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Does approach motivation account for the impact of locomotion on positive affect?

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**Does approach motivation account for the impact of locomotion on
positive affect?**

by

Jeffrey C. Miller

A dissertation submitted to the graduate faculty
in partial fulfillment of the requirements for fulfillment of the degree of
DOCTOR OF PHILOSOPHY

Major: Psychology

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2014

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ABSTRACT

Moving around seems to make us feel better...but why? In this dissertation I draw from research on affect, approach motivation, and embodied cognition suggesting that locomotion (i.e., walking) facilitates positive affect because it increases sensitivity to rewards, a key aspect of approach motivation. Approach motivation is an organismic tendency, either dispositional or induced, to pursue needed resources or rewarding experiences. To test the mediational hypothesis that approach motivation mediates the impact of locomotion on positive affect, two studies were conducted and mediational hypotheses were tested using statistical bootstrapping procedures. In Study 1, locomotion in the form of a walk increased incentivized performance on a card-sorting task. According to the results of the bootstrapping analyses, performance on the card-sorting task partially mediated the relationship between locomotion and positive affect change, although the overall effect did not reach significance. In Study 2, locomotion increased self-reported approach motivation, partially mediating the impact of locomotion on positive affect, backing the results of Study 1. However, another proposed measure of approach motivation in Study 2, object desirability, was not impacted by locomotion. Taken together, the results of these studies support the hypothesis that approach motivation mediates the causal relationship between locomotion and positive affect when approach motivation is measured behaviorally as reward-sensitivity (Study 1) or as self-reported readiness to respond to rewards (Study 2). In short, locomotion increases our readiness to invest effort in obtaining rewards that make us feel better.

Key words: locomotion, approach motivation, embodiment, dopamine, positive affect

CHAPTER 1. INTRODUCTION

People typically spend a significant amount of time each day moving to get from place to place. To cover smaller distances, or when motorized transport is not available, we generally walk. We do so much walking during the day, going from rest to movement repeatedly, that we generally do not think about whether such movement has any immediate psychological consequences. Although most people are aware that physical exercise can feel pleasant and energizing, the potential impact of everyday, routine movement on psychological experiences has been ignored. The current research aims to fill this gap; specifically, it seeks to address how routine-purpose movement through one's environment engages positive affect by increasing approach motivation. By considering social-psychological, personality, and bio-psychological processes, the proposed research seeks to answer the following question: Why and how does the act of moving around increase positive affect?

Existing research where participants are put in motion typically focuses on exercise, suggesting that (1) mild-intensity exercise leads people to consistently feel "better" and more "energized" (Reed & Ones, 2006; Yeung, 1996) and (2) the general public is aware that going for a brisk-walk for the explicit purpose of improving mood will often result in exactly that (Hsiao & Thayer, 1998; Thayer, Newman, & McClain, 1994). Note that "exercise" is a dedicated activity loaded with expectations, many of them emotional in nature (Silberstein et al., 1988). Recent research and pilot studies reported below reveal that people need *not* be cognizant of the fact their movement is of any significance in order to experience mood improvement, and that such locomotion improves positive affect even while moving through a drab environment or expecting one's emotional state to deteriorate due to an upcoming aversive task (Miller & Krizan, 2014).

Moreover, people spend far more time engaged in movement for reasons that are more utilitarian (e.g., walking through stores, going to their next class) than aimed at improving health or fitness. Thus, general locomotion – routine movement through one’s environment – is significantly under-researched. Given that locomotion, even when not represented as exercise or the focus of ongoing activity, seems so inextricably tied to positive affect it is critical to ask *why* does the unencumbered act of simply moving around cause such a robust increase in positive mood?

Does Approach Motivation Account for the Impact of Locomotion on Positive Affect?

A useful starting point to begin explicating the relationship between locomotion and positive affect is an observation that is currently nearly a century and a half old:

"Now with animals of all kinds, the acquirement of almost all their pleasures, with the exception of those of warmth and rest, are associated with active movements..." –

(Charles Darwin, 1872)

In this quote Darwin suggested that good feelings are strongly associated with movement; that moving around should be indicative of positive feelings. Research examining momentary fluctuations in movement and positive affect within real-life contexts is consistent with Darwin’s proposed association (Schwerdtfeger et al., 2010; Wichers et al., 2012), but the key word in Darwin’s statement for the research proposed herein is *acquirement*.

Since the time Darwin wrote these words, researchers have empirically examined bio-behavioral systems that regulate our resource-seeking behaviors and resulting reward-responses, suggesting that movement is critical to these systems. Building on these insights and the notion

that cognition can be embodied through processes that have an impact on both affect and behavior even when we are not aware of their activation, I propose that locomotion increases positive affect by increasing approach motivation – a motivational tendency that is closely tied to positive affect across individuals (Lucas, Diener, Grob, Suh, & Shao, 2000; Watson et al., 1999; Depue & Collins, 1999). The goal of this research, then, is to establish that approach motivation mediates the impact of locomotion on increased positive affect (Figure 1).

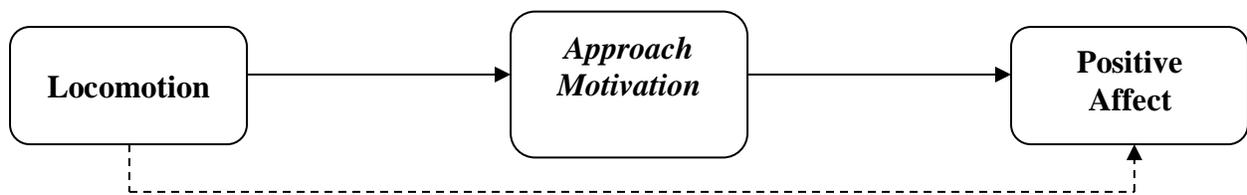


Figure 1. Approach motivation as a mediator of the influence of locomotion on positive affect.

Specifically, people should feel more positive affect when they are moving around their environment because locomotion is an activity associated with the acquirement of resources, rewards, and social interactions necessary for both continued survival (e.g., acquiring food) and pleasure (e.g., sexual encounters). Associated good feelings are in part the impetus for satisfying the evolutionarily driven base-goals of all organisms. “You can’t win if you don’t play”, a former motto of the Powerball Lottery organization, demonstrates the notion that in order to thrive, organisms need to take action. Regardless of the reason you go to your local convenience store (whether to buy a winning lottery ticket or merely a cup of coffee), walking there should itself improve positive affect.

This proposal is novel because it focuses on a hitherto neglected factor central to the experience of emotion, namely movement through one's environment. Key research studies

analyzing the efficacy, utility, and popularity of mood-induction manipulations do not list any manipulations that are movement-based, despite the knowledge that physical activity may make one feel better (Westermann et al., 1996; Gilet, 2008; Larsen & Ketelaar, 1989; Albersnagel, 1988; Chartier & Ranieri, 1989). In fact, the *Handbook of Emotion Elicitation and Assessment* contains not a single reference to inducing mood or emotion by putting research participants in motion (Coan & Allen, 2007). Accordingly, a key contribution of the proposed research will be to establish locomotion as a robust mood-induction procedure.

In order to elucidate the proposed mediational framework (Figure 1), the literature review is organized as follows. First, I explicitly define locomotion and the specific class of locomotion key to positive affect. Then, I review the relevant literatures on (1) positive affect, (2) the Behavioral Approach System and related concepts of reward-sensitivity and motivational intensity, (3) research in personality and neurobiology that has examined movement, positive affect, and approach behaviors, and (4) the anticipatory nature of affect as reflected in the concepts of “wanting” vs. “liking”. Finally, (5) I present evidence supporting the proposal that the complex pattern of nervous system activation occurring during locomotion embodies positive affect. Accordingly, engaging in locomotion triggers positive affect given that experiencing energetic good feelings accompanies movement toward rewards and resources. In other words, locomotion tracks approach motivation in most “acts” associated with positive affect. To examine these ideas, I describe two studies that tested the impact of locomotion on approach motivation (i.e., reward-sensitivity), as well as their joint impact on positive affect.

