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Breakfast Choices Influence Brainwave Activity: Single Case Study of a 12-year-old Female

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Abstract

Research into the benefits of children eating breakfast has previously focused on educational and cognitive performance as well as behavior. Few nutritional investigations have utilized brain imaging technology in order to examine how breakfast influences brain function. This single case study used quantitative electroencephalography (qEEG) in order to assess how three different breakfast choices affected a 12-year-old female's brainwave activity. The three different breakfast conditions included no breakfast, a high-sugar/high-carbohydrate breakfast, and a nutritionally balanced breakfast. The findings indicated that skipping breakfast significantly increased high beta activity associated with anxiety and focus issues. Eating a high-sugar/high-carbohydrate breakfast was also associated with increased high beta activity, but less significant than the no-breakfast option. Most importantly, eating a nutritionally balanced breakfast was found to normalize the qEEG. The variation in high beta activity in the different breakfast options suggested that eating a nutritionally balanced breakfast may reduce anxiety and increase focus compared to skipping breakfast. These results may help explain why previous research has found cognitive, academic, and behavioral improvements when children consume breakfast. Furthermore, the qEEG should be considered in future nutritional studies as a measurement of brain function.

Keywords: breakfast; nutrition; qEEG; children; performance; behavior

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Introduction

Breakfast is commonly considered the most important meal of the day. Previous research has emphasized the importance of a healthy and balanced breakfast. O'Neil et al. (2014) proposed the definition of breakfast as "the first meal of the day that breaks the fast after the longest period of sleep and is consumed within two to three hours of waking" (p. S9). They suggested that a quality breakfast should be composed from at least three food groups like lean proteins, fruits/vegetables, nonfat or low-fat dairy, and fiber-rich grains. In addition, O'Neil et al. (2014) advised that breakfast should consist of 15–25% of recommended total daily calories depending on their metabolic output.

Such guidelines have been widely disseminated, yet breakfast is commonly omitted by people of all ages. Deshmukh-Taskar et al. (2010) and Corder et al. (2011) found that approximately 20–30% of school-age children and adolescents skip breakfast in developed countries. Furthermore, it has been shown that children and adolescents who do eat breakfast often choose foods that are high in sugar and carbohydrates. A study by Corcoran, Elbel, and Schwartz (2016) evaluated the federally subsidized school breakfast program for disadvantaged children in New York City and found no evidence of gains in academic performance. The study reported low turnout of children coming in early to eat a hot nutritious breakfast in the cafeteria. Because of this, they instituted an in-the-classroom breakfast that contained “cold prepacked items such as cereal, fresh fruit, or bagels” (p. 5). The academic performance gains that Corcoran et al. (2016) were expecting could have been nullified due to the high-sugar and high-carbohydrate nature of the in-classroom meals.

Breakfast has been previously recognized to improve educational outcomes (Littlecott, Moore, Moore, Lyons, & Murphy, 2015) and behavior (Ahadi et al., 2016). Adolphus, Lawton, and Dye (2013) conducted a systematic review of studies involving children and adolescents. They assessed 19 studies on the effects of breakfast on behavior and 21 studies on the effects of breakfast on academic performance. Overall, the evidence from these studies suggested that breakfast positively influences on-task behavior in classrooms, particularly in children under 13 years of age. In addition, Adolphus et al. (2013) found a positive association between the quality of school grades or achievement test scores and habitual breakfast frequency. This result was notably seen in children of deprived or low socioeconomic backgrounds and undernourished children. The conclusion of the review stated that the beneficial outcomes of breakfast were clearer on academic performance in comparison to behavior (Adolphus et al., 2013).

