



The cascade of positive events: Does exercise on a given day increase the frequency of additional positive events?



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ARTICLE INFO

Article history:

Received 16 February 2016

Received in revised form 1 March 2017

Accepted 13 March 2017

Available online 27 March 2017

Keywords:

Exercise

Daily diary

Daily events

Social events

Achievement events

Well-being

Behavioral activation

ABSTRACT

Research suggests exercise promotes well-being while reducing the risk and symptoms of certain psychiatric disorders. Similarly, positive events improve quality of life and may minimize the impact of negative life events; a dearth of positive events is also associated with increased psychiatric symptoms. Thus, increasing physical exercise and the occurrence of positive events is central to well-being promotion. Behavioral activation theory suggests the occurrence of one positive event increases the likelihood of engaging in subsequent positive events. We used a daily diary approach to examine this possible positive cascade, exploring relationships between exercise and positive social and achievement events. For three weeks, participants ($N = 179$) completed questionnaires at the end of each day. Multi-level modeling analyses revealed that daily exercise predicted increased positive social and achievement events on the same day. Exercise on one day also predicted greater positive social events on the subsequent day. Positive events did not affect exercise on the next day. Findings suggest that exercise creates a positive cascade, increasing positive social and achievement events experienced on the same day and positive social events on the following day.

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1. Introduction

Growing interest in the mechanisms underlying subjective well-being has prompted increased investigation of positive events in daily life. Existing research has linked positive daily events to a plethora of well-being indicators, including increased life satisfaction (McCullough, Huebner, & Laughlin, 2000), positive affect (e.g., Watson, 1988), self-esteem (Nezlek, 2005), and meaning in life (Machell, Kashdan, Short, & Nezlek, 2015). Relatedly, a lack of positive daily events often co-occurs with various psychopathology symptoms, such as depression and anxiety (Cuijpers, van Straten, & Warmerdam, 2007; Kashdan & Steger, 2006). While the benefits of regular positive events are manifold, the strategies to increase day-to-day positive events remain poorly understood. The present study sought to address this gap by examining the benefits of one particular, controllable positive event, daily exercise, as a precursor to subsequent positive events.

1.1. The benefits of exercise

Exercise, defined as “bodily exertion for the sake of developing and maintaining physical fitness” (Merriam-Webster, 2015), significantly benefits both physical and psychological health. Exercise can serve as a protective factor against heart disease, stroke, type 2 diabetes, hypertension, obesity, and some cancers (CDC, 2015), and it is often used as a first-line intervention for better physiological health. A wealth of literature also supports a link between exercise and increased positive mood, reduced depression and anxiety, and greater well-being (for a review, please see Stathopoulou, Powers, Berry, Smits, & Otto, 2006). Individuals who report higher psychological well-being tend to exercise more frequently than those with low well-being (Lox, Burns, Treasure, & Wasley, 1999), and exercise is associated with lower emotional distress (Steptoe & Butler, 1996). A large number of studies illustrate the effectiveness of physical exercise for reducing depressive symptoms in both clinical (e.g., Dunn, Trivedi, Kampert, Clark, & Chambliss, 2005) and community (e.g., DiLorenzo et al., 1999) samples. Even brief, low-intensity episodes of physical activity, such as walking, can result in significant same-day mood improvements (Kanning & Schlicht, 2010), and there is empirical support for significant associations between exercise

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and lower rates of social anxiety disorder, specific phobias, and agoraphobia (Goodwin, 2003). Not only does exercise contribute to physical and psychological well-being, but it may also reduce the symptoms associated with certain psychiatric disorders.

1.2. Exercise as a positive event

Considering the established physical and psychological benefits of exercise, it is unsurprising that exercise might be categorized as a positive event within the context of an individual's day-to-day life. Indeed, exercise frequently appears on measures of positive events, such as the Daily Events Survey (Butler, Hokanson, & Flynn, 1994) and the Positive Events Scale (MacPhillamy & Lewinsohn, 1982). Evidence from daily diary studies upholds this inclusion, linking exercise to improved mood on a given day (Giacobbi, Hausenblas, & Frye, 2005), while research using ecological momentary assessment has demonstrated immediate and sustained increases in positive affect following exercise (e.g., Wichers et al., 2012). In addition, recent work by Kanning and Schlicht (2010) provides evidence of increased feelings of contentment, energy, and calmness following periods of physical activity in daily life. Research indicates that affective responses significantly influence whether an event is judged as positive or negative (Brendl & Higgins, 1996). Given the positive affective response associated with exercise, its categorization as a positive event is supported.

