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The reinforcing value and liking of resistance training and aerobic exercise as predictors of adult's physical activity☆

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ABSTRACT

Objective: Reinforcing value (motivating value) is a stronger predictor than hedonic value (liking) for engaging in drug use, gambling, and eating. The associations of reinforcing value and liking with physical activity of adults have not yet been studied and may depend on the modes of exercise (e.g., aerobic/cardiovascular exercise, resistance training) under consideration. The purpose of this study was to test associations of the reinforcing value and liking of aerobic exercise training (AT) and resistance exercise training (RT) modes of exercise with usual participation in aerobic and resistance exercise in adults.

Methods: Men (n = 38) and women (n = 50) were measured for their liking and relative reinforcing value (RRV) of AT and RT, for their usual vigorous physical activity (VPA) participation, and for usual resistance exercise behavior (Yale physical activity questionnaire).

Results: The RRV of AT (RRVAT) and liking of AT were correlated, ($r = 0.22$, $p < 0.04$), as were the RRV of RT (RRVRT) and liking of RT ($r = 0.42$, $p < 0.01$). The reinforcing value for, but not the liking of, a mode of exercise predicted how much an individual engaged in that mode of exercise. RRVAT ($p < 0.01$) was positively associated with usual VPA. RRVRT ($p < 0.01$) was positively associated with RT behavior. The hedonic value of AT and of RT were not associated ($p > 0.30$) with VPA or RT behavior.

Conclusion: Reinforcing value of a mode of exercise is a stronger predictor than the liking of that mode of exercise for usual amount of participation in the exercise.

1. Introduction

Engaging in exercise involves choosing to be active over a concurrent and powerfully competing sedentary behavior (such as choosing to exercise in the evening after work over choosing to watch television) [1].The reinforcing, or motivating, values of different modes of exercise relative to that of sedentary alternatives is likely a strong predictor of the choice to be active or sedentary [1].Behavioral reinforcement can be conceptualized as the motivational appetite to engage in a behavior or as the operant responding (i.e., work measured as button presses or lever presses) that an individual is willing to engage in to obtain a reinforcer [2] and is controlled via the central dopamine system [3].The relative reinforcing value (RRV) of a behavior is determined by the amount of operant responding an individual chooses to engage in for access to that behavior relative to a competing alternative [4–6].

Based on observational and correlational studies of children, the RRV of aerobic-type exercise (RRV_{AT}) is low compared to the RRV of sedentary activities (RRV_{SED}) [7,8], explaining the difficulty many youth have choosing to be physically active over more reinforcing sedentary alternatives. Indeed, previous work has shown that RRV_{AT} predicts moderate-to-vigorous physical activity (MVPA) in children [9,10], that obese children have a lower RRV_{AT} than non-obese children [10], and that children find an interval-type pattern of exercise that models the bout-type nature of children's free- play more reinforcing than continuous constant load exercise [11].

Similar to children [11], the mode, intensity, or pattern of bouts of exercise may influence the RRV of exercise in adults [12]. Resistance training exercise (RT) is also a popular mode of exercise with numerous health benefits that have led to its inclusion in physical activity guidelines [13]. Recent work demonstrated, for the first time, that in adults, RRV_{AT} or RRV of resistance exercise training (RRV_{RT}) is greater in those who meet physical activity guidelines for aerobic exercise and muscle strengthening recommendations, respectively [14]. Thus, RRV

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of different modes of exercise appears to be an important factor in determining the choice of engaging in that mode of exercise for both children and adults.

An individual's affective (emotional) response to exercise, in effect, liking or hedonics of exercise, may also play a role in exercise behavior [15]. An individuals' liking and reinforcing value of exercise are distinct constructs. Liking of exercise is assessed by subjective ratings using visual analog scales or Likert scales rather than the operant responding task used to assess RRV. Liking is determined more by the central opioid system whereas RRV is controlled by central dopamine signaling [16–18]. Liking of exercise may impact choice because people will usually choose to engage in activities that are more liked [9,19–21]. Choices can be influenced by affective variables, such as whether previous exercise experiences were associated with pleasure or displeasure [15].

In adult humans, reinforcing value, but not hedonic value, predicts the amount of food earned during an operant responding task and the amount of energy consumed [22,23]. In contrast to the findings with food, liking, in addition to RRV_{AT}, independently predict MVPA in children [9]. This first attempt at understanding the relationships of RRV and liking of exercise with children's usual MVPA relied on a paper-pencil task to assess RRV_{AT} [9] rather than the computer task used to assess the associations of RRV and liking of food with energy intake [24–27]. Such results of the associations of the RRV and liking of exercise are not yet available for adults. Research that uses the computer-based RRV task is needed to compare results to eating behavior research and to draw conclusions of RRV and hedonic value as predictors of exercise behavior in adults.

If RRV is a stronger predictor of exercise behavior than liking in adults, as has been shown for food [23,25], then increasing the RRV of exercise may be crucial for increasing exercise behavior (both aerobic exercise and RT). On the other hand, if liking is a strong predictor of exercise behavior, then approaches shown to be effective for increasing the liking of other behaviors such as the taste of specific foods [28,29] may be more appropriate for changing exercise behavior.

