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FEATURE

Breakfast for Academic Performance

Gary Hullquist

Abstract: *Breakfast has long been shown to be an important part of a healthy lifestyle. But recent changes in society find ever larger numbers of individuals choosing not to eat in the morning. Studies show connections between breakfast eating and various aspects of brain function, lowered abdominal fat, and behavior, though not all studies show significant differences. Reasons for not eating include a lack of time, appetite, and attempts to lose weight. A typical breakfast is high in fat, calories, and carbohydrates, but a healthy breakfast should be more balanced, containing more fiber, nuts, and whole foods, and less dairy, caffeine, fats, and sugars.*

"Therefore I tell you, do not worry about your life, what you will eat or drink; or about your body, what you will wear. Is not life more important than food, and the body more important than clothes?" (Matt 6:25). Do not think about what you will eat? Perhaps we *should* think about what we should eat!

After all, "you are what you eat." And if you don't eat breakfast…you haven't *eaten* anything. Nutritionists, dieticians, and health educators all agree that a good breakfast has recognized benefits for students beyond simply feeding their growing bodies. The past two decades have shown a noticeable increase in attention directed toward the role that this foundational meal has on cognitive function.

Breakfast Benefits

According to the Dairy Council of California report of 2009, students eating breakfast had

- "Improved attention in late morning task performance"
- "Quicker, more accurate retrieval of information" (better memory performance)
- "Fewer errors in problem solving"
- "Better concentration and ability to perform complex tasks."

Just a reminder of how complicated the human brain is compared to the latest technology: The IBM Blue Gene/P is the latest attempt to build a simulated human brain. Blue Gene consists of four refrigerator-sized racks each containing 16,000 individual processors which together can process 56 teraflops per second (a teraflop is one trillion floating-point operations). With this IBM is able to simulate 1000 virtual neurons in a single neocortical column of a two-week old rat.

But does fueling our brains with breakfast really make a difference in academic performance? A 2002 study of 97 inner city children at nutritional risk were shown to have poorer attendance and grades than a similar group of well nourished students. Testing 6 months after the start of a free school breakfast program demonstrated significantly greater improvements in attendance and math grades (Kleinman et al., 2002). This confirms the findings from 13 years earlier when 1023 low-income 3rd-5th grade students also nutritionally at risk had "significantly greater gains" in overall standardized test scores for math, reading and vocabulary than their well-fed counterparts when they participated in a school breakfast program (Meyers et al., 1989).

Five years ago, 1405 9-10-year old primary school children and 1317 parents reported in a self-administered questionnaire about their breakfast eating habits. Academic performance was based on the students' report card grades, and intellectual performance was assessed with Raven's Colored Progressive Matrices. The best academic performance was found to correlate with breakfast eaters and a history of breast eating, higher family income and educational levels of the parents. Increasing student BMI (16.3% overweight, 6.3% obese) was associated with lower scholastic performance in those not eating a regular breakfast (Anuar Zaini et al., 2005).

Breakfast and Behavior

Teachers have long appreciated the relationship between hunger and classroom performance. Research shows that as the length of time between meals increases, concentration suffers (Derelian, 1994). Aggression and anxiety at school are also strongly associated with hunger. Public schools in Philadelphia and Baltimore measured performance before and after the start of a free breakfast program in a study involving 133 students in the late 1990s. Breakfast eaters were noted to pay closer attention in class, receive higher grades in math, and behave positively, with significantly improved attendance, punctuality, and reduced depression, anxiety and hyperactivity (Kleinman et al., 1998). A 3-year school breakfast program in 6 Minnesota elementary schools reported the same year showed "general increase in composite math and reading scores" (Minnesota Department of Children, Families, & Learning, 1998).

Breakfast first began to be seriously studied in the 1980s. Nearly all the results reported better cognitive performance in students who ate breakfast before school (see for example; Pollitt et al., 1981-83; Simeon & Grantham-McGregor, 1989; Worobey, 1999). The Simeon and Grantham-McGregor (1989) experiment compared the effects of breakfast on cognitive function in three groups:

- 30 students with normal growth patterns
- 30 students with stunted growth patterns
- 30 students who were malnourished/undernourished (lacking essential vitamins, minerals, calories)

All students were tested with:

Arithmetic assays (digit-span, coding test subsets of the Wechsler Intelligence Scale for Children), measuring attention span, math skills, short-term memory, speed, and accuracy.

Fluency and listening comprehension tests (Clinical Evaluation of Language Functions), and capabilities to generate ideas, auditory short-term memory.

