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RESEARCH REVEALS ROLES FOR EXERCISE AND DIET IN AGING, DEPRESSION

Lifestyle changes in diet and exercise show promise for learning, depression in teens, and more

SAN DIEGO — New studies released today underscore the potential impact of healthy lifestyle choices in treating depression, the effects of aging, and learning. The research focused on the effects of mind/body awareness, exercise, and diet, and was presented at Neuroscience 2013, the annual meeting of the Society for Neuroscience and the world's largest source of emerging news about brain science and health.

The experiences and choices people make throughout life actively impact the brain. As humans live longer, these choices also affect aging and quality of life. Lifestyle changes to diet and exercise will be important to aging populations as non-drug, easy-to-follow interventions with few side effects,make ideal potential therapies.

Today's new findings show that:

- As few as 12 consecutive days of exercise in aging rats helps preserve and improve movement function, an effect possibly caused by changes in dopamine. The results suggest that exercise could stave off or reverse the slowed movements that are hallmarks of age (Jennifer Arnold, abstract 334.02, see attached summary).
- Practices like yoga or meditation that increase mind/body awareness help people learn a brain-computer interface quicker. This finding may have implications for those who need brain-computer interfaces to function, such as people with paralysis (Bin He, PhD, abstract 16.06, see attached summary).
- Long-term exercise in aging rats improves memory function, as well as increases the number of blood vessels in the white matter of their brains — the tracts that carry information between different areas of the brain. Increased blood flow may explain why exercise can help preserve memory (Yong Tang, MD, PhD, abstract 236.09, see attached summary).
- Regular, supervised exercise helped young adults with depression overcome their symptoms in a pilot study. The results suggest that exercise could be an important treatment for depression in adolescents (Robin Callister, PhD, abstract 13.02, see attached summary).
- A low calorie diet starting in middle-age onward protected rats against the effects of aging on movement. The results suggest that dietary interventions can help preserve movement function in a manner similar to exercise (Michael Salvatore, PhD, abstract 334.17, see attached summary).

"We all know that keeping fit is critically important to a healthy lifestyle, from combating the effects of aging to boosting our mood," said press conference moderator Teresa Liu-Ambrose of the University of British Columbia, who is an expert on exercise and its role in healthy aging. "Today's results begin to show us not only how different types of exercise interventions can improve our lives, but how other types of lifestyle behaviors, from diet to meditative practice, can help us achieve wellness in our body and our brain as we age."

This research was supported by national funding agencies such as the National Institutes of Health, as well as private and philanthropic organizations. Find more information on exercise and brain wellness at *BrainFacts.org*.

Related Neuroscience 2013 Presentation:

Symposium: **Brain, Cognition, and Genetics in Healthy Aging**
Tuesday, Nov. 12, 8:30–11 a.m., Room 6A

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Abstract 334.02 Summary

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Recapturing the Spring in Your Step

New research shows regular exercise in aged rats improves and restores mobility

Treadmill exercise in older rats prevents the slowed movements that come with age, and can restore movement even after periods of inactivity. Jennifer Arnold, of Louisiana State University Health Sciences Center, presented the findings at Neuroscience 2013, the annual meeting of the Society for Neuroscience and the world's largest source of emerging news about brain science and health.

"Our study shows that treadmill exercise could be a useful treatment to not just maintain, but actually improve mobility in the elderly," said Arnold. "This could provide a relatively easy, non-drug approach to help people remain active as they age."

Many people speak of "slowing down" as they age, but it is a very real phenomenon called bradykinesia. An estimated 50 percent of people over the age of 85 experience the disorder which impairs their movement and increases risk of injuries and death. As people live longer, more of the population will begin to suffer the symptoms of aging, including motor disturbances like bradykinesia.

Here, researchers examined the effect of treadmill exercise on movement impairments in rats. They showed that just 12 consecutive days of treadmill activity in elderly rats was enough to improve their ability to get around. The activity was beneficial even in rats that had previously been inactive, reversing the effects of age on their movement abilities. This finding suggests that similar treatments could be effective in humans, preventing or reversing the effects of aging on motor ability.

Future research will help determine exactly how the treadmill exercise aids the older rats. The authors hypothesize that dopamine, a chemical in the brain that is important in movement and reduced in diseases such as Parkinson's, might decrease in those with bradykinesia, and that treadmill exercise might improve dopamine levels. A better understanding of this process could offer a non-drug intervention and open up new treatment options for people in whom bradykinesia is more severe.

Research was supported with funds from the National Institutes of Health.