Routine Locomotion

Locomotor movement, or locomotion, is a form of movement that allows an organism to travel through space (Kassing & Jay, 2003). Walking, running, skipping, galloping, sliding,

hopping, leaping, and jumping are common forms of locomotion most people learn about as children in basic physical education classes. Notice that, outside of all being done on land (contrast with swimming, for example), all of these examples of locomotion involve the use of the legs and allow for movement of a person towards or away from some other person, object, or thing. Locomotion typically results in net translation through space, from some “Point A” to some *other* “Point B”. Waving around one’s arms or nodding one’s head is not locomotion as these movements do not result in net translation through space. One exception critical to this research is the use of a treadmill. Is a walking on a treadmill a form of locomotion? Clearly people do not move through space while on a treadmill, but a discrete amount of distance *is* covered with respect to the actual mat being spun underneath. Most important, the physical movements are exactly the same as if one was moving through space.

There are all the reasons in the world to engage in locomotion. Whatever their current status might be, all people will inevitably have a *need* to move from their current location. This need could be a “flight” response based on fear, a negative emotion whose primary purpose is to motivate escape (Canon, 1932). More frequently, however – and more importantly for this research – people engage in locomotion because resources and rewards they want or need are always located at some distance away from them. The most common way people approach these resources and rewards is by moving towards them at a confident, brisk pace -- walking. Therefore when references are made to "locomotion" in this research, the reader should have the image of a person walking in mind. While often aiding relief, behaviors such as fidgeting, shivering, and knuckle-cracking bring people no closer to the resources they need. Locomotion, on the other hand, is virtually always necessary to bring us closer to resources we need to survive and to desires that bring us pleasure.

CHAPTER 2. LITERATURE REVIEW

1. Affect

Affective science is the study of the experience of emotional states over varying lengths of time, how people understand these states, what behavioral consequences the states have, and their interplay with cognitive processes (e.g., Frijda, 1986). Two structural theories of affect are now reviewed, with particular attention paid to how positive emotion is conceptualized.

The Circumplex Model of Affect. James Russell's (1980) original circumplex model posits that all affective states can be described along two dimensions; valence (i.e., pleasantness), and arousal (i.e., engagement). The model's pleasantness factor is a bipolar dimension underlying pleasant and unpleasant affective states, whereas the arousal factor is a presumably orthogonal dimension ranging from lack of arousal to high arousal. For example, a person who is currently excited would be experiencing a relatively high level of arousal and a pleasant perception of their current affective state, whereas a person who is calm would similarly be experiencing a pleasant affective state, but one that is low in arousal. I note this valence/arousal model primarily because the Positive and Negative Affect model (as measured by the PANAS; Watson, Clark, & Tellegen, 1988) was in part based upon the valence/arousal model and shares considerable agreement with it regarding the similarities and differences across various emotions.

The Positive and Negative Affect Model. The Positive and Negative Affect model is essentially a 45 degree rotation of the same factorial space conceptualized in Russell's (1980) valence/arousal circumplex model of affect. However, the Positive and Negative Affect model conceptualizes affective states as reflecting activation of two independent, unipolar affect systems, each thought to be related to a distinct neurological network. Positive affect (or

activation) is the experience of feelings that reflect positive engagement with the environment and involves emotions such as excitement, joy, and self-assurance. Negative affect (or activation) involves avoidant reactions to the environment and emotions such as anxiety (Watson, 2002; Watson & Tellegen, 1985; Watson et al., 1999). There are also affective states that are less “pure” forms of either positive affect or negative affect, existing as mixes of both positive *and* negative affect, such as depression (high negative and low positive affect; Watson, Clark, & Carey, 1988). Basically, a person’s current affective state need not be valenced either pleasantly, neutrally, *or* unpleasantly, as in Russell’s (1980) model. Rather, a person’s current affective state is a combination of the level of functionally independent positive and negative activation in ongoing experience, although each state can be *described* as a combination of engagement (arousal) and pleasantness (valence, see Figure 2).

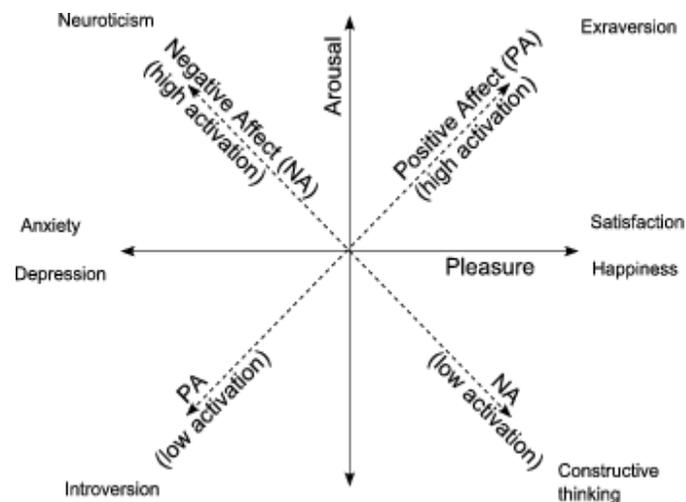


Figure 2. The Positive and Negative Affect dimensions (dashed lines) in reference to associated personality traits and pleasantness–arousal dimensions (from Saerbeck & Bartneck, 2010).

This perspective fits well with the hypothesized evolution and purpose of affective states in humans; that affect exists in part for knowing when and how to engage with the social world

(Darwin, 1872; Ekman & Friesen, 1971; Ekman, 1992). The Positive and Negative Affect model is consistent with biological considerations that have informed the scientific understanding of the affective experience (Watson et al., 1999, Depue & Collins, 1999; Gray & McNaughton, 2000); Larsen & Diener, 1992). In this vein, the proposal to add a dominance factor to Russell's (1980) original circumplex model in part reflects the realization that affect has an engagement component otherwise absent in the original valence-arousal configuration (Mehrabian, 1997). Put another way, this addition of dominance seems to confirm the theoretical notion that affect is critical to approach and avoidance behavior, consistent with the assumptions underlying the Positive and Negative Affect model. Affect is not experienced passively, but rather both reflects and motivates engagement with the world.

Accordingly, and critical to this proposed work, the separate activation and distinct functionality of the positive and negative affective systems is consistent with behavioral and neurological findings in both human and animal research (Carver, Sutton, & Scheier, 2000; Depue & Collins, 1999; Fowles, 1987; Gray, 1990; Kunzmann, 2008). Recall that positive affect reflects engagement-activated states, especially those that involve engagement with the world for purposes of acquisition. The expanded Positive and Negative Affect Schedule (PANAS-X; Watson & Clark, 1994) delineates positive affect into more specific features that further reveal this engagement-oriented nature. These aspects of positive affect are *attentiveness*, *self-assurance*, and *joviality* (Watson & Clark, 1994).

There are, however, valid concerns about the structure of the Positive and Negative Affect model as measured by the PANAS. First, the conceptually independent positive and negative affect factors are not always entirely independent when analyzed, particularly across emotional states within specific individuals (Goldstein & Strube, 1994; Rafaeli, Rogers, &

Revelle, 2007; Russell & Carroll, 1999). Second, considering anger (“hostility” in the PANAS-X) to be a negative affect does not seem fully appropriate given anger is linked to approach motivation (Carver & Harmon-Jones, 2009). However, the terms used to capture the experience of positive affect on the Positive Affect scale do not seem problematic. Additionally, the otherwise strong psychometric properties of the PANAS, as well as my hypothesis that it is specifically the *positive affect system* that is impacted by locomotion, make these issues of only tangential concern for the proposed research. Furthermore, measurement using the PANAS according to the Positive and Negative Affect model reveals a very clear relationship with other phenomena suggested to be related to positive affect, including individual differences in extraversion and behavioral approach motivation (Depue & Collins, 1999; Lucas et al., 2000; Gray & McNaughton, 2000; Panksepp, 1998).