Matching Familiar Figures Test (MFFT) measured problem-solving ability and response speed

Hagen's Central-Incidental Task measuring visual short-term memory.

Breakfast skipping was found to have a greater negative impact on performance in poorly nourished & stunted children (Simeon & Grantham-McGregor, 1989).

From 1981-1983, Pollitt studied children ages 9-11 who were given a breakfast of waffles and syrup, margarine, orange juice, and milk. A control group was given non-caloric, non-caffeinated drink. After one week, the groups switched diets. Real breakfast eaters were found to make fewer mistakes on their tests. In a 1995 study, Pollitt measured cognitive functioning in fasting children and teenagers. Negative effects were once again worse in undernourished students.

In another study, two randomized controlled trials investigated the effect of a school breakfast on achievement test scores and school attendance in rural Jamaica. Combined, the studies followed over 900 students for one year and demonstrated improved performance in the breakfast eaters (Powell et al., 1983). These results were consistent with other studies in Malaysia and Korea showing benefits in grades, school attendance, and tardiness rates (Boey, Omar, & Philips, 2003; Kim et al., 2003; Kleinman et al., 2002).

College, Memory and Glucose

What about older students? In one study involving 33 university students (16 men, 17 women) with an average age of 21.3 years, measured recall of word lists, spatial memory tests, the Wechsler Memory Scale, abstract reasoning tests demonstrated that blood glucose is an important function of memory but not general intelligence (Benton & Parker, 1998).This was consistent with another 1988 study determining that glucose accounts for memory improvement (Morse & Pollack).

One study of 1259 college students which took place over an 11-year period measured students' grades on a General Biology exam. Of the students who took the exam, 65% had eaten breakfast. A higher percentage of breakfast eaters passed the exam than those who had skipped (Phillips, 2005).

Evaluation of 96 freshmen undergraduate students showed that 54 were breakfast eaters, 42 skippers. Memory test scores were significantly better in breakfast eaters (4.4 vs. 3.4) but all other measurements (alertness, participation, attention span, concentration, mood, note-taking, and test-taking) showed no difference. The hope is that if students routinely eat a nutritious breakfast "there will be less reliance on medication (e.g., Ritalin and anti-sleep agents) to help people function" (Staub, 2008).

One study of 569 students ages 11 to 13 years old measured performance of tests taken 30 minutes after a school-administered breakfast. Recall was improved even if the students had eaten breakfast at home earlier (Vaisman et al., 1996).

Children who participated in the 2005 School Breakfast Program sponsored by the US Department of Agriculture had greater cognitive achievement (Taras, 2005). But it has also been demonstrated that carbohydrates can have adverse effects on performance in children—the hyperactive "sugar high" noted by parents for decades interferes with concentration (Worobey & Worobey, 1999).

Backsliding Breakfast

"The most important meal of the day" is also the meal most often skipped. One study found that up to 50% of all children in US schools arrive at school hungry (Dairy Council of California, 2009). Because of this, more schools are providing breakfast at school. The problem tends to increase with age. Another study showed that only 10% of elementary school, but 25% of middle school, and 30% of high school students start their day without breakfast (Meyers et al., 1989). A third study showed that breakfast consumption by children declined between 5% and 20% (pre-schoolers and adolescents respectively) over a 30 year period from 1965 to 1995 (Rampersaud, et al., 2005). Breakfast skipping

was found to be more prevalent among girls, adolescent smokers, and those engaging in infrequent exercise.

Why skip?

Four primary reasons are most often offered for not eating breakfast.

1. No appetite, not hungry in the morning because they had a big supper the night before
2. No access to food (low socioeconomic status)
3. Diet strategy to lose weight
4. No time.

Several studies have shown that actually it is breakfast skippers who tend to gain weight. Breakfast eaters tend to consume more daily calories yet are less likely to be overweight—a point promoted by the Kellogg cereal ads (Rampersaud et al., 2005). A 2009 study involving 93 teenagers 10-17 years old concluded that "breakfast skipping was related to increased intra-abdominal fat independent of age, gender, total fat, total lean tissue, and total energy intake" (Alexander et al., 2009). In addition, kids who eat early in the day (breakfast and a corresponding early or smaller supper) tend to have better overall nutrition and are less likely to be obese (Boutelle et al., 2002). In adults, breakfast skipping is also associated with increased risk of obesity (Ma et al., 2003). Ready-to-eat or cooked cereal breakfasts have been associated with lower BMI (Cho et al., 2003), but some see this association only in women (Song et al., 2005).