Although cognitive performance is related to academic performance, it is an area under separate investigation. Evidence indicates that consuming breakfast had a positive relationship to cognitive performance in schoolchildren (Hoyland, Dye, & Lawton, 2009; Wesnes, Pincock, & Scholey, 2012). In a study conducted on kindergarten children, those who consumed breakfast regularly had significantly higher full-scale, performance, and verbal scores on Intelligence Quotient (IQ) tests compared to children who consumed breakfast infrequently (Liu, Hwang, Dickerman, & Compher, 2013). Adolphus, Lawton, Champ, and Dye (2016) conducted a systematic review of studies assessing the impact breakfast had on the cognitive performance of children and adolescents. Their review found that breakfast consumption had a temporary beneficial increase in cognitive function within four hours of the meal. Their findings indicated that breakfast affected specific cognitive domains, specifically in tasks that require executive function, memory, and attention. Specifically, Cooper, Bandelow, and Nevill (2011) found that breakfast consumption improved accuracy on Stroop tests and responses on visual search tests, as well as improved response times on the Sternberg paradigm. The data from the review by Adolphus et al. (2016) also indicated that the beneficial effects on cognition were more apparent in undernourished children when breakfast was consumed as opposed to those who fasted. In the review, only a few studies were found to have compared the impact of breakfast composition. Brindal et al. (2012) compared lower glycemic breakfasts with higher glycemic breakfast and found some evidence that cognitive performance was enhanced when blood glucose concentrations returned to baseline. Similarly, Taki et al. (2010) found that the difference in the glycemic index of breakfasts modifies brain gray and white matter volumes, as well as cognitive function in healthy children. However, because of the paucity of studies that examine the outcomes of breakfast composition, firm conclusions cannot be drawn.

Prior studies on breakfast consumption discussed measuring changes in performance or behavior. Another area of investigation is changes in brain metabolism, structure, and function. Sizonenko et al. (2013) provided a comprehensive review of brain imaging techniques that could have utility in nutritional intervention studies. They evaluated multimodal magnetic resonance imaging (MRI), as well as electroencephalography (EEG), magnetoencephalography (MEG), near-IR spectroscopy (NIRS), positron emission tomography (PET), and single-photon emission computerized tomography (SPECT). Their review revealed that the number of nutritional studies using these techniques outside of clinical settings were limited and that this was likely due to the high cost of the technology, the imaging methodology not being sensitive enough to detect changes, and the lack of guidelines for standardization and data collection (Sizonenko et al., 2013). Pivik, Tennal, Chapman, and Gu (2012) performed spectral analysis of EEG activity to examine the influence of breakfast on mental arithmetic functions in children. Their findings suggested that brain activity involved in the processing of arithmetic calculations was enhanced when breakfast was consumed (Pivik et al., 2012). Spectral analysis has rarely been used to evaluate nutrition, although the study by Pivik et al. (2012) produced promising results. The quantitative EEG (qEEG) spectral analysis establishes parameters of normalcy for age-matched individuals, and this could be a valuable investigative tool (Cantor & Chabot, 2009). These benchmarks could be used as references to compare changes under different experimental conditions, for example, the impact of nutritional.

In order to investigate the utility of qEEG when assessing the nutritional intake of children, we sought to design a single case study that would not only further the research of brain function but also investigate how different breakfast choices change measurable electrical output. This study will analyze qEEG data in order to determine how three different breakfast conditions affect brainwave activity in a 12-year-old female. We expect that conditions of no breakfast, high-sugar/high-carbohydrate breakfast, and nutritionally balanced breakfast will produce differential effects on the qEEG as compared to the normative sample. This data would suggest that children's eating habits in the morning have an effect on their performance and behavior due to the electrical state of their brain. In addition, we propose that the qEEG be utilized in future nutritional studies, as it provides an informative measure of change regarding educational and cognitive performance and behavior.

Methods

Subject

The subject of this single case study is a healthy, neurotypical 12-year-old female with no mental or physical health issues. At the time of the study, she was a high-performing 7th grade student at a private college preparatory school for girls. The subject reported herself as a breakfast skipper: she regularly did not eat breakfast before going to school. She also reported experiencing anxiety and difficulty to focus her attention prior to eating lunch. The subject has provided written consent for the publication of this study in accordance with the Declaration of Helsinki.

Procedure

Three sets of EEG/qEEG data were recorded with different breakfast conditions on separate days over a 3-week period. Each recording was done at 12:00 p.m. prior to the subject eating lunch. All three sets of data were recorded on a day when the subject was attending school. The first set of EEG/qEEG data was recorded on a day where the subject ate no breakfast. The second set was recorded on a day when the subject ate a high-sugar/high-carbohydrate breakfast. The high-sugar/high-carbohydrate breakfast condition consisted of one fruit-filled toaster pastry and one glass of orange juice. The third set of data was recorded when the subject ate a nutritionally balanced breakfast, following USDA guidelines (U.S. Department of Agriculture, 2000) that consisted of two scrambled eggs, one half slice of toasted wheat bread, one and one fourth cup of tomatoes, one half cup of fruit (strawberries, bananas, and apples), and one cup of whole milk.