1.3. The benefits of positive events

There is extensive research supporting the influence of positive events, such as exercise, on well-being. In one study, college students engaged in either two or twelve enjoyable events, including exercise, during a 1-month period (Reich & Zautra, 1981). Participants in the experimental groups reported greater quality of life compared to controls, who were not encouraged to engage in positive events. Further, more positive events led to better outcomes, as participants who reported more initial negative events exhibited lower distress when instructed to engage in twelve activities rather than two or none.

Research has traditionally classified positive events into two subcategories: social and achievement events. The two represent conceptually distinct domains, with the former referring to events involving a successful or enjoyable interaction with others (e.g., a pleasant conversation with friends), while the latter involves events that promote goal-achievement (e.g., completing a project). Daily positive achievement events have been linked to greater daily well-being, and daily positive social events to increased self-esteem (Nezlek, 2005). More recent research found that both positive daily social and achievement events were related to greater daily meaning in life, above and beyond the contributions of daily positive and negative affect (Machell et al., 2015). Given the empirical support for the association between these types of positive events and various indicators of well-being, we opted to assess the daily occurrence of both positive achievement and social events, as a better understanding of how to increase positive events on a daily basis may improve efforts to enhance well-being.

1.4. The generation of positive events: Creating a positive cascade

There is reason to believe that one positive event might increase the likelihood of subsequent positive events. In line with behavioral activation (BA) theory, a positive event, such as exercise, may expose an individual to environmental reinforcers and subsequently improve thoughts, mood, and overall quality of life (Hopko, Lejuez, & Robertson, 2006). BA has been successfully implemented as a treatment for depression (e.g., Jacobson, Martell, & Dimidjian, 2001) and anxiety (e.g., Hopko et al., 2006), where clinicians emphasize strategies to reduce avoidant behaviors and augment engagement in potentially rewarding situations. Ultimately, repeated engagement in rewarding situations is theorized to disrupt habitual patterns of withdrawal

behavior. Engagement in exercise may serve as a mechanism to increase engagement in future positive events, leading to a "cascade" of positive experiences. Results of a specific case study provide support for the notion that the engagement in goal-directed activities (e.g., spending time with family, practicing relaxation techniques, exercising) provided increased positive reinforcement, leading to an overall decrease in withdrawal behavior (Hopko et al., 2006). By providing this reinforcement, positive events such as exercise may increase the likelihood that an individual will continue to pursue positive reinforcement by engaging in additional positive activities. In this vein, successful engagement in one positive event (e.g., exercise) may increase the likelihood that subsequent positive events will occur.

Given the possibility of this positive cascade, it is important to note that exercise may be a uniquely attractive positive event to target. Not only is exercise linked to various psychological and physical benefits, it also has the capability of serving as both a social (e.g., jogging with friends) and achievement (e.g., completing a workout routine) event. Though exercise can be a social event, many exercise activities (e.g., walking or jogging) may be done alone, and the completion of solitary exercise may be classified as an achievement event. Furthermore, many exercise activities can be completed without specific equipment. As a result, exercise requires little to no cost and can be immediately available to the majority of individuals. With this in mind, we chose to focus on exercise as a simple and controllable positive event, which might serve to trigger a cascade of subsequent positive events.

1.5. Present study

We designed our study to examine the relationship between exercise on a given day and other daily positive social and achievement events. As our study is the first to explore these constructs together at the daily level, we reached our hypotheses cautiously. Our primary hypothesis was that exercise on a given day would be positively related to the occurrence of positive social and achievement events on the same day. Because the same-day relationships discussed so far do not address direction of causality, we also examined lagged relationships between daily exercise and positive social and achievement events. Specifically, we explored the relationship between exercise on day n and positive social and achievement events on day $n + 1$. We expected exercise on one day to predict increased positive social and achievement events on the next day.

Daily diary methodology may be particularly apt to examine the impact of exercise on positive events. This contextualized approach is able to capture within-person variability which can be missed by traditional global assessments. Daily diary studies also reduce the potential for recall bias by minimizing both the distance between an event and its recollection, as well as the number of events being recalled at one time (Nezlek, 2011). Relatedly, reviews of the exercise literature identify the frequent use of correlational designs by researchers examining the effects of exercise (e.g., Michie, Rothman, & Sheeran, 2007; Webb & Sheeran, 2006) as a limitation warranting immediate attention. To our knowledge, no research to date has explicitly examined the relationship between daily exercise and daily positive social and achievement events.