Scientific Presentation: Monday, Nov. 11, 9–10 a.m., Halls B–H

334.02, Forced exercise: A lifestyle strategy to mitigate bradykinesia by increasing dopamine signaling and glutamate uptake in nigrostriatal neurons of aged rats
***J. C. ARNOLD[1]**, V. FIELDS[1], D. K. INGRAM[2], M. F. SALVATORE[1]; [1]Pharmacology, Toxicology, & Neurosci., Louisiana State Univ. Hlth. Sci. Ctr., Shreveport, LA; [2]Nutritional Neurosci. and Aging Lab., Pennington Biomed. Res. Ctr., Baton Rouge, LA

TECHNICAL ABSTRACT: Bradykinesia will affect ~50% of the elderly population by age 85, impairing their ability to execute locomotor function and increasing the risk of injury and mortality. Nigrostriatal dopamine (DA) neurons are vital for executing voluntary movement, and aging may challenge their function in two major ways; impaired DA biosynthesis in their cell bodies, and impaired glutamate uptake at their terminals. In Parkinson's disease (PD), bradykinesia emerges when striatal DA loss exceeds 70%, but this level of loss has never been observed in aging. However, similar levels of DA loss in the substantia nigra are detected with bradykinesia in PD and aging. Furthermore, nigral DA is significantly correlated to locomotor activity, and may be a target to improve bradykinesia. The loss of nigrostriatal DA neurons in PD impairs not only dopaminergic, but also glutamatergic neurotransmission, resulting in increased extracellular glutamate in PD models. Glutamate transporters remove extracellular glutamate, reducing the constant potential for glutamate excitotoxicity. In aging, however, striatal glutamate uptake and glutamate transporter expression is diminished, conceivably resulting in increased extracellular glutamate, and potentially creating an excitotoxic environment to nigrostriatal DA neurons. Given the similarities of these molecular deficiencies in both PD and aging models, we hypothesize that forced exercise (EX), a strategy shown to mitigate bradykinesia in PD models and patients, may similarly improve locomotor function in aged rats in association with increased DA biosynthesis and glutamate uptake capacity. Our preliminary work demonstrates that 12 consecutive days of treadmill EX may prevent aging-related bradykinesia, as exhibited in non-exercised counterparts. Additionally, we have evidence to show that EX increases striatal glutamate uptake in aged rats. We speculate that EX-mediated prevention of bradykinesia is associated with increased nigral DA tissue content, via increased expression of tyrosine hydroxylase. Results from these studies may delineate molecular targets to prevent bradykinesia in aging while providing a non-pharmacological, clinically translatable strategy to improve locomotion in elderly individuals with locomotor impairments.

Abstract 16.06 Summary

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Yoga and Meditation May Help Achieve Computer-Brain Meld

Results could help "train" paralyzed patients in brain-computer interfaces

Training in mind/body awareness through practices like yoga or meditation allows people to learn a brain-computer interface faster. The findings were presented at Neuroscience 2013, the annual meeting of the Society for Neuroscience and the world's largest source of emerging news about brain science and health.

"Increasingly, we're turning to systems that connect brains with computer systems to help patients with physical disabilities like paralysis, but the length of training has been a major obstacle to success," said lead author Bin He, PhD, Director of the Center for Neuroengineering at the University of Minnesota. "This research tells us that we can significantly cut this time with practices like yoga and meditation to make these tools more successful for more patients who need these devices."

Training in mind/body awareness takes many forms, from yoga and meditation to Reiki, but all are designed to direct awareness to specific areas of the body. This ability to direct attention to discrete areas might be an important aspect of how we learn to manipulate objects using systems that connect our brains with computers.

The researchers took 12 participants who practiced mind/body awareness, and 19 who practiced no form of mind/body awareness, and trained them on an electroencephalography (EEG)-based brain-computer program. This experiment used monitors on the scalp to pick up electrical impulses from the brain. The participants had to imagine moving their hands, and the EEG program interpreted the brain activity as they imagined and translated the electrical signals into the movement of a cursor on the screen.

Scientists found that participants who practiced mind/body awareness learned the brain-computer interface faster than those who did not, with 75 percent of them achieving competence versus 42 percent of controls. This suggests that training in mind-body awareness could aid in the learning of brain-computer interfaces, devices that help people regain functions lost to disease or injury.

Research was supported with funds from the National Science Foundation.