In order to prevent variables other than the breakfast conditions from influencing the brainwave activity of the subject, controls were set. The following variables were consistent for each of the three EEG/qEEG recordings: 1) 8 hours of sleep prior to the day of data recording, 2) the time of the recording was 12:00 p.m. on a weekday (Monday–Friday), and 3) data was recorded while the subject was at a resting state with eyes closed.

EEG acquisition was done using TruScan EEG 32-channel equipment (DEYMED Diagnostic, Payette, ID). The subject was seated in a slightly reclining chair in a silent and low-light environment. Electro-Cap™ (Electro-Cap International, Inc., Eaton, OH) was used to collect the data according to the International 10–20 System with Linked Ears (LE) montage (Fp1, Fp2, F7, F3, Fz, F4, F8, T3, C3, Cz, C4, T4, T5, P3, Pz, P4, T6, O1, and O2). The data was processed and then sent to a board certified electroencephalographer for analysis.

Results

Absolute power eyes-closed data was analyzed for each of the three qEEGs with LE montage. The *Z*-score results are presented in Tables 1, 2, and 3. The hertz (Hz) range from 1 to 30 was assessed in each qEEG. The only significant range affected was high beta, with the delta, theta, alpha, and low beta ranges within the normal variation of the mean. The significant deviations from the mean found in absolute power were in the 26 to 28 Hz range in qEEG 1 and in the 27 to 30 Hz range in qEEG 2.

For qEEG 1 (no-breakfast condition): Table 1 shows 2.0 to 4.0 standard deviations (*SD*) above the mean in the 26 to 28 Hz range in the frontal, central, and left posterior temporal regions (F7, F3, Fz, F4, C3, C4, T5, P3) with a mean of 2.9 *SD*.

Table 1
Absolute Power LE High Beta Standard Deviations – qEEG 1 (No Breakfast)

	25 Hz	26 Hz	27 Hz	28 Hz	29 Hz	30 Hz
FP1	0.7	1.3	1.6	1.2	1.2	1.3
FP2	0.3	0.6	0.6	0.9	1.0	1.4
F7	0.8	1.3	2.0*	1.3	0.8	0.8
F3	1.3	3.3**	4.0**	2.5*	1.1	1.1
Fz	1.1	3.0**	4.0**	3.0**	1.7	1.5
F4	1.0	2.7*	3.9**	2.9*	1.6	1.2
F8	-0.1	0.3	0.8	0.5	0.5	1.0
T3	-0.1	0.5	0.8	0.2	0.0	0.0
C3	1.4	1.7	2.7*	1.6	0.5	1.2
Cz	0.9	1.4	1.8	1.3	0.8	1.3
C4	1.6	1.8	2.5*	1.6	0.9	0.9
T4	-0.3	0.2	0.7	0.2	0.0	0.0
T5	1.3	2.2*	2.5*	1.9	1.4	1.6
P3	1.3	2.0*	2.5*	1.9	1.3	1.3
Pz	1.0	0.9	1.2	1.6	1.2	1.5
P4	0.8	1.1	1.2	1.2	1.4	1.4
T6	0.8	1.3	1.9	1.4	1.7	1.7
O1	0.7	0.9	1.3	1.4	1.5	1.5
O2	0.4	0.8	1.2	1.1	1.1	1.4

* => 2.0 < 3.0 *SD*; ** => 3.0 *SD*.

For qEEG 2 (high-sugar/high-carbohydrate condition): Table 2 shows a 2.0 to 3.5 *SD* above the mean in the 27 through 30 Hz range in the left anterior temporal, frontal, central, left posterior temporal, and mid parietal regions (F7, F3, Fz, F4, C3, Cz, C4, T5, Pz) with a mean of 2.5 *SD*.