Next, I review research on approach motivation with special attention paid to the relationship of positive affect with approach motivation. I first outline the bio-psychological systems regulating approach motivation, and then move to key concepts in this domain including classic approach motivation, reward-sensitivity, and appetitive motivational intensity.

2. The Behavioral Approach System

I have proposed that approach motivation is a key mediator of the influence of locomotion on positive affect, but what is approach motivation? Neurological and behavioral evidence regarding organisms’ responses to reward-opportunities suggests existence of a Behavioral *Approach* System (Depue & Collins, 1999; Fowles, 1987; Gray, 1990; Harmon-Jones, Price, Gable, & Peterson, in press), whose function is to orient individuals to rewards and to motivate their acquisition via approach behaviors. Put simply, it ensures that organisms notice opportunities to acquire or achieve something that is rewarding (often necessary), directing their

behavior accordingly. This resource acquisition and approach function is typically distinguished from the function of the Behavioral *Inhibition* System, thought responsible for negative emotions, vigilance, detection of goal obstacles, and avoidance of goal conflicts (Gray & McNaughton, 2000; Fowles, 1987). The Behavioral Inhibition System complements the Flight-Fight-Freeze System whose function is to mobilize organisms' resources to escape or counteract immediate threats (Cannon, 1932).

I now review three key aspects of approach-oriented behavior: approach motivation, reward-sensitivity, and appetitive-motivational-intensity. All three are important to consider in order to explicate the role of locomotion in the facilitation of positive affect.

Classic Approach Motivation. Motivation researchers who adopt a biological perspective often define approach motivation as the impulse to go towards positive stimuli, where such positive stimuli are desirable external goal objects or reward-cues (Lang & Bradley, 2008). Thus, according to the classic definition, approach motivation is caused by having goals that can only be realized by noticing attractive external stimuli and interacting with them (Scholer & Higgins, 2008). An even simpler definition of approach motivation eliminates the valence aspect from the classic definition, leaving an approach-motivated organism possessing an impulse merely to go *towards* something, whether that something is explicitly interpreted to be a reward-cue or a threat (Harmon-Jones, Harmon-Jones, & Price, 2013). In the subsequent section of this proposal I expand further on this point by considering embodiment phenomena. For now, note that both the classic definition (requiring incentive stimuli to cause approach motivation), as well the more contemporary, reward-free definition, involve the notion of at least figurative *movement towards* something. In this research, I examined the notion of *movement towards* quite literally, along with its relationship to approach motivation and positive affect.

Approach-motivation is elicited by interactive person-situation processes involving stimulus driven or self-stimulated states, but it also reflects dispositional tendency to engage in approach behaviors (Carver & White, 1994; Depue & Collins, 1999; Gray & McNaughton, 2000; Panksepp, 1998). Individual differences in dispositional approach motivation are often measured with the Behavioral Approach System and Behavioral Inhibition System scales (Appendix 2, BAS/BIS scales; Carver & White, 1994). Importantly, the BAS scale correlates strongly with both dispositional positive affect (e.g., Watson, 2002), as well as extraversion (e.g., Lucas et al., 2000; see also Kuppens, 2008). Further, the BAS scale has distinct facets including drive, fun seeking, and reward-sensitivity, implying there are multiple aspects to approach-oriented behavior. In sum, all organisms inherently engage in approach behaviors, with dispositional differences in their tendency to do so. Depending on within-species, between-species, or even between-*kingdom* variability in biology (think of a plant anchored to the ground), some organisms are more likely to engage in approach behaviors, but all organisms engage in approach. Even a stationary plant grows *towards* the Sun.

Reward-Sensitivity. Approach motivation can also be understood from a *sensitization* perspective. Extraverts, and by proxy people who are higher on dispositional approach motivation, do not necessarily engage in movement *more* than less approach-motivated people (Wilt & Revelle, 2009). Rather, individuals who are higher in approach motivation generally notice opportunities for reward more easily than others, and subsequently act on them more quickly. Extraverts, and by proxy more approach motivated individuals, thus move more expeditiously, or respond more *quickly* to stimuli (Smille, 2013; Smille, Cooper, Wilt, & Revelle, 2012; Doucet & Stelmack, 1997). Neuroscience research further backs this claim, determining that dispositional approach motivation (measured with the BAS scale; Carver &

White, 1994) predicts more rapid activation in the left prefrontal cortex (associated with approach behaviors) when participants were presented with pictures that evoked desire or appetite (Gable & Harmon-Jones, 2013). Movement, therefore, appears to be at least indirectly related to approach motivation, as approach motivated people will initiate movement more quickly in response to stimuli, and move more quickly to acquire a resource.

In short, rewards have a greater *pull* on people who are highly approach motivated due either (1) to their overall disposition (e.g., extraversion) or (2) to some situational event that has caused a temporary increase in their approach motivation (e.g., sexual attraction). Making the acquisition of a reward more salient for a person, for example, can have the effect of increasing approach motivation (Gable & Harmon-Jones, 2011).

Appetitive Motivational Intensity. Imagine a movie scene involving two loving partners separated by some distance in a field. They move towards each other, slowly at first, and then gathering speed until they collide in a passionate embrace. This behavior exemplifies motivational *intensity* in regards to acquiring a desired stimulus. Intensity of affective experience likely allows people to monitor their progress towards a goal (Harmon-Jones et al., *in press*; Harmon-Jones, Harmon-Jones, & Price, 2013; Carver & Harmon-Jones, 2009). Exact underlying processes remain to be explicated, but it is likely that two people running late for the start of concert will move at different rates depending on their desire, that is excitement about the show.

Affective states exist to signal whether people need to move either towards or away from something (e.g., “affective tuning”, Frijda, 1986). A positive affective state such as excitement is high in inherent approach motivation because it is highly appetitive – an excited person is highly involved in acquiring a reward. A less intense positive affective state such as contentment denotes a somewhat less intense state of motivation and therefore, reflects less approach

motivation (Harmon-Jones, Harmon-Jones, & Price, 2013). Approach motivational intensity is thus reflected in how engaging, arousing, and directed one's state positive affective experience is at the moment.

To summarize, three conceptualizations of approach motivation were offered. Given that each has empirical backing, an integrative definition is warranted. To this end, approach motivation can be broadly viewed as an impulse to go towards something, typically a reward, and this impulse can be measured as responsiveness (i.e., sensitivity) to act on the desirability of the target object. To better understand how positive affect and approach motivation are connected, I next review the trait of extraversion and the role of dopamine in approach behavior.

3. Linking Positive Affect to Approach Motivation

Extraversion. Examining the extraversion personality trait helps connect the key concepts of positive affect and approach motivation. The trait of extraversion correlates strongly with positive affectivity, in addition to movement expediency described above (Watson, 2002; Wilt & Revelle, 2009). Specifically, positive affectivity correlates strongly with the extraversion facets of venturesomeness, ascendance, and affiliation (McCrae & Costa, 1991). Thus, one reason extraverts experience more positive affect is that they seem to enjoy social interaction more than less extraverted people (Srivastava, Angelo, & Vallereux, 2008). However, given the link with venturesomeness, it also follows that people who are engaged in “venturing about” their environment might experience increased state positive affect given the trait-level relationship with positive affectivity. A synonym for venturesomeness is exploration, which implies locomotion through one’s environment and approach behavior. The neuroscience perspective presenting dopamine as a neural driver of exploratory behavior, presented next, backs this reasoning.