Scientific Presentation: Saturday, Nov. 9, 1–3:15 p.m., Room 5B

16, Mind-body awareness training in the initial learning of a sensorimotor rhythm based brain-computer interface
*K. E. CASSADY, A. J. DOUD, **B. HE**; Biomed. Engin., Univ. of Minnesota, Minneapolis, MN

TECHNICAL ABSTRACT: In recent years, increasing research efforts have been dedicated in the development of noninvasive brain-computer interface (BCI) systems as potential therapeutic outlets for individuals with physical disabilities. However, a substantial limitation of these systems is the lengthy training time that is required by users to achieve satisfactory performance. Mind body awareness training (MBAT), in the forms of Yoga and meditative practice, has become prevalent in the United States due to an increase in awareness of the potential health benefits and improvements in concentration that this training may impart to practitioners. As such, a formal investigation of MBAT practices in the context of brain-computer interface training may identify a means to reduce the training obstacles to BCI utility. The aim of the present study is to discover whether experience with MBAT practices, such as yoga and/or meditation, can accelerate the initial learning of a 1D sensorimotor (SMR) based BCI.
12 subjects with regular exposure to yoga, meditation, or a combination of both practices, in addition to 19 healthy control subjects with little or no MBAT experience, each participated in three, 2-hour brain-computer interface training sessions. All subjects used motor imagery to move a computer cursor to hit targets on the left or right side of a screen, before progressing to an up vs. down control task, using a separate set of motor imagery. Overall, 75% of subjects with MBAT experience passed a predetermined 1D BCI competency threshold in the three experimental sessions, while only 42.1% of healthy controls from the general population achieved the same level of BCI competency. Furthermore, 100% of MBAT subjects passed the progression criteria for left vs. right control during the experimental period, while only 52.6% of control subjects achieved left vs. right control.
Subjects with MBAT experience identified the practices of Yoga Nidra, meditation, and Reiki as the most useful in learning to control a motor-imagery based BCI. Such practices are aimed at learning to consciously direct awareness to specific areas of the body. The results of the present study suggest that MBAT may provide an effective means to reduce the time it takes for subjects to successfully control a motor imagery-based BCI. The potential to integrate MBAT practices into BCI training holds great promise for future SMR-based BCI research that is aimed at delivering intuitive BCI systems with minimal training requirements for use by both healthy and paralyzed patient populations.

Abstract 236.09 Summary

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Running Away From Memory Loss — and Toward a Healthier Brain

Exercise improves blood flow and memory function in older rats

The benefits of exercise extend beyond previously known health benefits and may help to preserve memory function, according to new research presented today at Neuroscience 2013, the annual meeting of the Society for Neuroscience and the world's largest source of emerging news about brain science and health.

As we age, our memories and other brain functions decline. In particular, aging brains begin to lose white matter, the "superhighways" of the brain that help carry information between different regions. Aging brains also begin to lose capillaries, the tiny blood vessels that bring oxygen and nutrients to the white matter highways. This study shows that exercise might help avoid these losses by increasing blood vessels in the white matter of the brain.

"Our results suggest that part of the decline of white matter in the brain is its lack of blood supply," said lead author Yong Tang, of Chongqing Medical University. "Exercise can improve this supply and even help restore some function to the aging brain."

The researchers investigated the effects of exercise on memory and blood vessels in the brain using young and old, male and female rats. Rats ran for 4 or 14 months, while another group of rats did not exercise. Tang and colleagues then looked at memory function in rats andthe blood vessels and white matter of their brains.

Younger rats always outperformed older ones in tests of memory, and had more capillaries and white matter. But when older rats ran, for either 4 months or 14 months, they showed improvements in blood vessel density, white matter density, and in memory function. These findings indicate that running or other exercise may aid the elderly in preserving their white matter and their cognitive function.

Research was supported with funds from the National Natural Science Foundation of China, Research Foundation for 100 Academic and Discipline Talented Leaders of Chongqing, P. R. China.