Table 2
Absolute Power LE High Beta Standard Deviations – qEEG 2 (High-Sugar/High-Carbohydrate Breakfast)

	25 Hz	26 Hz	27 Hz	28 Hz	29 Hz	30 Hz
FP1	0.5	1.0	1.6	1.4	1.4	1.3
FP2	-0.1	0.9	0.9	1.5	1.1	1.1
F7	0.5	1.0	2.1*	1.8	1.9	1.8
F3	0.7	1.9	3.5**	2.7*	2.4*	1.8
Fz	0.8	1.6	3.0**	3.3**	2.9*	1.9
F4	0.5	1.4	2.4*	3.2**	2.0*	1.3
F8	0.2	1.0	1.3	1.7	1.6	1.6
T3	-0.1	0.3	0.8	0.7	0.6	0.7

Table 2
Absolute Power LE High Beta Standard Deviations – qEEG 2 (High-Sugar/High-Carbohydrate Breakfast)

	25 Hz	26 Hz	27 Hz	28 Hz	29 Hz	30 Hz
C3	0.8	1.1	1.8	1.5	1.7	2.1*
Cz	1.1	0.8	1.4	1.3	1.9	2.2*
C4	1.0	1.1	1.6	2.1*	2.1*	1.7
T4	-0.2	0.1	0.5	0.6	0.2	0.2
T5	0.9	1.6	2.4*	1.9	1.4	1.6
P3	0.9	1.3	1.9	1.8	1.4	1.8
Pz	1.3	1.2	1.4	1.7	1.5	2.1*
P4	1.3	1.6	1.7	1.6	1.8	1.9
T6	1.3	1.2	1.8	1.7	1.4	1.3
O1	0.4	1.0	1.1	1.0	0.9	1.1
O2	0.2	0.8	1.2	0.8	0.6	0.8

* => 2.0 < 3.0 *SD*; ** => 3.0 *SD*.

For qEEG 3 (nutritionally balanced breakfast condition): Table 3 shows no significant *SD* from the mean in absolute power in any location in the high beta range.

Table 3
Absolute Power LE High Beta Standard Deviations – qEEG 3 (Nutritionally Balanced Breakfast)

	25 Hz	26 Hz	27 Hz	28 Hz	29 Hz	30 Hz
FP1	0.8	0.6	1.2	1.4	1.7	1.2
FP2	-0.2	-0.3	-0.1	0.3	0.1	0.2
F7	0.2	0.3	0.5	0.9	1.0	1.0
F3	0.0	0.1	0.6	0.9	1.1	0.8
Fz	0.3	0.3	0.8	1.1	1.2	1.0
F4	0.1	-0.2	0.4	0.8	0.7	0.6
F8	-0.4	-0.5	-0.1	0.3	0.2	0.7
T3	-0.8	-0.6	-0.2	-0.3	-0.2	-0.5
C3	0.0	-0.3	0.2	0.2	0.6	0.6
Cz	-0.1	-0.3	-0.2	-0.1	0.5	0.9
C4	0.0	-0.2	-0.1	0.1	0.3	0.6
T4	-0.7	-0.8	-0.4	-0.4	-0.6	-0.2
T5	-0.3	-0.1	0.8	0.5	1.0	0.5
P3	-0.1	-0.2	0.5	0.5	0.7	0.7
Pz	0.3	-0.4	0.2	0.6	0.5	1.2
P4	0.5	-0.1	0.3	0.5	0.7	1.0
T6	0.4	0.1	0.6	0.6	1.1	0.7

Table 3
Absolute Power LE High Beta Standard Deviations – qEEG 3 (Nutritionally Balanced Breakfast)

	25 Hz	26 Hz	27 Hz	28 Hz	29 Hz	30 Hz
O1	0.0	0.3	0.6	0.8	1.0	1.1
O2	-0.1	-0.1	-0.1	0.3	0.7	0.7

* => 2.0 < 3.0 *SD*; ** => 3.0 *SD*.

Discussion

In this young female, we found that her qEEGs differed significantly with each of the breakfast conditions. In the no-breakfast condition (qEEG 1), there was a significant increase in high beta (26–28 Hz) activity in the left anterior temporal, frontal, central, left posterior temporal, and central parietal regions. Statistically compared to norms, the standard deviation ranged from 2.0 to 4.0 above the mean.

The widespread distribution noted in the no-breakfast condition also involved electrode sites located over Wernicke's area. This suggests that expressive and receptive language areas may be altered when a child is a breakfast skipper. The widespread distribution of excessive high beta activity may help to explain research findings of improved cognitive performance (Adolphus et al., 2016; Cooper et al., 2011; Hoyland et al., 2009; Wesnes et al., 2012), educational outcomes (Adolphus et al., 2013; Littlecott et al., 2015) and behaviors (Adolphus et al., 2013; Ahadi et al., 2016) in those who eat breakfast compared to those who do not.