Dopamine and Approach Behavior. The evidence reviewed thus far suggests that positive affect is of central importance to the operation of the behavioral approach system. Individual differences in reward-sensitivity underlie the trait of extraversion (Fowles, 1987; Lucas et al, 2000). In turn, extraversion is closely associated with chronic positive affect (Watson, 2002), desire for rewards (Lucas et al., 2000), and increased dopamine activity in the nervous system (Depue & Collins, 1999). Dopamine is a neurotransmitter associated with reward-mechanisms and feelings of desire (Beaulieu & Gainetdinov, 2011; Berridge & Kringelbach, 2008). Since dopamine is associated with extraversion, extraverted people are more sensitive to reward-opportunities and thus more driven and likely to experience positive emotions, consistent with the hypothesized function of the Behavioral Approach System. Dopamine is involved in a variety of motivational processes represented by a diverse pattern of neurological activity throughout the brain. These diverse motivation processes are theorized to share in common one higher-order function, *exploration* (DeYoung, 2013). The activation of any part of the dopaminergic system is likely to cause the urge to explore one's environment, most often requiring movement.

Approach Motivation and Movement. Critically, evidence indicates that operation of the approach system is closely linked to movement. First, extraverted individuals are faster to initiate movement and exhibit higher rate of movement in response to rewards, as noted (Costa & McCrae, 1995; Doucet & Stelmack, 1997). Second, dopaminergic systems play a central role in regulation of motor behavior (Beaulieu & Gainetdinov, 2011) and promote physical exploration of one's environment (DeYoung, 2013). For example, the Ventral-Tegmental area of the brain, a primary producer of dopamine, is found to be more active in animals who are more motivated, as measured by their level of movement, to obtain a reward (Puryear et al., 2010). Third, evidence

increasingly suggests a close link between movement and experiences of positive affect. People undergoing treatment for depressed mood are found to have decreased gait during movement, including reduced walking speed and slower body-part movement in general (Michalak et al., 2009). In addition, recent experience- and behavioral-sampling evidence suggests that positive affect is followed by more bodily movement (Schwerdtfeger et al., 2010), while movement is followed by increased positive affect (Wichers et al., 2012). Taken together, these findings suggest a key physical connection between one's level of positive affect and the tendency to move about. Moving ones' arms and legs in a coordinated, locomotive manner is, again, not enjoyable in- and of-itself. Rather, movement typically results in the acquisition of a reward – something that can be enjoyed (liked). Thus, locomotion should embody positive affect, as suggested by neurobiological evidence involving dopaminergic neural pathways and dopamine's relationship with movement.

4. “Wanting” and Anticipatory Affect

Anticipatory affect is a conceptualization of affect that derives from the distinction between “wanting” and “liking” (Berridge, 1996). Wanting, or being engaged in a pleasant state of anticipation over some future event or acquisition, is often pleasant and appears to have a strong relationship with dopamine activity in the brain. Liking, on the other hand, is actual enjoyment derived from the consumption of a reward and is related to increased opioid activity in the brain. Dopamine production increases when one is anticipating enjoyment of something in the future and is involved in the reinforcement of the desired activity. The cortical systems involved in “wanting” and “liking” overlap somewhat, but are distinct in their pattern of activation (Berridge & Kringelbach, 2008; Berridge & Kringelbach, 2013).

As wanting and liking can be distinguished in their pattern of activation, wanting can conceivably occur without liking, though the two often co-occur (Berridge, 2009). Wanting often motivates behavior that results in subsequent liking. There is a time-gap in between desire/wanting and eventual liking, with positive affect partially existing as a motivational impetus to achieve a state where liking/enjoyment can occur (Knutson & Greer, 2008). Note that when entering an approach motivated state time seems to pass more quickly, further backing the approach-oriented function of wanting (Gable & Poole, 2012).

Given the relationship of movement and dopamine it is likely that locomotion causes increased positive affect primarily through “wanting”, or anticipatory mechanisms, as there is nothing specific to the act of locomotion that is explicitly enjoyable (barring a person being extremely stiff due to prior lack of movement). Contrast walking, for example, with genuinely rewarding activities such as eating desserts or using heroin. Put differently, spontaneous movement may be linked to positive affect through an increase in dopamine activity, but the positive affect derived from movement -- while certainly “positive” as understood and represented in measurement -- is anticipatory in nature.

I now review the notion of embodied cognition which is crucial to the hypothesis that locomotion impacts positive affect via approach motivation.

5. Embodiment

Building on the personality, behavioral, and neurobiological evidence presented above, I propose that incidental, on-going movement is likely to increase approach motivation, and in turn, positive affect, even if the movement does not involve obvious rewards, is not the focus of awareness, or occurs under somewhat unpleasant conditions. This proposal relies in part on the principle of *embodiment*. The notion of embodiment assumes that psychological experiences

involve parallel activations (“simulations”) in modality-specific bodily systems (Niedenthal et al., 2002). Put differently, psychological experiences are not amodal cognitive abstractions, but events grounded in actual bodily states and sensory-motor modalities (Wilson, 2002). There is substantial evidence that perception, cognition, emotion, and social judgment all involve corresponding activation of bodily states and modality-specific neural architecture, be it during actual encounters with stimuli (Wallbott, 1991) or during “off-line” processing (see Niedenthal et al., 2002, for review).

For example, adopting an erect, confident posture speeds up retrieval of pleasant autobiographical memories and facilitates positive responses to emotionally-relevant events (Stepper & Strack, 1993; Riskind, 1984). Similarly, simulation of approach (e.g., pulling) versus avoidance (e.g., pushing) behavior facilitates development of positive versus negative reactions toward social objects, respectively (Cacioppo et al., 1993). In short, simulating behaviors that embody more abstract psychological processes can result in consequences associated with such processes. In regards to the present research, locomotion -- even without a clear reward-object as a goal -- simulates the process of exploring one's environment with the anticipated result of requiring a reward. Locomotion likely embodies positive affect through intermediary neurobiological processes, specifically dopaminergic activity, which drive motivational intensity and in turn anticipation-based positive affect.

Locomotion as Embodied Positive Affect and Approach

I thus propose that approach motivation underlies the embodiment of global positive affect during locomotion. As noted by Darwin, almost all searches for *pleasure* are associated with active *movements*, and the literature confirms that bio-behavioral processes involved in movement are also critical to the experience of approach motivation, and in turn, positive affect.

Barring a clear threat or extreme circumstances, most organisms' movements are marshaled toward acquiring rewards and seeking resources, being only periodically interrupted by the necessity to avoid predators or other environmental dangers (Darwin, 1872). For example, animals foraging for food (an essential reward) frequently rely on extensive and random movement patterns which tend to maximize resource acquisition and occupy most of their active time (Bell, 1991). As noted earlier, the vast majority of our own day is spent walking with the aim of acquiring resources (e.g., to earn a paycheck, get groceries, see a movie, meet a friend) rather than escaping threats (e.g., fleeing a robber or seeking shelter from a storm). Finally, both movement and positive affect follow a circadian pattern where organisms' engagement is highest during times when acquiring resources is most likely (e.g., during daylight, Clark, Watson, & Leeka, 1989). As a result, locomotion should involve embodiment of an approach orientation and should facilitate feelings of energy, self-assurance, and joviality at the core of positive affect. The extremely close connection between motion and positive affect in daily experience supports this proposition (Schwerdtfeger et al., 2010; Wichers et al., 2012), as does my own previous research: Participants who walked on a treadmill for ten minutes during a video presentation experienced increased positive affect, whereas those who either stood on the treadmill or sat near it did not (Miller & Krizan, 2014, Experiment 3).