Skipping breakfast because of lack of time is closely related to sleep deprivation. Adolescents are often too exhausted to eat in the morning. With little sleep because of too much midnight oil the night before, whether socializing or studying, the youth want to just sleep in. There is no time to eat. Besides, after 6-8 hours of network deprivation (AKA sleep) the first priority in the modern broadband family is checking e-mail, twitter and facebook accounts.

But teenagers, who still need 9 hours sleep each night, with active social lives, just aren't getting it. When they average only 7 hours sleep on weeknights, no wonder they sleep till noon on weekends! Night owls do not perform well in the morning; early birds do. Are you a morning person or a night owl? Tradition says: "Early to bed, Early to rise makes a man healthy, wealthy, and wise." But one's ability to rise and shine depends on sleep patterns and time-of-day preference. Breakfast-eaters have been shown to excel at memory-related tests taken in the morning. Lack of sleep is also associated with poor academic performance and moodiness (Schaffer, 2005).

The Consequences of Skipping Breakfast

A Norwegian study of interviewed 7343 10th grade students (ages 15-16) for breakfast eating habits. Girls reported a rate of 27% breakfast skippers, whereas only 19% of boys missed the first meal of the day. Boys, however, reported that they were "mentally distressed" when skipping breakfast twice as often as girls. The study concluded that "Implications of skipping breakfast on mental distress and academic performance are stronger for boys than girls" (Lien, 2002).

Meta-Analysis of Breakfast Eating Studies

The role of breakfast in enhancing cognitive performance has been shown to alleviate hunger, supplying nutrients to the central nervous system, particularly glucose. However, several experimental studies have failed to demonstrate a significant association between test performance and blood glucose concentrations. This has led to the suggestion that breakfast might cause a change in neurotransmitter concentrations (Pollitt, 1995; Pollit & Matthews, 1998).

In fact, a 2005 meta-analysis (Rampersaud et al.) reported "no significant difference" among the 47 studies reviewed between those showing a significant effect and those not showing a significant effect of breakfast on a series of attributes (see Table 1). Except for math, the subjective attributes (attention, impulsivity, reasoning, creativity) were those most difficult to measure a consistent positive response to breakfast eating on academic performance. In all, 22 of the studies specifically addressed the issue of academic performance and supported the observation that breakfast-eating seems to "improve cognitive function related to memory, test grades, and school attendance."

Part of this failure to find significance between breakfast and academic performance could have to do with definitions that are not explicit, at least in the study writeups. How many days a week must one eat breakfast to qualify as a breakfast eater? Once a week? Every day? How much breakfast qualifies? A full-course meal? At least 25% of the daily calories? A donut? Do we just measure calories or a balance of nutritional components? For example, breakfast may provide 25% of the daily calorie intake but it may be all fat and sugar! This sort of information was not indicated in the meta-analyses, and might explain at least part of the variance encountered.

Diabetes of the Brain

Not only relating to breakfast, is there a more general correlation between nutrition and cognitive function? A new potential relationship between food and brain function is what some investigators are calling Type 3 Diabetes: Alzheimer's disease. Some Alzheimer's patients exhibit low insulin levels and

insulin resistance in the brain just as peripheral insulin resistance is associated with Type 1 and 2 Diabetes (DeFronzo, Simonson, & Ferrannini, 1982).

The controversy over whether Alzheimer's dementia is caused by beta-amyloid placques or neuro-fibril tau protein tangles continues but the cause may be more fundamental: glucose starvation from insulin deficiency. In fact, Type 1 and 2 Diabetics have a 65% risk of developing Alzheimer's disease.

Suzanne de la Monte at Brown University demonstrated that reducing insulin levels in mice brains could produce a model of Alzheimer's in rodents complete with plaques and tangles (Steen et al., 2005). Bill Klein at Northwestern showed that hippocampal brain cells responsible for memory were protected by the presence of insulin in tissue culture from destructive amyloid concentrations. Seattle clinical trials in 2007 showed significant improvement in attention and memory recall in early Alzheimer's patients receiving daily intranasal insulin puffs (Craft, 2009).