In the high-sugar/high-carbohydrate breakfast condition (qEEG 2), the excessive high beta was slightly reduced. The standard deviation was significantly less from 2.0 to 3.5 above the mean. The distribution was now seen in the 27 to 30 Hz range in the frontal, central, left posterior temporal, and central parietal sites (F7, F3, Fz, F4, C3, Cz, C4, T5, Pz). In addition, we found a 0.4 reduction in *SD* mean when comparing the high-sugar/high-carbohydrate breakfast condition to the no-breakfast condition. This finding suggests any food intake is better than no food intake in regard to brain function in children. Finally, the nutritionally balanced breakfast condition (qEEG 3) showed completely normalized high beta activity in all 19 sites assessed. A complete normalization was unexpected and is noteworthy, as we were expecting some residual deviation from the mean.

In an interview with the subject following the three testing conditions, the subject reported experiencing less anxiety with the high-sugar/high-carbohydrate condition than she did with the no-breakfast condition. Furthermore, when she ate the nutritionally balanced breakfast, her anxiety was reported as almost nonexistent and her ability to focus was superior to the other two conditions. Excessive high beta activity has been linked to a small subset of children with attention-deficit/hyperactivity disorder (ADHD) who are overaroused (Clarke, Barry, McCarthy, & Selikowtiz, 2001). Additionally, they found that these children often present as moody and with behavioral issues, anxiety, and obsessiveness. Clarke et al. (2001) found that excessive high beta in the frontal regions is associated with a deficit of frontal lobe self-regulation and inhibition control issues.

This was a case study of one, healthy neurotypical young female. Controlled studies are needed before any generalizations or conclusions can be made, because the subject is not representative of the general population. Furthermore, it would be logical to expect that in unhealthy and/or neuroatypical populations, the findings would be more significant. Future investigations may also want to consider the impact of stimulants on children's breakfast choices. It may help to explain why long-term stimulant use does not appear to improve grades (Currie, Stabile, & Jones, 2014), because stimulants, by their nature, suppress appetite. Thus, the appetite suppression may produce an excessive high beta ADHD subtype nullifying the stimulants gains.

Our findings suggest that breakfast is important in regulating children's anxiety and improving focus. This is the first study that utilized qEEG to investigate the impact of breakfast choices electroencephalographically. The findings are in support of prior research regarding nutrition being a critical component for cognitive and educational performance as well as behavior. To conclude, this single case study offers evidence to show why eating a nutritionally balanced breakfast is essential for healthy brain function in children.

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References

Adolphus, K., Lawton, C. L., Champ, C. L., & Dye, L. (2016). The effects of breakfast and breakfast composition on cognition in children and adolescents: A systematic review. *Advances in Nutrition: An International Review Journal*, *7*(3), 590S–612S. http://dx.doi.org/10.3945/an.115.010256

Adolphus, K., Lawton, C. L., & Dye, L. (2013). The effects of breakfast on behavior and academic performance in children and adolescents. *Frontiers in Human Neuroscience*, *7*, 425–452. http://dx.doi.org/10.3389/fnhum.2013.00425

Ahadi, Z., Kelishadi, R., Qorbani, M., Zahedi, H., Aram, M., Motlagh, M. E., … Heshmat, R. (2016). Association of breakfast intake with psychiatric distress and violent behaviors in Iranian children and adolescents: The CASPIAN-IV study. *The Indian Journal of Pediatrics*, *83*(9), 922–929. http://dx.doi.org/10.1007/s12098-016-2049-7

Brindal, E., Baird, D., Danthiir, V., Wilson, C., Bowen, J., Slater, A., & Noakes, M. (2012). Ingesting breakfast meals of different glycaemic load does not alter cognition and satiety in children. *European Journal of Clinical Nutrition*, *66*(10), 1166–1171. http://dx.doi.org/10.1038/ejcn.2012.99

Cantor, D. S., & Chabot, R. (2009). QEEG studies in the assessment and treatment of childhood disorders. *Clinical EEG and Neuroscience*, *40*(2), 113–121. http://dx.doi.org/10.1177/155005940904000209

Clarke, A. R., Barry, R. J., McCarthy, R., & Selikowitz, M. (2001). Excess beta activity in children with attention-deficit/hyperactivity disorder: An atypical electrophysiological group. *Psychiatry Research*, *103*(2–3), 205–218. http://dx.doi.org/10.1016/s0165-1781(01)00277-3

