.

Results -- In case of complete and incomplete contractions showed a decided caffeine effect. In case of complete contractions amount of work on caffeine days increased by 25% while on control days it fell off to extent of 22%, this increase on caffeine days being due to increase in number of contractions, though there was also an effect on heights, for these remain level instead of decreasing as on control days. In case of incomplete effect is not so pronounced and is more evident in 2nd than 3rd set of ergograms. Falling off of 6% here as compared to 22% in complete more effect on left hand.

6 months later third experiment - now due to practice could do 5 sets of 6 ergograms - same as U but only right hand used. Caffeine dose was same - experiment discontinued after 6 days.

Results -- In 2 set no sign of caffeine effect, in 3rd and 4th there is a very pronounced increase in first or 1st and 2nd ergograms, while in remaining ergograms curves of caffeine days fall below those of control days.

Curves show that increase in beginning of each set is due to increase both in number and height of contractions, but decrease as sets of ergograms were continued was entirely due to decrease in number of contractions, "the curves for height remaining in some cases above those of normal days, though not to an extent which would justify any decided conclusions as to the action of the caffeine in this respect."

Conclusions -- (1) Caffeine produces increase in capacity for muscular work, this increase not being due to various physical factors which were here excluded. (2) Ind. diff. in actions of drug at different stages of a set of ergograms. (3) Diff. in effect on no. and height of contractions.

"These facts seem to point strongly to a double action on the part of caffeine. One effect which is consistent throughout a set of 6 ergograms and another which shows itself chiefly at the beginning of each set, the former acting predominantly on the height of the contractions, the latter on their no.. Former may be said to be one which diminishes the effects of fatigue, while other is merely of the nature of a transitory stimulation followed by so great a reaction that we are justified in speaking of the effect as one of acceleration of fatigue."

"Some Scientific Aspects of Tea Drinking"
Wade, Frank, B. Indiana Acad. of Science, 1905

Summary -- Tea is wholesome, aromatic, stimulating and gives pleasure to its users.

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Many functional disturbances arising from the lack of water might be removed by acquiring the habit of tea drinking.

To persons of sedentary life with digestive power not of the strongest... The cup of tea is probably of material aid in facilitating natural digestion. It also acts as a mild stimulant on account of the presence of the alkaloid theine.

Any reasonable use of tea is unlikely to cause serious reaction from this stimulant and the benefits upon digestion, of the cheerful state of mind produced by it probably more than compensate for any drain produced by it upon the nervous system.

I may then conclude that tea ... affords a wholesome source of fluid for the body, while at the same time it gives, on account of its aromatic flavor and slightly stimulating properties a pleasure to its users which makes it worthy of a far more extended use among us than it has yet reached.