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SHORT REPORT

Behavioural support of a proposed neurocognitive connection between physical activity and improved eating behaviour in obese women

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Abstract
Problem: An explanation of the association between physical activity and improved eating behaviours has recently been posited via the effect of physical activity on executive functions of the brain resulting in a reduction in the hedonic drive to overeat. Decomposition and clarification of embedded relationship through a behavioural/psychological framework was sought.
Methods: Changes in theory-based psychosocial factors over 26 weeks were tested with 134 severely obese women (age 41.7 ± 10.4 years) initiating a physical activity support treatment. Mediation and reciprocal effects analyses incorporating these changes were then computed.
Results: Significant improvements in mood, self-regulation for eating, and self-efficacy for controlled eating were found. Emanating from mood change, a reciprocal relationship between changes in the self-regulation and self-efficacy measures was found. Thus, each factor reinforced the other's change.
Conclusion: Findings suggest a convergence of neurocognitively and behaviourally based explanations of the relations of physical activity and controlled eating. Implications for behavioural weight-loss theory and treatments were suggested.

Introduction

Controlling eating in the present ''toxic environment'' has been a problem associated with rising obesity rates [1]. Physical activity has

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been the strongest predictor of long-term success with weight reduction [2]. However, because deconditioned and obese individuals cannot complete more than minimal volumes [3], researchers have posited that physical activity may induce the requisite energy deficits for weight loss through its indirect association with improved eating behaviours (rather than directly through caloric expenditure) [4]. Through a comprehensive review using a neurocognitive framework, Joseph and colleagues [5] suggested that physical activity is associated with enhanced executive functions through induced changes in the prefrontal cortex of the brain. Resulting from this is a predominance of homeostatic (maintaining energy balance) vs. hedonic (pleasure-related) eating, and a better reliance on satiety signals to limit energy intake. Influenced by mood change (which is also improved through physical activity [6]), the enhanced executive functioning is linked to better self-regulation — especially in a challenging environment where opportunities for excess food abounds [5]. Successfully self-regulating eating may lead to increased feelings of ability (self-efficacy), and improved self-efficacy may then increase volition to use self-regulation in the future (e.g., self-efficacy may be both a determinant and outcome of self-regulation of eating [7]).

Through a behavioural framework, specifically via social cognitive theory [8], it has also been suggested that physical activity is related to improved mood, and self-regulation and self-efficacy for controlled eating [4,7]. Mood change, depending on its direction, might either benefit or detract from self-regulation and perceptions of ability to persist at a goal of healthy eating and weight loss [8,9]. While this indicates a convergence of neurocognitive and behavioural explanations of the effects of physical activity on correlates of eating behaviours and weight-loss, a more refined understanding of interrelationships of the aforementioned behavioural factors across the 2 frameworks may be advantageous for improvement of weight-loss treatments.

Thus, for this investigation, severely obese women were selected because of their high health risks. A field setting was chosen to enhance rapid generalisability of findings to applied use. It was expected that initiating a program of physical activity would significantly improve participants' mood, self-regulation, and self-efficacy; and emanating from the mood changes, changes in self-regulation and self-efficacy would significantly influence each other in a reciprocal manner.

Methods

Participants

Women from the southeast U.S. volunteered by responding to newspaper advertisements. Inclusion criteria were: (a) age $\geq$21 years, (b) BMI, 35—55 kg/m^2, and (c) no regular exercise (<20 min/week reported) in the previous year. Pregnancy, current participation in a weight-loss program, previous weight-loss surgery, and use of medication for a psychological/psychiatric condition were reasons for exclusion. Written consent to participate was obtained from each participant and her physician. Appropriate institutional review board approval was granted, and requirements of the Declaration of Helsinki were followed.

Of the 172 women who responded to the newspaper advertisements, phone screening indicated that 146 of them were eligible for participation. Of those, there was minimal attrition prior to the start of the study for the following reasons: self-reported problems with transportation (n = 5), self-reported illness (n = 2), and failing to return phone calls or e-mails from study staff (n = 5). The 134 participants (age, 41.7 $\pm$ 10.4 years; BMI, 45.1 $\pm$ 3.8 kg/m^2) had a racial/ethnic make-up of 48% White, 47% African American, and 5% of other racial/ethnic groups. Nearly all were in the middle class.

Measures

Physical activity was measured by the Godin-Shephard Leisure-Time Physical Activity Questionnaire [10]. It incorporates estimates of metabolic equivalents of task (METs), or the physiological energy cost of physical activity intensities. Respondents recalled weekly frequencies of strenuous (e.g., running; 9 METs), moderate (e.g., fast walking; 5 METs), and light (e.g., easy walking; 3 METs) physical activities for $\geq$15 min/session, that are then summed. Reported test—retest reliability over 2 weeks was 0.74 [11]. Construct validity was previously indicated by significant correlations with accelerometer and maximum volume of oxygen uptake measurements [12,13].

Self-efficacy for controlled eating was measured using the Weight Efficacy Lifestyle Scale [14]. It incorporates 5 subscales (negative emotions, availability, physical discomfort, positive activities, and social pressure) of 4 items each that are typically summed for a total score, but may be used individually (e.g., use of only the negative emotions subscale in the context of assessing emotional eating). Responses range from 0 (not confident)