Cooper, S. B., Bandelow, S., & Nevill, M. E. (2011). Breakfast consumption and cognitive function in adolescent schoolchildren. *Physiology & Behavior*, *103*(5), 431–439. http://dx.doi.org/10.1016/j.physbeh.2011.03.018

Corcoran, S. P., Elbel, B., & Schwartz, A. E. (2016). The effect of breakfast in the classroom on obesity and academic performance: Evidence from New York City. *Journal of Policy Analysis and Management*, *35*(3), 509–532. http://dx.doi.org/10.1002/pam.21909

Corder, K., van Sluijs, E. M. F., Steele, R. M., Stephen, A. M., Dunn, V., Bamber, D., … Ekelund, U. (2011). Breakfast consumption and physical activity in British adolescents. *British Journal of Nutrition*, *105*(2), 316–321. http://dx.doi.org/10.1017/s0007114510003272

Currie, J., Stabile, M., & Jones, L. (2014). Do stimulant medications improve educational and behavioral outcomes for children with ADHD? *Journal of Health Economics*, *37*, 58–69. http://dx.doi.org/10.1016/j.jhealeco.2014.05.002

Deshmukh-Taskar, P. R., Nicklas, T. A., O'Neil, C. E., Keast, D. R., Radcliffe, J. D., & Cho, S. (2010). The relationship of breakfast skipping and type of breakfast consumption with nutrient intake and weight status in children and adolescents: The national health and nutrition examination survey 1999–2006. *Journal of the Academy of Nutrition and Dietetics*, *110*(6), 869–878. http://dx.doi.org/10.1016/j.jada.2010.03.023

Electro-Cap system [Apparatus]. Eaton, OH: Electro-Cap International, Inc.

Hoyland, A., Dye, L., & Lawton, C. L. (2009). A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. *Nutrition Research Reviews*, *22*(2), 220–243. http://dx.doi.org/10.1017/s0954422409990175

Littlecott, H. J., Moore, G. F., Moore, L., Lyons, R. A., & Murphy, S. (2015). Association between breakfast consumption and educational outcomes in 9–11-year-old children. *Public Health Nutrition*, *19*(9), 1575–1582. http://dx.doi.org/10.1017/s1368980015002669

Liu, J., Hwang, W.-T., Dickerman, B., & Compher, C. (2013). Regular breakfast consumption is associated with increased IQ in kindergarten children. *Early Human Development*, *89*(4), 257–262. http://dx.doi.org/10.1016/j.earlhumdev.2013.01.006

O'Neil, C. E., Byrd-Bredbenner, C., Hayes, D., Jana, L., Klinger, S. E., & Stephenson-Martin, S. (2014). The role of breakfast in health: Definition and criteria for a quality breakfast. *Journal of the Academy of Nutrition and Dietetics*, *114*(12), S8–S26. http://dx.doi.org/10.1016/j.jand.2014.08.022

Pivik, R. T., Tennal, K. B., Chapman, S. D., & Gu, Y. (2012). Eating breakfast enhances the efficiency of neural networks engaged during mental arithmetic in school-aged children. *Physiology & Behavior*, *106*(4), 548–555. http://dx.doi.org/10.1016/j.physbeh.2012.03.034

Sizonenko, S. V., Babiloni, C., de Bruin, E. A., Isaacs, E. B., Jönsson, L. S., Kennedy, D. O., … Sijben, J. W. (2013). Brain imaging and human nutrition: Which measures to use in intervention studies? *British Journal of Nutrition*, *110*(S1), S1–S30. http://dx.doi.org/10.1017/s0007114513001384

Taki, Y., Hashizume, H., Sassa, Y., Takeuchi, H., Asano, M., Asano, K., & Kawashima, R. (2010). Breakfast staple types affect brain gray matter volume and cognitive function in healthy children. *PLoS ONE*, *5*(12), e15213. http://dx.doi.org/10.1371/journal.pone.0015213

TruScan EEG 32-channel system [Apparatus]. Payette, ID: DEYMED Diagnostic.

U.S. Department of Agriculture. (2000). My Plan. Retrieved November 8, 2016, from SuperTracker, https://www.supertracker.usda.gov/myplan.aspx

Wesnes, K. A., Pincock, C., & Scholey, A. (2012). Breakfast is associated with enhanced cognitive function in schoolchildren. An internet based study. *Appetite*, *59*(3), 646–649. http://dx.doi.org/10.1016/j.appet.2012.08.008

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