Table 1

Performance Differences in Meta-Analysis of Breakfast Studies

Performance attribute	Significant	Not significant
Attention, concentration	3	7
Memory	8	6
Impulsivity	2	2
Reasoning	1	1
Creativity, idea generation	2	1
Problem solving, addition, math	3	6
Learning	1	1
Vocabulary	1	
Discrimination	1	
Physical endurance	1	
Academic/achievement test scores	4	
Academic grades	3	
School attendance	6	
School tardiness	2	1
Psychosocial function	2	
Total	40	25

Breakfast Composition

Not only when we eat it, but what we eat for breakfast is critically important. The typical American breakfast consists of:

	Calories	Fat	Protein
Ham & cheese omelet (10oz)	590	44g	40g
Donut (glazed, cake-like)	310	19g	4g
Egg McMuffin with cheese	300	12g	18g
Scambled eggs (4oz)	250	21g	13g
Fried hash browns	210	12g	2g
Cold cereal and milk	190	2g	5g
Fried Sausage (2 links)	182	18g	5g
Biscuits and gravy	160	11g	3g
Waffles	130	5g	3g
Pancakes	110	3g	3g
Fried egg	92	7g	6g
Fried bacon (2 strips)	90	7g	7g

Carbohydrates: lots of sugar in pancake syrup, donut icing, sugary cereals.

Protein: lots in eggs, ham, cheese.

Fat: too much in fried eggs, fried sausage, fried bacon, fried pancakes, fried potatoes, and deep-fried donuts.

There are some problems with these excesses. Simple **sugar** spikes produce excessive insulin response with short peak times. **Protein** requires increased gastric acid production for proteolysis, and this produces systemic metabolic acidosis, and calcium mobilization to buffer the depressed blood pH. This process contributes to tooth decay and eventual osteoporosis. High **fat** intake raises blood viscosity, increasing the tendency for red blood cells to adhere to each other and create the clumping patterns known as Rouleaux formation. Thick plasma and cell "sludging" reduce the amount of oxygen carried to the peripheral parts of the body.

Breakfast Quality and Academic Performance

In one study, 132 college students in three university classes recorded their breakfast intake over a 4 week period. Test scores recorded from 2 exams showed no correlation between breakfast eaters and breakfast skippers and total calories, but if the carbohydrate content was greater than 65%, this had a significant negative effect on academic performance, and fat intake of more than 20 % of the total calories had a negative effect on test scores (Fekete & Head, 1997).

A Healthy Breakfast

The old saying is true, and should be followed:

Eat breakfast like a king,
lunch like a prince,
and supper like a pauper.

Eat dessert for breakfast! You have all day to work it off. But don't have ONLY desert for breakfast! Remember, breakfast *quality* must be balanced: carbohydrate, protein, and a little fat. Complex carbohydrates for slow, sustained glucose release, and limited protein, limited fat provides adequate medium and long-term energy release without detrimental side effects.

A healthy breakfast should include a balanced assortment of fruits, grains, nuts and seeds. Fruits provide a natural source of glucose for the brain, grains, nuts and seeds provide protein for intermediate energy needs, and fats in the form of free fatty acids in germinated seeds and nuts deliver long term release of energy for endurance. The goal is to stay energized until lunch: to sustain blood sugar (principal brain energy substrate) for 5-6 hours.

Fruit glucose is packaged along with important flavonoids, phytonutrients, vitamins and enzymes needed to digest and deliver the glucose in an effective, sustained pattern of bioavailability. The choices are abundant:

Sweet Fruits: Apple, apricot, banana, cherry, grapes (raisins), dates, guava, mango, nectarine, peach, papaya, pear, persimmons, plums, pomegranate, tamarind, melons, cantaloupe.

Citrus Fruits: oranges, lemons, limes, grapefruit, tangerines, kumquat.

Other Fruits: olives, avocado, tomato, beans, peas, eggplant, cucumbers, squash, pumpkin.

Grains: Rice, wheat, oats, barley, rye, corn, millet, quinoa, amaranth.

Seeds: Sunflower, pumpkin, sesame, flaxseed, poppy seed, breadfruit, chia.

Nuts: walnuts, almonds, pecans, brazil nuts, cashews, hazel nuts, macadamia nuts, pine nuts, peanuts (ground nuts) coconut, chestnuts, hickory nuts.

Nutritional News about Nuts and Seeds

Nuts are seeds. They are an excellent source of protein and fat. Seeds, like eggs, need a supply of energy for new plant growth. Sprouting and germination depend on the storage of protein (4 calories/g) and fat (9 calories/g) within the seed. Seeds also need protection against premature germination, e.g. inside the gut of birds, so they contain enzyme inhibitors for this purpose.

Enzyme inhibitors like those contained in seeds prevent proteinases and lipases from immediately activating when exposed to moisture. Extended water environments, however, will leach the enzyme inhibitors out of the seed and allow germination to proceed.