2. Methods

2.1. Participants

We initially sampled 186 college students from the Northern Virginia area. Seven participants were excluded for providing <14 days of data. The final sample consisted of 179 participants (127 women) with a mean age of 24.00 years ($SD = 9.07$) and an ethnic composition of 56.6% Non-Hispanic White, 12.7% Latino/Hispanic, 12.7% Asian, 7.8% African American, 1.8% Middle Eastern, 1.2% Native American, and 7.2% other.

2.2. Procedures

Participants were recruited via flyers and online advertisements. Each participant attended an initial in-person session (1.5 h), during which they were given instruction on how to provide daily reports using the website. Research staff asked participants to complete a report before going to sleep at the end of each day for 21 days. Researchers also emphasized that data was desired from at least two weekends, as weekends tend to allow for more free time during which to engage in activities such as exercise. The 179 participants provided 3996 valid daily entries ($M = 24.01$, $SD = 4.35$). Participants received emails each week reminding them to provide daily reports as originally instructed.

2.3. Measures

2.3.1. Daily exercise

We developed a 9-item, face-valid measure to assess the daily occurrence of exercise. Items included eight athletic activities (e.g., cycling, weight training, and swimming), as well as an “other” item to include additional physical activity not mentioned in the previous items. Participants responded using a binary scale indicating whether or not they engaged in the activity on a given day and an aggregate score represented the total number of activities they engaged in each day.

2.3.2. Daily positive events

We assessed the occurrence of daily positive events via items from the Daily Events Survey (DES; Butler et al., 1994), which has been used in previous experience-sampling studies (e.g., Kashdan & Steger, 2006). The measure consisted of 6 items assessing the occurrence of positive social events (e.g., “Had a good social interaction”) and 5 items assessing the occurrence of positive achievement events (e.g., “Completed a project”). Of note, none of the social or achievement events included were related to fitness or exercise. Participants provided responses using the following scale: 0 = did not occur, 1 = occurred and not important, 2 = occurred and somewhat important, 3 = occurred and pretty important, and 4 = occurred and extremely important. Two optional items assessed the occurrence and importance of one additional event not listed in the survey. For both social and achievement events, we created a composite score of average self-rated importance by calculating the average of the items. We also calculated a frequency count, which represented the total number of events a person described as having had occurred on that day.

2.4. Data analysis

Primary analyses focused on within-person relationships between daily exercise, daily positive social events, and daily positive achievement events. We conceptualized the data as hierarchically nested, that is, days nested within persons. We conducted analyses with a series of multilevel models using the program HLM 6.0 (Raudenbush, Bryk, Cheong, & Congdon, 2000) and followed guidelines outlined by Nezlek (2011, pp. 71–104).

3. Results

3.1. Daily measures: descriptive statistics

We did not compute reliabilities for daily exercise or daily positive events because these variables are essentially behavioral recordings (Stone, Kessler, & Haythomthwatte, 1991). Specifically, we did not expect people to experience each positive event or engage in every unique exercise activity on a given day, thus we did not expect these measures to be internally consistent at the daily level. Daily life event measures are not designed to maximize internal reliability; they are designed to capture a wide breadth of possible events in a particular category (in this case, events that span romance, large parties, sports, solitary

physical activity, etc.). We calculated the intraclass correlation coefficient (ICC), which represents the ratio of between-person variance to total variance, for each variable. We found that there was greater within-person variability than between-person variability for each measure (exercise ICC = 0.44, social event frequency ICC = 0.44, social event importance ICC = 0.43, achievement event frequency ICC = 0.37, achievement event importance ICC = 0.38). These results supported our approach of conducting within-person (day-level) analyses.

3.2. Concurrent analyses

Our first set of analyses examined relationships between daily exercise and daily positive events (separated into social and achievement events). Daily exercise was entered as the predictor, and it was group-mean centered, meaning that coefficients described relationships between deviations from a person's mean daily exercise and the outcome measures. The model is presented below. In these analyses, we tested the null hypothesis that the mean within-person relationship between exercise and the outcome measure was 0. We tested this via the y_{10} coefficient in the equations below. In these models, there were i days nested within j participants.

$$\text{Day level: } y_{ij} = b_{0j} + b_{1j} (\text{Daily Exercise}) + r_{ij}$$

$$\text{Person-level intercept: } b_{0j} = y_{00} + u_{0j}$$

$$\text{Person-level slope: } b_{1j} = y_{10} + u_{1j}$$

Consistent with hypotheses, daily exercise predicted increased frequency ($y_{10} = 0.09$, $t = 2.89$, $p < 0.01$) and average rated importance ($y_{10} = 0.04$, $t = 2.48$, $p < 0.05$) of positive daily social events. On a given day, the more someone exercised, the more positive social events they also experienced. Similarly, daily exercise predicted increased frequency ($y_{10} = 0.14$, $t = 3.96$, $p < 0.001$) and average rated importance ($y_{10} = 0.08$, $t = 4.10$, $p < 0.001$) of positive daily achievement events.