Research Hypotheses

I have proposed that approach motivation mediates the relationship between locomotion and positive affect. To examine this possibility I proposed two studies that were similar in critical respects. First, both were double-blind, two-condition experimental designs where controlled manipulation of the independent variable, locomotion, was executed. Second, I engaged participants in locomotion both through a natural environment where a net translation through space was gained (Study 1) as well as using a treadmill where locomotion was simulated

(Study 2). Both methods have been used in previous and pilot studies and were incorporated into the present work. In previous research (e.g., Miller & Krizan, 2014) brief bouts of locomotion caused substantial increases in positive affect in comparison to non-locomotive conditions (.57 > $d > 1.19$). Third, care was taken to keep participants blind to any link between movement and improved feelings by employing rich cover stories steeped in complimentary levels of both mundane and experimental realism. Finally, both studies followed the same pre-post manipulation method of measuring positive affect with a measurement of approach motivation taken last. In addition to these design considerations, I note that a pilot study revealed small to moderate effects of locomotion on self-reported approach motivation when participants were asked to focus their attention on their current feeling states while responding to the Behavioral Approach Scales (Cohen d 's of .46 for BAS drive, .27 for BAS fun seeking, and .39 for BAS reward responsiveness, see Miller & Krizan, 2014, Study 3). Therefore it was expected that the locomotive manipulations used in the present research would increase *self-reported* approach motivation as well.

The studies were designed to be sufficiently different in order to increase generalization of the proposed meditational link. Specifically, Study 1 was conducted in a field setting where participants walked around an athletic track, whereas Study 2 was conducted in a tightly controlled lab setting where participants walked on a treadmill. Further, Study 1 used an incentivized card-sort task to measure approach motivation while Study 2 used self-rated *desire* for attractive stimuli. Moreover, given the pilot finding that state-feeling focused responses to the BAS scale could be impacted by locomotion, an ad-hoc 5-item self-report scale aimed at measuring *state* approach motivation based on the BAS scales was created and administered to

participants in both studies (cf. Carver & White, 1994). Finally, response times were collected for critical actions in both studies.

To summarize, approach motivation was operationalized across the two studies using a reward-dependent behavioral performance (Study 1), perceived object-desire (Study 2), and self-reported approach motivation (Study 1 and Study 2).

Overview of Studies. In Study 1 locomotion was manipulated and both approach motivation (as reward-sensitivity) and positive affect were measured. Participants in Study 1 either engaged in locomotion or remained sedentary under the guise of a cover story emphasizing the potential impact of unfamiliar and familiar indoor environments on simple task performance. Positive affect was measured both before and after the locomotion manipulation. Approach motivation was quantified using a behavioral task and by self-report. It was expected that locomotion would increase approach motivation, which would in turn mediate the relationship between locomotion and higher positive affect. Bootstrapping (Preacher & Hayes, 2004) was used to test for the existence of an indirect effect of locomotion on increase in positive affect through approach motivation.

In Study 2 locomotion was manipulated using a treadmill, and desirability of rewarding objects was measured. Participants in Study 2 either engaged in locomotion on a treadmill or remained stationary next to a treadmill under the guise of a cover story stressing the impact of visual stimuli in the proximity of workout equipment on subsequent preferences. Approach motivation was measured by self-rated preferences for objects presented visually to the participants post-manipulation while positive affect was measured both before and after the locomotion manipulation so the requisite analyses could be conducted to test for mediation. It was expected that locomotion would increase desirability for offered objects, which would in

turn mediate the relationship between locomotion and increases in positive affect. Bootstrapping (Preacher & Hayes, 2004) was again used to test for the existence of an indirect effect of locomotion on positive affect through object desirability.

Secondary Hypotheses. An additional set of measures was included in both studies. Their purpose was to supplement any findings obtained that were based on the primary dependent measures and to explore the role of individual difference.

State Behavioral Approach. The ad hoc, 5-item behavioral approach scale that participants completed in both studies was predicted to be impacted by locomotion. Specifically, as a result of walking on a track (Study 1) or on a treadmill (Study 2) participants should report more state approach motivation. The scale items are listed in Figure 5. Further, it was expected that locomotion would increase state approach motivation which in turn would mediate the relationship between movement and positive affect.

Exploratory Predictions. As discussed, positive affectivity, extraversion, and trait behavioral approach are related, consistent with theorizing about personality differences in approach motivation (Lucas et al., 2000). In this vein, participants in both studies completed the BAS/BIS scales (Carver & White, 1994) and a 60-item, 6 facet extraversion scale (Lee & Ashton, 2004). Accordingly, these dispositional BAS and extraversion scale scores should generally predict increased approach motivation (as measured behaviorally and by self-report), as well as increased positive affect levels.

CHAPTER 3. STUDY 1 METHOD, RESULTS, AND DISCUSSION

Study 1: Behavioral Approach Motivation as a Mediator of the Influence of Locomotion on Positive Affect

Method

Measures. In Study 1 locomotion was the independent variable, positive affect was the main dependent variable, and state approach motivation was measured behaviorally and by self-report as a mediator. Figure 3 provides a basic Study 1 outline including the measures collected and the timing of the manipulation.

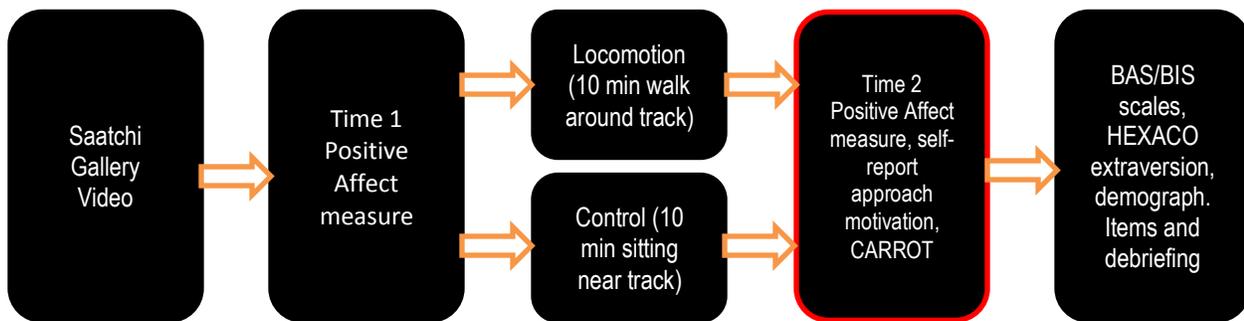


Figure 3. The basic flowchart for Study 1.

Participants and Power Analysis. Undergraduate students who were members of the Iowa State Psychology Department Research Participant pool were recruited to participate in the experiment to earn partial course credit. The effect of locomotion on positive affect in previous studies utilizing the proposed paradigm is generally moderate to large, with standardized mean differences ranging from .57 to 1.19 (Miller & Krizan, 2014). However the effect of locomotion on approach motivation was largely unknown prior to the study. In a pilot experiment, approach motivation was measured approximately 10 minutes after cessation of locomotion on a treadmill

by asking participants to respond to the revised BAS scale with the instructions stressing current feeling states (see Miller & Krizan, 2014). Although not reaching statistical significance due to relatively small sample size, the sub-scale means of all three aspects of approach motivation (drive, fun seeking, and reward-sensitivity) tended to be larger following routine locomotion, with Cohen's d effect sizes ranging from .27 to .46; small to moderate effects (Cohen, 1988). Given that the proposed experiment used a more directed method of assessing approach motivation, it was expected that the effect of locomotion on measured approach motivation would be at the upper end of this pilot-range, a moderate effect ($\sim .5$).

To estimate the necessary sample-size to detect the hypothesized indirect effect, I used calculations from Fritz and MacKinnon (2007) under the assumption of 80% power and the chosen method of using bias-corrected bootstrapping. As the locomotion manipulation is dichotomous, Cohen's d was used as an estimate of the relationship between the independent variable and the mediator (Shrout & Bolger, 2002; Preacher & Kelley, 2011). Given the estimated moderate effect of locomotion on approach motivation ($d = \sim .5$), and assuming a moderate effect ($d = \sim .5$) of approach motivation (the mediator) on positive affect (the ultimate dependent variable) in this design, an indirect effect would likely be detectable with a sample size of 54 participants. However, given the paucity of information regarding the exact size of the effects in question due to the novelty of this work, it was possible that detecting the indirect effect would require as many as 115 participants to detect (Fritz & MacKinnon, 2007) should the effect of approach motivation on positive affect be relatively small ($d = \sim .2-.3$). To this end data were collected from 80 participants (over 17 weeks) in order to attempt to ensure sufficient power should the effect of approach motivation on positive affect be small. Data from five

participants was removed due to termination of their sessions for technical problems prior to the administration of the primary dependent measure.

