

Is the role of cognitive factors in exercise responses intensity-dependent? Extending the dual-mode model to perceived exertion.

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Introduction

Ekkekakis (2003) has proposed a theoretical model, the “dual-mode model”, which hypothesizes that affective responses to exercise will be influenced by both cognitive factors and interoceptive cues. However, the strength of the relationship between these “modes” will be dependent on exercise intensity with cognitive factors having their strongest influence at ranges of exercise intensity where a physiological steady state can be maintained; at higher intensities interoceptive cues will dominate the affective response.

Rejeski (1981) proposed a conceptual fore-runner of the dual-mode model in his social psychophysiological model of perceived exertion. This integrative model examined the salience of physiological and psychological factors on Ratings of Perceived Exertion (RPE) at varying intensities of exercise. Psychological factors were hypothesized to be most important at low and moderate intensities of exercise and less important at higher intensities of exercise. At higher intensities and/or longer duration exercise, physiological variables are hypothesized to dominate the perceived exertion response. Previous research has found personality traits and self-efficacy to correlate with RPE. In a series of studies, Morgan (1973) found anxiety, somatic perception, depression, and neuroticism were positively associated with perceived exertion; however, extraversion was found to be negatively correlated with perceived exertion and positively correlated with preferred exercise intensity. McAuley and Courneya (1992) examined self-efficacy and RPE and as hypothesized, they found a significant inverse correlation ($r = -0.22$) between pre-exercise self-efficacy and RPE during a cycle ergometer test at 70% of predicted maximal heart rate in a sample of middle-aged and older adults.

Main Text

The purpose of the current study was to use these two similar models to examine the influence of cognitive factors, specifically personality and self-efficacy, on RPE at three different intensities of exercise. It was hypothesized that as exercise intensity increased, the correlations between the cognitive factors and RPE would decrease with the strongest correlations coming at the lowest exercise intensities and the weakest correlations occurring at the highest exercise intensities.

Participants

Thirty, physically active volunteers (14 females, mean age = 21.2 ± 2.0 years mean $VO_{2max} = 47.7 \pm 7.6 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$; 16 males, mean age = 21.5 ± 2.5 years, mean $VO_{2max} = 56.6 \pm 7.3 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$) participated in this study.

Measures

Perceived exertion was assessed using Borg’s Rating of Perceived Exertion (RPE) Scale (Borg, 1998). The scale ranges from 6 to 20 with 6 = “No exertion at all” and 20 = “Maximal exertion.” Personality was assessed using two scales: Eysenck Personality Questionnaire (EPQ; Eysenck and Eysenck, 1975) measured neuroticism and extraversion and the Behavioral Inhibition System and Behavioral Activation System (BIS/BAS; Carver and White, 1994) which measured BIS and BAS. Self-efficacy was assessed by an 8-item

questionnaire that asked the participants' belief in their capability to continue to run for incremental 2-minute periods "beyond the point at which exercise starts to become challenging" ranging from 2 minutes up to 16 minutes.

Procedures

Participants visited the laboratory five different times. During the first session, participants performed an incremental treadmill exercise test to determine VO_{2max} and ventilatory threshold (VT). The second session was a validation session to determine the three intensities that the participants would be running on subsequent sessions. The exercise intensities utilized in this study were 20% below ventilatory threshold (<VT), at the ventilatory threshold (@VT), and an exercise intensity 10% above VT (>VT). On sessions 3 through 5, participants ran on treadmill for 15 minutes at the determined intensities. The order of the conditions was randomized.

Participants began the last 3 sessions with a 5 minute warm-up, walking at $4.84 \text{ km}\cdot\text{hr}^{-1}$. Intensity was then increased to desired levels. Following completion of the 15 minute run, treadmill was decreased to $4.84 \text{ km}\cdot\text{hr}^{-1}$ for a 5 minute cool down. RPE was assessed during the last 15 seconds of minutes 3, 6, 9, 12 and 15 (last).

Results

Correlations for personality and self-efficacy and RPE at each exercise condition can be seen in Table 1. Overall, for all personality variables and for self-efficacy, the correlations were strongest in the <VT exercise condition and decreased as exercise intensity increased, thus being weakest in the >VT exercise condition. Significant correlations were found between extraversion, BAS, BIS and self-efficacy in the <VT and extraversion, BIS and self-efficacy in the @ VT exercise intensities. Only BIS was significant in the >VT exercise intensity.

Table 1. Pearson product-moment correlation coefficients of RPE with personality variables and self-efficacy across the three exercise intensities

	Min 3	Min 6	Min 9	Min 12	Min 15	Average
<VT						
Extraversion	-0.35*	-0.46**	-0.39*	-0.46**	-0.51**	-0.44**
Neuroticism	0.02	0.13	0.14	0.23	0.29	0.16
BAS	-0.39*	-0.36*	-0.32*	-0.28	-0.22	-0.32*
BIS	0.49**	0.59**	0.64**	0.69**	0.79**	0.65**
Self-efficacy	-0.52**	-0.52**	-0.48**	-0.50**	-0.53**	-0.51**
@VT						
Extraversion	-0.32*	-0.39*	-0.44*	-0.34*	-0.40*	-0.38*
Neuroticism	0.11	0.12	0.07	0.07	0.21	0.12
BAS	-0.2	-0.12	-0.11	0.01	0.00	-0.08
BIS	0.26	0.35*	0.41*	0.45*	0.54**	0.41*
Self-efficacy	-0.39*	-0.52**	-0.48**	-0.53**	-0.56**	-0.50**
>VT						
Extraversion	0.09	-0.09	-0.07	-0.13	-0.28	-0.1
Neuroticism	-0.29	-0.18	-0.05	0.00	0.19	-0.07
BAS	-0.01	0.09	0.13	0.15	0.11	0.09
BIS	0.07	0.28	0.45**	0.46**	0.45**	0.35*
Self-efficacy	-0.12	-0.11	-0.19	-0.21	-0.28	-0.18

Note: *: $P < 0.05$; **: $P < 0.01$; Single-tail tests of significance were used due to the directional nature of the study hypotheses.

Conclusions

The results from this study support the notion of Ekkekakis's dual-mode model and Rejeski's social psychophysiological model of perceived exertion which states that the relationship between psychological factors would be strongest at low to moderate intensities and become weaker at higher exercise intensities. These findings may have implications in using RPE during exercise testing and for determination of intensity in exercise prescription. These results suggest that psychological factors may cause the exerciser to possibly under or overestimate perceived exertion, depending on the exercise intensity, and not allow the exerciser to achieve the desired exercise intensity. Future research should replicate these findings and continue to examine these models to determine the extent of the influences of cognitive factors and interoceptive cues on affect and perceived exertion. Future studies may want to examine different modes of exercise and examine cognitive interventions that are believed to alter affective and perceptual responses to exercise. Additionally, attempts should be made to test the relative contribution of physiological and psychological factors in the same study (e.g., manipulating self-efficacy and respiratory/metabolic function).

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