3.3. Lagged analyses

The same-day analyses we presented thus far do not address issues of directionality. We conducted a series of analyses examining lagged relationships (Nezlek, 2011) to further understand the relationships between daily exercise and our outcomes. In these analyses, the previous day's exercise predicted the current day's positive social and achievement events (controlling for the outcome of interest on the previous day). We present the model that tested these lagged effects below.

$$\text{Day level: } y_{ij} = b_{0j} + b_{1j} (\text{Previous day outcome}) + b_{1j} (\text{Previous day exercise}) + r_{ij}$$

$$\text{Person-level intercept: } b_{0j} = y_{00} + u_{0j}$$

$$\text{Person-level slope: } b_{1j} = y_{10} + u_{1j}$$

$$\text{Person-level slope: } b_{2j} = y_{20} + u_{2j}$$

Yesterday's exercise significantly predicted increased frequency ($y_{20} = 0.09$, $t = 2.45$, $p < 0.05$) of the next day's positive social events. The relationship between yesterday's exercise and the average rated importance of next day's positive social events was marginally significant ($y_{20} = 0.03$, $t = 1.90$, $p = 0.059$). We also tested the reverse of these relationships to explore the possibility that yesterday's social events might be impacting exercise on the next day. Neither yesterday's frequency ($y_{20} = -0.02$, $t = -0.96$, $p = 0.34$) nor average rated importance ($y_{20} = -0.02$, $t = -0.64$, $p = 0.53$) of positive social events was related to the next day's exercise. This provides support for the argument that exercise initiates a cascade of positive social events, but it does not occur in response to a positive social event.

Yesterday's exercise did not predict the next day's frequency ($y_{20} = -0.04$, $t = -1.01$, $p = 0.32$) or average rated importance ($y_{20} = -0.02$, $t = -1.34$, $p = 0.19$) of positive achievement events. The reverse of these lagged relationships, with yesterday's positive achievement events predicting today's exercise, were also nonsignificant. This suggests that, while exercise and positive achievement events are concurrently related, the relationship does not span across days as it does for positive social events.

4. Discussion

The present study represents the first attempt to explore the relationship between daily exercise and positive social and achievement events, both on the same day and consecutive days. Specifically, we explored the potential for daily exercise to create a positive cascade, increasing the occurrence of additional positive social and achievement events. Multi-level modeling analyses revealed that daily exercise predicted increased frequency and importance of positive social and achievement events on the same day. Exercise on one day also predicted a greater frequency and importance of positive social events, but not achievement events, on the subsequent day. Our lagged findings indicated that the relationship between exercise and other positive events is not bidirectional, in that yesterday's frequency and average rated importance of positive social and achievement events did not predict the next day's exercise. These findings imply that exercise might possess a unique ability to initiate a cascade of subsequent positive social events.

The observed relationship between exercise and increased frequency of positive social and achievement events may be understood through the lens of behavioral activation therapeutic techniques (BA), which seek to reduce avoidant behaviors by providing people with strategies to increase engagement in potentially rewarding situations (Hopko et al., 2006). Stathopoulou et al. (2006) have equated exercise interventions to BA treatments for depression and anxiety (e.g., Hopko, Lejuez, Ruggiero, & Eifert, 2003), citing the modification of action tendencies as a core feature of both therapeutic techniques. In this context, exercise requires an individual to initiate action (i.e., approach behavior) that is incongruent with avoidant action tendencies (e.g., inactivity, withdrawal), which may exist as maladaptive behaviors that bar the individual from experiencing positive events. Thus, exercise may serve as an easily accessible BA strategy that encourages approach-based action tendencies and increases the probability of exposure to other rewarding experiences (e.g., positive social and achievement events).

Our findings also highlight the importance of using a within-person design when examining the relationship between exercise and positive events. Study of exercise at the between-person level has demonstrated positive associations between high activation positive affect, well-being, and frequency of exercise (Garcia, Archer, Moradi, & Andersson-Arntén, 2012); however, these findings offer little insight into the directionality and causality of these relationships. Moreover, while such research offers valuable comparison of global measures of well-being and exercise, between-person designs do not capture how these experiences might vary within an individual from day to day. We propose that the relationship between exercise and indicators of well-being may be more complex, with exercise predicting an increase in positive social and achievement events concurrently, as well as an increase in positive social events on the next day. Indeed, this has been supported by findings which suggest that daily diary methodology is an ecologically valid technique for the study of exercise (Michie et al., 2007; Webb & Sheeran, 2006). Over time, the continual experience of positive social and achievement events may culminate in increased well-being, thus acting as a potential mechanism by which exercise improves psychological health.