Equipment and Cover Story. All data were collected using programmable features of Qualtrics' online survey software on a netbook with an attached mouse. As in cover stories used in prior research, participants were told that they were participating in an study about how peoples' experiences are affected by exposure to unfamiliar as well as familiar environments (see Miller & Krizan, 2014), in this case indoor environments. Details regarding the expected outcome of the study were not provided to either participants or research assistants to guard against potential experimenter bias or experimental demand. Thus, the study was double-blind.

Procedure. Participants participated individually to guard against potentially unpredictable mere presence effects (Zajonc, 1965; Zajonc & Sales, 1966). Each participant met with a research assistant in the large, open lobby of the Lied Recreation Center on the Iowa State University campus. Lied was used for this study because (1) data collection occurred in part during the harsh Midwestern winter months when outdoor activity was often aversive, (2) Lied has a large, open-use indoor track for participants to walk on adjacent to (white) tables ideal for the study's administration, and (3) activity in Lied is often minimal during the experimental session times that were offered. After written consent was obtained, the research assistant said:

"Thanks for agreeing to participate in today's study. We are interested in how experiencing unfamiliar and familiar indoor environments affects people's experiences. You will primarily be working independently during this experiment using the netbook you see before you. I will be sitting across from you while you are working and will not disturb you.

First, you'll be immersed in an unfamiliar environment by watching a video on the netbook. Please follow all instructions given to you explicitly and thoughtfully. The data you

provide might be disqualified if you do not. When the experiment instructions direct you to do so, or if you have a technical glitch, please let me know.”

After receiving these instructions participants started the Qualtrics program. First, participants watched a video depicting a brief tour through the Saatchi Gallery in London, whose purpose was to bring participants to relatively low levels of positive affect and physiological arousal, while maintaining the cover story regarding unfamiliar and familiar environments. This video was chosen because it has been successful in this capacity in past studies (Miller & Krizan, 2014).

After viewing the calming video, the Qualtrics software instructed the participants:

“Please click ‘continue’ and complete the surveys you see so we can better understand your experiences regarding the unfamiliar environment you just viewed in the video.”

Participants then completed the partially expanded positive and negative affect scales (PANAS-X; Watson & Clark, 1994; Appendix 1). For this research the 20 positive and negative affect items of the original PANAS (Watson, Clark, & Tellegen, 1988) as well as additional items measuring attentiveness, self-assurance, and joviality facets of positive affect were included. All of the one-word affect terms of the PANAS-X are rated using a 5-point scale (“not at all” to “extremely”) which allowed for the construction of a rich profile of each participant’s affective experience prior to the manipulation.

After completing the pre-manipulation portion of the study, participants read:

“In the next part of the study you will experience a more familiar local indoor environment, the Lied Recreation Center. Please click ‘continue’ on the screen and thoughtfully follow the instructions you are given.”

On the next screen, the participants were randomized into one of two conditions by the Qualtrics survey program. Participants were assigned to a *control* or a *locomotion* condition.

Participants in the *control* condition read:

"We would like you to experience the large, indoor space in the Lied Recreation Center for a short period of time. You will do this without the research assistant and you should not inform the research assistant what you were asked to do at this point in the study. After clicking 'continue' please re-locate to the track area nearby, and take a seat in one of the red benches you see near the track..." [Figure 4]



Figure 4. The white tables (at right), red benches (at left), and indoor track at the site of Study 1.

"...We want you to be fully immersed in this large, indoor environment for a little while. Using the clock on the wall adjacent to this area, remain seated for 10 minutes so you can be fully immersed in it. Remain seated throughout your time in this area. After 10 minutes has passed, return to the table you are at now, and click 'continue'."

Participants in the *locomotion* condition read:

“We would like you to experience the large, indoor space in the Lied Recreation Center for a short period of time. You will do this on foot and alone, without the research assistant and you should not inform the research assistant what you were asked to do at this point in the study. After clicking ‘continue’, please go over to the track and walk two brisk laps in the counter-clockwise direction. This should take you approximately 10 minutes. Maintain a continuous, moderate pace and fully immerse yourself in this large, indoor environment. When you are finished, return to the table you are at now and click ‘continue’.”

Using this design, all the study participants spent roughly 10 minutes in the same physical area with the research assistant blind to their activities during the manipulation. The difference between the conditions, then, was limited to participants moving around the track area versus sitting on a bench in it. With the crucial exception of movement through the space, participants in the *control* condition should have had approximately the same auditory and visual experience as those in the *locomotion* condition. Moreover, prior research reveals that even complete control over such environmental differences does not change the impact of locomotion on boosting positive affect (Miller & Krizan, 2014, Experiment 3).

After returning from the indoor track area, participants completed the primary dependent measure – their post-activity affect ratings (PANAS-X, see Appendix A) which allowed the effect of the manipulation to be analyzed as both (1) an affect difference score and a (2) post-activity affect score.

Participants then completed a behavioral task meant to assess their current level of approach motivation. The task was the Card Arranging Reward-Responsivity Objective Test (CARROT; Al-Adawi, Powell, & Greenwood, 1998; Powell, Al-Adawi, Morgan, & Greenwood,

1996). Participants were first instructed that they would do a card-sorting task and then read the instructions for the task on the computer.

The CARROT is a simple, 3-trial card-sorting task used frequently to measure reward-sensitivity – a key feature of approach motivation. The task was slightly modified to fit the requirements of this study. In the task participants are given 60 cards with 5 single digits on each card. One of the digits on each card is 1, 2, or 3. The remaining four digits are random numbers between 4 and 9. Participants are tasked with sorting all of the cards into three piles numbered 1 through 3, based on which of those numbers they see on each card. The first trial is represented as a practice round to ensure familiarity with the procedure. For the second trial, the research assistant produces another deck of cards, identical to the first, and informs the participant that they will do the task again now that they are familiar with it, but that this time they will be timed. For the third and critical trial, the participant is told they will now have a chance to earn a monetary reward if they were to beat their previous time in the second trial. During this third round the research assistant places a monetary reward (i.e., 50 cents) in front of the participant for every 10th card sorted (ensuring up to \$3 reward).

Approach motivation (i.e., reward-sensitivity) is operationalized as the difference between the time it took participants to sort the deck with incentivization in the last trial minus the time it took participants to sort the deck in the second trial. The CARROT has been validated using normal and clinical populations (Al-Adawi et al., 1998; Dawkins, Powell, West, Powell, & Pickering, 2006; Kambouropoulos & Staiger, 2002; Powell et al., 1996). Performance on the CARROT task is also associated with dopamine activity in the nervous system (White, Morris, Lawford, & Young, 2008).

In this study the length of each trial was timed by the experimenter by discretely clicking a “start” button on the Qualtrics program when telling the participant to start sorting. Pushing the start button advanced the program to the next screen and started an internal timer within Qualtrics. On the next screen the experimenter would click a “stop” button when the participant was done sorting which would stop the timer and record the sort-time in the Qualtrics data file. In addition to not being aware of what experimental condition participants were randomized into, research assistants were also never aware of the exact time participants spent sorting the decks of cards during any of the CARROT trials as the Qualtrics timing was not displayed on-screen. To this end, after the third trial the research assistants always told the participants that they had successfully sorted the cards faster than they did during the second round given the research assistant did not actually *know* the times of the second and third round. Therefore, the participants always got \$3 regardless of the actual timing outcome of the sorting.

After completing the CARROT task, participants completed a 5-item self-report measure used to assess state approach motivation. This 5-item measure was a set of questions assessing state approach motivation, reward responsiveness, and intensity of approach motivation (see below, Figure 5) adapted from the BAS scale (Carver & White, 1994, Appendix B). Responses to these items were factor analyzed and reliability of the aggregate was acceptable ($\alpha = .79$).