Thus, the purpose of this study was to test the associations of the RRV and hedonics of aerobic and resistance exercise with participation in vigorous physical activity (VPA) and RT. It was hypothesized that the RRV of each exercise mode would be a stronger predictor of usual exercise behavior (VPA, weekly minutes of RT) than hedonic ratings of exercise.

2. Materials and methods

A total of 88 participants (50 female) aged 25 ± 7 years with a BMI of 25.6 ± 5 kg/m^2 (mean ± SD) volunteered for the study and were compensated with either $90 or were given a free 3-month membership to a local fitness center. Participant characteristics are reported in Table 1.Vigorous physical activity (VPA) was assessed in favor of moderate to vigorous physical activity (MVPA) as the VPA measure is more representative of exercise behavior (planned, structured physical activity performed with the goal of increasing fitness) where as MVPA would include non-exercise activities that included walking or were of walking intensity [30]. 16% of participants met VPA activity requirements (75 min/week) [13]. Recruitment occurred during the spring and summer of 2015 in the greater Grand Forks, North Dakota metropolitan area. Participants were a sample who responded to recruitment media including printed brochures and fliers and online advertisements placed on the Grand Forks Human Nutrition Center website. All participants were non-smoking, free of orthopedic injuries that would hinder exercise training, and had no contraindications to exercise participation. The current study participants were part of another study recently published [14].

Table 1
Demographics and physical activity behavior of the study participants.

	Male (n = 38)	Female (n = 50)	All subjects (n = 88)
Age (years)	25.6 ± 6.7	24.5 ± 6.4	24.9 ± 6.5
Weight (kg)	86.5 ± 17.3*	69.3 ± 12.7*	76.7 ± 17.0
Height (cm)	178.5 ± 7.7*	168.0 ± 6.6*	172.6 ± 8.8
BMI (kg/m^2)[b]	27.1 ± 5.1*	24.6 ± 4.7*	25.7 ± 5.0
VPA (min/week)[a]	32.8 ± 43.5	34.5 ± 59.0	33.7 ± 52.5
RT (min/week)[c]	42.5 ± 62.6	28.0 ± 40.5	34.3 ± 51.5
RRV_{AT}	4.24 ± 2.33	4.24 ± 2.60	4.24 ± 2.47
RRV_{RT}	4.53 ± 2.36*	3.16 ± 2.32*	3.75 ± 2.42

Data are mean ± SD.
[a] VPA: weekly minutes of vigorous physical activity.
[b] BMI: body mass index.
[c] RT: weekly minutes of resistance training.
* Sex difference, $P < 0.05$.

After providing written informed consent, participants were measured for anthropometrics, given an accelerometer for seven days to assess habitual physical activity, and completed the Yale Physical Activity questionnaire [31] to determine habitual engagement in different modes of exercise. Particpants' realitive reinforcing value of aerobic and resistence training (RRV_{AT} and RRV_{RT}) were then tested in randomized order on two separate days. The study was approved by the University of North Dakota Institutional Review Board.

3. Measures

3.1. Height and weight

Height was measured in triplicate to the nearest 0.1 cm using a stadiometer (Seca; Chino, CA). Body weight was measured using a calibrated digital scale (Fairbanks Scales- Model SCB-R9000-HS; MO) to the nearest 0.1 kg. Measures were completed with participants wearing either provided lab scrubs or light casual clothes (t-shirt, shorts) and not wearing shoes.

3.2. RRV

The participants' RRV of both aerobic training (AT, i.e., aerobic exercises such as running/walking, and biking) and resistance training (RT, i.e., weight-lifting, using machines in the current study) was assessed against a sedentary alternative (reading magazines, playing word games, crossword puzzles, watching TV, playing video games). The RRV of exercise ($RRV_{exercise}$) is assessed by evaluating the amount of operant responding (computer mouse button presses) a participant is willing to complete to gain access to exercise [23,32].The procedure begins by determining the liking of the exercise options and sedentary alternatives using a 10-point scale (1 = “do not like at all” and 10 = “like very much”). The highest rated activity is used for the testing session. The lab space includes two workstations. One station is a computer and mouse on which the participant can earn points toward their highest liked exercise activity while the other station is a computer that can be used to earn points toward the highest liked sedentary alternative. Participants can switch between stations as much as they choose. The program presents a game that mimics a slot machine; a point is earned each time the shapes match. For every 5 points a session is completed and the participant receives 5 min of access to the reinforcer that was earned (either exercise or sedentary activity). The game is performed until the participant no longer wishes to work for access to either the exercise or sedentary activities. Once the participant is finished earning points, they are awarded the time they earned and engage in the sedentary or exercise behaviors for the amount of time that was earned. At first, points are delivered after every 4 presses, but then the schedule of reinforcement doubles (4, 8, 16, 32, […] 1024) each time 5 points are earned. For instance, the participant initially has to click the mouse 4 times to earn each point for schedule one. After the first 5 points are earned, schedule one is complete and the participant earns 5 min for exercise. Then 8 clicks are required to earn each of the