Scientific Presentation: Sunday, Nov. 10, 1–2 p.m., Halls B–H

236.09, Exercise has positive effects on the capillaries in the white matter of aged brain
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TECHNICAL ABSTRACT: Our previous studies found that during aging process, the white matter was significantly shrunk and the myelinated fibers in the white matter were markedly lost. Our previous studies also found that running exercise had positive effects on the white matter and the myelinated fibers in the white matter of aged brain. What are the reasons for the effects of running exercise on the white matter of aged brain? The present study is the first study to investigate the age-related changes of the capillaries in the white matter and the effects of running exercise on the age-related changes of the capillaries in the white matter of Sprague Dawley rats using the immunohistochemistry technique and unbiased stereological techniques. For the investigation of the age-related changes of the capillaries in the white matter, young rats and aged rats were used. For the investigation of the effects of running exercise on the capillaries in the white matter of aged brain, 14-month-old male and female rats were randomly divided into running group and control group. Control group rats were reared in standard condition without running. Running group rats run 4 months and 14 months. The spatial learning capacity of running rats and control rats were assessed with Morris Water Maze. The white matter volume, the total volume, total length and total surface area of the capillaries in white matter were quantitatively investigated with immunohistochemistry and unbiased stereological methods. The total length, total volume and total surface area of the capillaries in the white matter of aged rats were significantly lower than those of young rats. Running exercise improved the spatial learning and memory ability of aged rats. After 4 month running exercise, the total length of the capillaries in the white matter of male and female exercised rats was significantly higher than that of male and female non-exercised rats. After 14 month running exercise, the total length, total volume and total surface area of the capillaries in the white matter of male and female exercised rats were significantly higher than those of male and female non-exercised rats. The age-related changes of the capillaries in the white mater may have important implications for age-related white matter atrophy and age-related cognitive impairments. The present results indicated that running exercise had positive effects on the capillaries in the white matter of aged brain, which might be one of the structural bases for the running exercise-induced improvement of the spatial learning ability. These results together demonstrated that running exercise could benefit the aging brain.

Abstract 13.02 Summary

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Run for Your Mood

Pilot study looks at exercise therapy for depression in teens

Exercise has been linked to depression relief in adults, and new research shows that it can also significantly reduce depression in youth. Robin Callister, PhD, of the University of Newcastle, presented the findings at Neuroscience 2013, the annual meeting of the Society for Neuroscience and the world's largest source of emerging news about brain science and health.

"Exercise has so many advantages as a therapy: it is non-drug, has few side effects, and has countless other health benefits. But it has never been tested in youth as treatment for depression," said Callister. "Evidence that exercise can lift mood in young people is a huge step forward in treatment of this delicate population. We are now conducting a larger trial to further evaluate the effects of exercise in depression and are hopeful that it could be used as a treatment in addition to other treatments for depression without potential problems."

According to the World Health Organization, major depressive disorder begins early in life and peaks between the vulnerable ages of 15 and 29. Many young people are at risk or are currently being treated for depression, but treatments can be expensive, time consuming, and are not always effective. Exercise, which has already been shown to be an effective therapy for depression in some adults, could be an important addition to the arsenal of treatments for youth depression.

The researchers conducted a pilot study with 13 young adults (3 male, 10 female) who were given a motivational interview and tasked to exercise for 12 weeks. The teens were given trainer-led exercises three times per week and encouraged to exercise 30 minutes per day on other days.

These young people averaged 66 percent attendance at the sessions, and their muscular fitness improved. Their mood improvedsignificantly, with depression severity cut by 63 percent, and 83 percent of participants who completed the program were no longer categorized as depressed by the end of the study. These findings point to exercise as a potential intervention or supplement to current therapies for young people suffering from depression.

Research was supported with funds from beyondblue.org.au and the Hunter Medical Research Institute.

Scientific Presentation: Saturday, Nov. 9, 1–3:15 p.m., Room 30B

13. 12-weeks supervised exercise training plus motivational interviewing can reduce depression symptoms in youth with major depressive disorder
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TECHNICAL ABSTRACT: Introduction: Major Depressive Disorder (MDD) has high prevalence among adolescents and young adults. Exercise has some support as an effective treatment for adults but studies in younger populations are lacking. The aim of this study was to investigate the feasibility and preliminary efficacy of brief motivational interviewing (MI) plus 12-weeks exercise training as a treatment for MDD in youth.
Methods: Youth (15-25 years) with MDD were recruited to participate in a prospective trial. 26 participants were screened (telephone then clinical psychology diagnosis) and 13 (9 females) were eligible (MDD from SCID, no psychotic illness, not pregnant, no physical barriers to exercise, not suicidal, no major eating disorder) to participate. Participants completed assessments at baseline and after 12 weeks training, which included questionnaires: the Beck Depression Inventory (BDI-II); blood samples for analysis of inflammatory biomarkers; and fitness measures: VO2max, YMCA bench press test, and a leg press endurance test. Before commencing training, participants engaged in MI with a psychologist to improve engagement with the program. The exercise program consisted of small group trainer-led supervised exercise (resistance and endurance) training 3 times a week (1h per session) for 12 weeks, and encouragement to do at least 30min of physical activity on other days. Paired t-tests were used to determine changes from baseline; Cohen's d to determine the magnitude of changes, and correlations used to explore relationships between changes in depression scores, training attendance and fitness levels.
Results: 12 participants (mean±SD, aged 20.7±1.7 y) completed 12-week assessments; one withdrew due to family issues. Attendance at training averaged 66±25% of sessions; 3 participants completed less than 40% of training sessions. At baseline all participants met the criteria for MDD; at 12 weeks only 2 still met the criteria; depression severity (BDI-II) decreased ($p<0.001$, $d=2.2$) from 32±9 to12±10. Baseline aerobic fitness levels were higher than anticipated (41.4±8.7 mL.kg-1.min-1) and no changes were observed with training. YMCA bench press repetitions increased ($p<0.001$; $d=0.66$) from 20±11 to 27±11. Changes in depression symptom scores were significantly correlated ($p<0.05$) with attendance ($r=0.33$) and improvements in bench press endurance ($r=0.66$).
Discussion: Exercise training is a feasible and potentially effective intervention for MDD in youth. This study has informed a randomized controlled trial to more rigorously assess the effectiveness of exercise as treatment for MDD.