How motivated do you feel to go get things you want today?
How motivated do you feel to do something fun (barring any responsibilities) right now?
How motivated are you to do something you would not normally do for \$10?
Do you feel “ready to go”?
If you saw some coins on the ground right now, how motivated would you be to pick them up?

Figure 5. The approach motivation questions asked of all participants in Studies 1 and 2, derived from the Behavioral Approach Scale items used in pilot testing (Carver & White, 1994).

After completing the self-report measure of approach motivation, participants completed the dispositional BAS/BIS scales (Appendix B), a 60-item measure of extraversion (HEXACO, Lee & Ashton, 2004, Appendix C), and demographic items. After an oral debriefing, participants were dismissed. The sessions lasted approximately 45 minutes.

Results

Compared to participants in the sedentary, *control* condition, participants in the *locomotion* condition were expected to (1) receive a greater boost to their experience of positive affect (i.e., have a larger positive affect difference score) and have higher positive affect post-manipulation, and (2) be more likely to endorse approach and reward-seeking motives. Critically, participants in the *locomotion* condition were also expected to be more sensitive to the card-sorting incentives provided during the CARROT task, with greater differences between the incentivized and non-incentivized card-sorting performance in regards to the time required to sort the cards. In other words, individuals who moved were expected to invest more effort to obtain an equivalent reward. Specifically, participants in the *locomotion* condition were expected to have a larger time difference between the incentivized and non-incentivized trials, with this difference mediating the relationship between locomotion and positive affect change. It was expected that all critical measures would *increase* as a result of engaging in locomotion. Therefore I used one-tailed significance tests in all analyses, and only two-tailed tests are noted. Positive affect scores were computed by summing the scores for the ten positive affect scale items in the PANAS-X. Internal consistency reliability is reported for all scales and indices in Table 1 in this section. All analyses were performed using SPSS statistical software Version 22.0 (IBM Corp., 2013).

Participants. Undergraduate psychology research pool participants ($n = 80$) were recruited over 17 weeks during the Spring 2014 semester on the Iowa State University campus. Participants were 57.5% female. Self-reported ethnicity was 72.3% white/Caucasian, 10.8% Asian, 6.0% black or African-American, 2.4% Hispanic or latino, and 4.8% either did not report or reported some other ethnicity not listed as a choice. 81.9% of participants identified English as their first language, 3.6% identified Mandarin Chinese, and 10.8% either did not report or reported some other first language, predominantly Spanish and additional East Asian languages or dialects. Demographic differences among participants did not correlate with the dependent measures in either study condition.

Scale and Index Reliabilities.

Measure	Number of Items	α
State Approach Motivation	5	.79
PA-PANAS (pre-manipulation)	10	.91
PA-PANAS (post-manipulation)	10	.95
BAS Drive	4	.76
BAS Fun Seeking	4	.66
BAS Reward Responsiveness	5	.70
Extraversion-Friendliness	10	.87
Extraversion-Gregariousness	10	.89
Extraversion-Assertiveness	10	.86
Extraversion-Activity Preference	10	.81
Extraversion-Excitement Seeking	10	.77
Extraversion-Cheerfulness	10	.85

Table 1. Study 1 scale and index reliabilities.

Positive Affect. The calming art-museum (Saatchi Gallery) video that was shown to all participants at the beginning of the study was meant to set a low-level of positive affect in both study conditions as measured pre-manipulation. To this end, there was no significant difference between the *control* ($M = 1.87, SD = .79$) and *locomotion* ($M = 2.07, SD = .66$) conditions in pre-manipulation positive affect using a two-tailed test, $t(78) = 1.27, p = .21, d = -.27$.

As expected, the locomotion manipulation resulted in a significant difference in post-manipulation positive affect. Participants in the *locomotion* condition ($M = 2.79, SD = .77$) had significantly larger positive affect scores post-manipulation than participants in the *control* condition ($M = 2.39, SD = 1.02$), $t(78) = 1.96, p = .027; d = .44$.

Note that positive affect increased significantly in both the *control* condition ($M = +.51, SD = .92, t(39) = 3.48, p < .001; d = .55$, and the *locomotion* condition ($M = +.73, SD = .77, t(39) = 6.00, p < .001; d = .95$). The effect of condition on positive affect difference scores did not quite reach significance, $t(78) = 1.19, p = .12; d = .27$, but the effect was consistent in direction with a pattern found in past research in regards to a higher positive affect boost after locomotion than when sedentary. Moreover, locomotion participants unexpectedly began the study with a slightly *higher* level of positive affect, which may have restricted any increases. In the subsequent mediational analyses I use affect difference scores as the primary dependent measure given the hypotheses focused on *increases* in approach motivation accounting for *increases* in positive affect. The level of positive affect across conditions is presented in Figure 6.

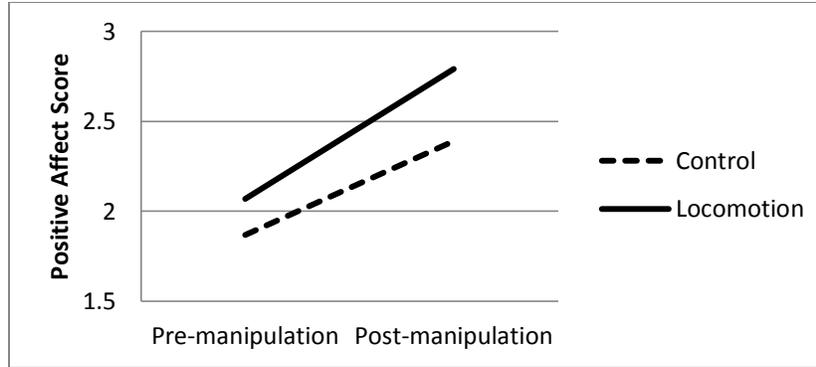


Figure 6. Study 1 positive affect change before and after manipulation by condition.

State Approach Motivation Scale. It was expected that locomotion would cause participants to self-report increased approach motivation using the 5-item index created for the study. However, participants in the *control* condition ($M = 35.23$, $SD = 10.62$) did not report a significantly different level of state approach motivation than participants in the *locomotion* condition ($M = 32.90$, $SD = 8.53$), $t(78) = -1.08$, $p = .28$ in a two-tailed test, $d = -.24$. In retrospect, this is likely due to the fact that this measure was taken immediately following the transfer of \$3 to all participants, which may have muted desire and approach motivation.

CARROT. Recall that participants were timed in all three rounds during the CARROT task. In the first round participants were told they would be practicing the task and were not informed of the timing. In the subsequent rounds, from where the primary CARROT measures were obtained, participants were informed that they were being timed. There were no significant differences in any of the rounds by condition. Table 2 (next page) summarizes the results of these round timings.

Round	Condition		<i>t</i>	<i>p</i>	<i>d</i>
	Locomotion	Control			
Round 1 (“practice round”)	83.44s (31.03)	88.29s (36.52)	.64	.52	.14
Round 2 (“timed”)	77.62s (23.73)	74.82s (33.11)	-.44	.66	-.10
Round 3 (“timed, incentivized”)	62.06s (17.68)	66.19s (25.59)	.85	.40	.19

Table 2. Study 1 CARROT task round timing means by condition (with standard deviation in parentheses) in seconds.

Round timings correlated with one another, as expected. However, there was a noticeably different pattern of correlations by condition. In particular, the round timings in rounds for which participants were informed they were being timed did not correlate as strongly with the first round in the *locomotion* condition as they did in the *control* condition. These correlations are presented in Table 3 (additional correlations of individual round-times with other Study 1 variables are presented at the end of this results section) which begins on the next page.