It is noteworthy that exercise on a given day predicted the increased frequency of positive social events on the next day, while positive events failed to predict subsequent exercise. Previous studies of overt daily behaviors concluded that engagement in social and physical behaviors are critical to mental health and effective emotion regulation (e.g., Hopko & Mullane, 2008). Similarly, depressive symptoms are associated with decreased social and physical activity (e.g., Coyne, 1976; Dunn et al., 2005). Not surprisingly, behavioral activation interventions target social and physical activities to increase well-being among depressed and healthy populations (for a review, see Mazzucchelli, Kane, & Rees, 2010). Our findings suggest that exercise activities may be uniquely valuable within this context, as their benefits could promote future social engagement. Thus, clinicians may wish to encourage

engagement in physical activities, with the expectation that they might serve as a vehicle to increase social engagement.

Given our hypotheses, it was unexpected that the lagged effect of daily exercise was specific to the next day's positive social events, as it failed to predict engagement in achievement events on the next day. It is intriguing to consider that certain forms of exercise, such as those involving additional individuals (e.g., jogging with a partner), may have provided unique opportunities for participants to obtain social reinforcers (e.g., enjoyable social interactions). These social reinforcers may, in turn, promote the pursuit of subsequent social events. Alternatively, it is feasible that certain proposed benefits of acute exercise may mediate the relationship between daily exercise and positive events such that the engagement in subsequent social activities is uniquely promoted. For instance, researchers note that improvements in positive affect (e.g., Bibeau, Moore, Mitchell, Vargas-Tonsing, & Bartholomew, 2010) occur immediately following bouts of anaerobic and aerobic exercise and persist following exercise cessation (e.g., Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991). Many theorists note that experiences of positive affect promote approach behavior (Fredrickson, 2001) by encouraging individuals to engage with their environment and participate in activities. Furthermore, positive mood can augment involvement in social activities and facilitate more frequent pursuit and engagement of social interactions (for a review, see Lyubomirsky, King, & Diener, 2005). Thus, increases in positive affect following exercise may drive approach behavior, specifically enhancing the probability that an individual pursues engagement in subsequent positive social events. The possibility that positive affect resulting from exercise increases the likelihood that events are perceived to be positive must also be considered. While the exploration of potential mediators was beyond the scope of the current study, future research should examine the potential mechanisms of the relationships between exercise and positive events.

5. Limitations and future directions

Beyond the inability to assess the influence of potential mediators, several other study limitations must be addressed. First, we used a self-report measure of daily exercise, and thus did not collect physiological data. Physiological measures (e.g., heart rate, blood pressure, cortisol levels, and oxygen consumption) will provide a more nuanced understanding of what types of exercise are most beneficial within the context of well-being promotion. Measures of exercise duration and intensity would offer greater insight into the benefits and limitations of exercise as a naturalistic treatment to improve daily experience of positive events. This information will also allow researchers to determine if a given day's exercise duration and intensity might influence concurrent positive experiences, either confirming or identifying exceptions to our results. We also underscore the importance of examining the perhaps differential effects of solitary and group exercise on subsequent positive events. Given that exercise may be dually classified as both a social and achievement event, it would be helpful to explore whether group exercise has a greater effect on subsequent positive events, particularly social events, when compared to exercising alone. We must also consider the possibility of measurement reactivity. The regular reporting of daily exercise and positive events might have led to the reporting of more instances of each due to increased awareness.

While the current study focused on positive events, it is necessary for future studies to explore the impact of exercise on negative events. Finally, subsequent studies of exercise and positive events should be conducted at the within-person level to better address the complexity of this relationship, which, as mentioned above, should explore the impact of potential mechanisms.

6. Summary

The present study is the first to explore the relationship between exercise and positive events in daily life. We found evidence that exercise

on a given day was associated with increased frequency and subjective importance of positive social and achievement events on the same day. Furthermore, exercise predicted the occurrence and importance of positive social events on the next day, while positive events failed to predict the next day's exercise. In line with behavioral theory, we propose that exercise may promote well-being by increasing exposure to environmental reinforcers and encouraging approach-oriented behavioral patterns, resulting in increased positive events. Evidence from the current study also suggests that exercise may uniquely promote engagement in additional positive social events on the next day. Therefore, the specific emphasis of exercise activities within behavioral activation interventions to promote well-being warrants further consideration.

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