Abstract 334.17 Summary

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Low Calorie Diet Staves Off Age-Related Decline in Movement, Mobility

Study reveals new benefits of caloric restriction in rats

A low calorie diet helps to stave off the reduced mobility that occurs in aged rats, suggesting that caloric restriction (CR) could help humans as well. Michael Salvatore of Louisiana State University Health Sciences Center presented the findings at Neuroscience 2013, the annual meeting of the Society for Neuroscience and the world's largest source of emerging news about brain science and health.

"Couch potatoes can rejoice," said Salvatore. "Our results show that a restricted diet alone could help prevent some of the movement effects of aging."

Bradykinesia, the slowing of movement as people age, is one of the hallmarks of Parkinson's disease. It drastically increases the risk of falls and death, as well as impairing everyday activities. Bradykinesia is present in 50 percent of the population over the age of 85, a population that is set to triple by 2050.

To investigate the effects of caloric restriction on bradykinesia, researchers put a group of middle-aged male rats on a 30 percent CR, the equivalent of 1,400 calories for someone usually on a 2,000 calorie-per-day diet. After six months, they let the CR rats and control rats eat without restriction. During the experiment, all rats were regularly monitored for how much they moved normally. Some rats had relatively high levels of daily movement, while others were relatively low.

The rats that had a normal diet all began to show decreased motor activity as they aged, characteristic of bradykinesia. But the rats on the calorically restricted diet showed no decline in their movements, suggesting that a calorically restricted diet can prevent some of the movement problems that come with age. Additionally, the rats that had low movement levels prior to the calorie restriction not only showed no decline in movement when kept on the regimen, but actually increased their movement abilities compared to their baseline performance. The results suggest that restricting calories could help combat some of the effects of aging, even in those with little inherent physical activity.

Research was supported with funds from the National Institutes of Health.

Scientific Presentation: Monday, Nov. 11, 8–9 a.m., Halls B–H

334.17, Couch potatoes rejoice! Prevention of age-related bradykinesia by caloric restriction initiated at middle age
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TECHNICAL ABSTRACT: After age 65, the risk of bradykinesia, a cardinal symptom of Parkinson's disease, increases dramatically to an extent that 50% of those over 80 years of age will be affected. The quality of daily life is compromised due to the impairment of initiating movements necessary for navigating the environment. Because of the prevalence of this impairment, lifestyle strategies initiated in middle age could possibly reduce the risk of bradykinesia. Calorie restriction (CR) initiated in aged primate or rodents increases locomotor activity, but here, we investigated whether this nutritional intervention could prevent bradykinesia associated with aging when initiated at middle age. Specifically, we imposed a 30% CR regimen beginning at 12 mo of age in male Brown-Norway/Fischer 344 F1 hybrid rats and measured their locomotor activity every 6 weeks until 18 mo of age. Compared to their baseline activity measurements, rats that were maintained on ad libitum feeding exhibited significant declines in locomotor activity every 6 weeks for a 30% overall decline over the course of 6 months. In contrast, rats on 30% CR showed no significant decline in locomotor activity during this period. Most notably, the response to CR differed between rats having a high versus low baseline locomotor activity. Low baseline activity rats responded to CR in a shorter period of time (within 6 weeks) compared to high baseline activity rats (within 12 weeks). Furthermore, low baseline activity rats on CR actually exceeded their original baseline activity level and maintained this increase throughout the study period. High baseline activity rats eventually returned to their original 12 month baseline despite an initial decrease below it and then maintained their baseline for the duration of the CR. In summary, we note early steady decline in locomotor activity in rats maintained on ad libitum diets beginning at 12 months of age, and this decline is totally attenuated in rats maintained on 30% CR. We speculate these changes will be related to prevention of age-related loss of dopamine in the substantia nigra.