Proteins are broken down into amino acids; fats into free fatty acids; carbohydrates (starches and polysaccharides) into simple sugars, glucose—these are the active ingredients and building blocks of new protein synthesis for sprout structure (new leaves, shoots, roots) and the energy needed by cells to accomplish all this.

Enzyme inhibitors have become a new area of research in the fight against AIDS. In the late 1990's an explosion of investigation identified anti-trypsins, anti-proteinases as effective inhibitors of virus replication. Hundreds of studies began to appear in the scientific literature. (Luckett, 1999; Schubert, Lansky, & Neeman, 1999; García-Carreño, 1996).

We can benefit from the transformation that occurs in the germination process by soaking nuts in water and pouring off the enzyme inhibitors for 18-24 hours, allowing germination to begin, changing the fats and proteins into readily digestible forms that reduce the need for our own body to produce digestive enzymes. The prevalence of diabetes may correlate with the increased use of cooked, denatured, enzyme depleted foods.

Many nuts, especially walnuts, are excellent sources of omega-3 fatty acids popularized by fish oils. Omega-3 fatty acids smooth out abnormal heart rhythms and, like aspirin, they prevent blood clots from forming by reducing platelet stickiness making them less likely to clump.

Nuts are also rich in arginine, the amino acid our bodies use to make nitric oxide, which is important in relaxing narrow blood vessels improving blood flow. Nuts also contain natural vitamin E, folic acid, magnesium, potassium, and fiber.

Pulses are dried beans and peas that can be sprouted. The pulse on which Daniel thrived was sprouted grains and seeds. He tested ten times wiser than all others enrolled at the University of Babylon. Pulse is 25% protein by weight, twice the protein of wheat and three times that of rice.

Yellow pea flour is being touted as a low glycemic index food to replace wheat in the management of type 2 diabetes. A 2009 study concluded that "pulses, including yellow peas, are now being studied as potential functional ingredients in foods because they possess a number of health benefits. They are high in fiber, protein, and antioxidants and are low in fat. Eating whole pulses has also been shown to lower glucose levels after meals" (Marinangeli, 2009).

The word *almond*, al-mond means "all world" (monde) Nuts like almonds are best eaten as the first food of the day. This sets the blood sugar throughout

day, and they are best digested at that time, as HCL acid is highest in morning after concentrating through the night. Eat 1 almond per 10 pounds body weight (more if you want to gain weight, less if you want to lose).

The Department of Nutrition, School of Public Health, Loma Linda University, reported on "one of the most unexpected and novel findings in nutritional epidemiology" —that nut consumption is protective against ischemic heart disease (Sabate, 1999, p. 500S).

> In a large, prospective epidemiologic study of Seventh-day Adventists in California, we found that frequency of nut consumption had a substantial and highly significant inverse association with risk of myocardial infarction and death from IHD (ischemic heart disease). The Iowa Women's Health Study also documented an association between nut consumption and decreased risk of IHD. The protective effect of nuts on IHD has been found in men and women and in the elderly. Importantly, nuts have similar associations in both vegetarians and nonvegetarians. The protective effect of nut consumption on IHD is not offset by increased mortality from other causes. Moreover, frequency of nut consumption has been found to be inversely related to all-cause mortality in several population groups such as whites, blacks, and the elderly. Thus, nut consumption may not only offer protection against IHD, but also increase longevity. (Sabate, 1999, p. 500S)

Suggested Breakfast Menu Exclusions

Cold cereals require milk—or do they? Milk has come under scrutiny in recent years. It has been found to be a causative factor in juvenile diabetes, and adult osteoporosis. Insulin-like Growth Hormone (IGF-1, Insulin Growth Factor) effects are also of serious concern.

Caffeine is often considered a vital necessity for anyone starting their day. It may get you going, but there are side effects. Caffeine is a central nervous system stimulant that can increase triglycerides, blood pressure, induce cardiac arrhythmia, disturb sleep patterns, and in males of reproductive age, increase the risks of birth defects due to chromosomal changes. Caffeine is also addictive. The best practice? Get naturally tired and get a full night's sleep. Rest naturally and wake up naturally.

Conclusion

When considering the major factors affecting academic performance among the student population, breakfast is without question a significant contributor. Benefits include improved late morning attention, memory, concentration, math and reading skills, reduced aggression, anxiety and absenteeism.

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Gary Hullquist, M.D.
J. A. Thomas & Associates
Atlanta, Georgia