	Round 1	Round 2	Round 3
Round 1 Control condition	--		
Round 1 Locomotion condition	--		
Round 1 All participants	--		
Round 2 Control condition	.87**	--	
Round 2 Locomotion condition	.53**	--	
Round 2 All participants	.73**	--	
Round 3 Control condition	.79**	.82**	--
Round 3 Locomotion condition	.37*	.76**	--
Round 3 All participants	.64**	.79**	--

Table 3. Correlations between time of sort completion during the CARROT task per round listed by condition and with all participants combined. $N = 40$ for the by-condition correlations. $N = 80$ for correlations for all conditions. ** indicates a correlation is significant at the .01 level (two-tailed), and * indicates a correlation is significant at the .05 level (two-tailed test).

Critically, locomotion caused a difference in the mean CARROT scores (measured in seconds) between conditions in the hypothesized direction. Recall, the CARROT score is the difference between the timed second and third rounds. Specifically, participants' CARROT scores were obtained by subtracting their Round 3, incentivized sort-times from their Round 2 sort-times. Accordingly, a larger CARROT score indicated participants sorted the cards faster during the Round 3 than they did during Round 2 implying increased sensitivity to the reward placed before them, and thus more state approach motivation demonstrated behaviorally.

As the CARROT is a difference score, one-sample t-tests revealed that in both conditions the incentivization caused participants to sort the cards significantly faster when moving from the second to the third round. Specifically, participants in the *locomotion* condition ($M = 16.47$, $SD = 15.43$), $t(39) = 6.75$, $p < .001$; $d = 1.07$ increased their sorting speed more when offered an

incentive than participants in the *control* condition ($M = 8.64$, $SD = 19.06$), $t(78) = 2.90$, $p = .006$; $d = .45$, according to a mean comparison of difference scores: $t(78) = 2.03$, $p = .023$; $d = .45$.

To summarize, participants in both conditions increased their sort-speed when offered incentives. However, participants in the *locomotion* condition increased their speed by 6.79 seconds more, on average, than participants in the *control* condition.

Mediation Analyses. Bootstrapping is the most appropriate method of performing mediational analyses for these data given the relatively small sample-size and target n determined from the study's power analysis (Preacher & Kelley, 2011; Fritz & MacKinnon, 2007). Due to the reported lack of a statistically significant difference by condition, the 5-item approach motivation index was not analyzed as a potential mediator in Study 1 leaving participants' mean CARROT score by condition as the only mediator of interest. Accordingly, the relationship between locomotion and positive affect difference score across the manipulation was tested for mediation by approach motivation as represented by participants' CARROT scores. As Figure 7 illustrates, the unstandardized regression coefficient between locomotion approach motivation (CARROT) was statistically significant, as was the unstandardized regression coefficient between approach motivation and positive affect change. The unstandardized indirect effect was $-.046$. The significance of this indirect effect was tested by computing unstandardized indirect effects for each of 10,000 bootstrapped samples. The 95% confidence interval was computed by determining the indirect effects at the 2.5th percentile and the 97.5th percentile. The bootstrapped unstandardized effect was $-.049$, and the 95% confidence interval ranged from $-.14$ to $-.001$. Thus, the indirect effect was statistically significant.

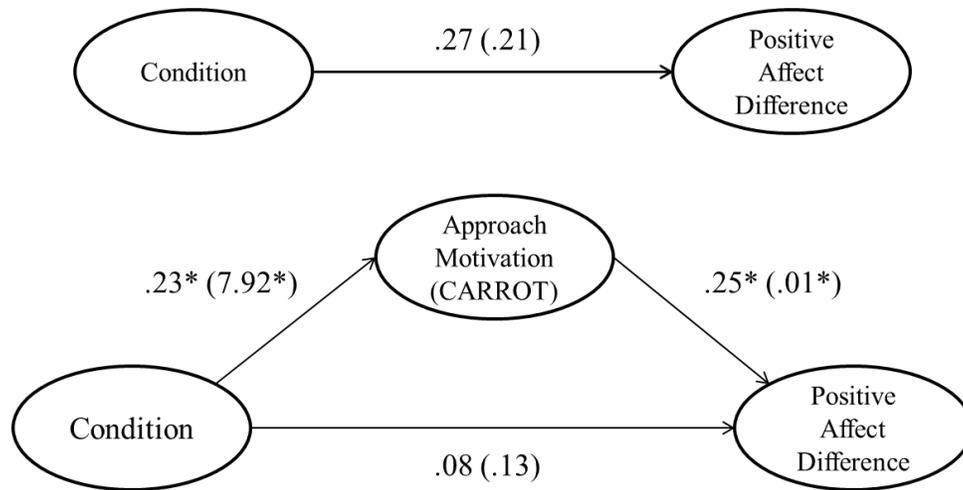


Figure 7. Study 1 results: Approach motivation (CARROT) has a significant impact on the (ns) relationship between locomotion and positive affect change. The impact of the mediator was significant, resulting in partial mediation of the direct effect. (Note: The *control* condition was coded as "0", and the *locomotion* condition was coded as "1"; unstandardized effects are in parentheses.) * $p < .05$.

BAS and Extraversion. The exploratory hypotheses regarding the influence of personality traits on approach motivation were also examined. These correlations are presented in Table 4 following this section. As expected based on random assignment, the condition did not predict any of the dispositional measures. Moreover, BAS and extraversion personality traits did not predict CARROT scores. However, BAS and extraversion scores did predict responses on the 5-item Approach Motivation Scale supporting the unsurprising conclusions that people who are dispositionally more approach-oriented and extraverted report more approach motivational tendencies in the moment.

Although the BAS scales did not correlate with the time spent sorting cards in any round, extraversion and facets including friendliness, gregariousness, assertiveness, and cheerfulness predicted *faster* sorting times overall. Also, extraversion and BAS-drive predicted the size of the PA boost participants had across both conditions, in line with the theorized engagement-oriented nature of extraversion and approach motivation.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Condition (0 = control, 1 = locomotion)	1																
2. CARROT	.22*	1															
3. First Round Sort-time	-.07	.41**	1														
4. Second Round Sort-time	.05	.65**	.73**	1													
5. Third Round Sort-time (\$\$)	-.10	.049	.64**	.79**	1												
6. Five-item Approach Index	-.12	.089	-.18	-.24*	-.24*	1											
7. PA difference score	-.13	.27*	-.12	.12	-.046	.092	1										
8. BAS drive	.11	.054	-.19	-.035	-.093	.31**	.37**	1									
9. BAS fun seeking	-.02	-.16	-.016	-.21	-.14	.46**	.031	.42**	1								
10. BAS reward responsiveness	-.02	-.05	-.097	-.19	-.21	.57**	.085	.56**	.51**	1							
11. Extraversion (full scale)	-.03	.052	-.27*	-.27*	-.30**	.44**	.21	.50**	.60**	.38**	1						
12. Extraversion friendliness	-.04	.061	-.19*	-.24*	-.25*	.42**	.13	.33**	.51**	.31**	.89**	1					
13. Extraversion gregariousness	-.05	.098	-.29*	-.27*	-.26*	.37**	.19	.37**	.51**	.29*	.91**	.85**	1				
14. Extraversion assertiveness	-.17	.035	-.30**	-.27*	-.30**	.31**	.23*	.45**	.37**	.26*	.84**	.72**	.65**	1			
15. Extraversion activity preference	-.09	.15	-.064	-.034	-.15	.28**	.11	.36**	.33**	.17	.74**	.58**	.59**	.67**	1		
16. Extraversion excitement seeking	-.01	.035	-.13	-.099	-.15	.35**	.25*	.53**	.66**	.39**	.77**	.56**	.68**	.57**	.51**	1	
17. Extraversion cheerfulness	-.11	-.22	-.35**	-.39*	-.34**	.43**	.11	.48**	.60**	.48**	.75**	.64**	.68**	.53**	.29**	.52**	1

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

Table 4. Study 1 correlations among dependent measures, BAS subscales, and Extraversion scales.

Discussion

The results of this study provide tentative evidence that approach motivation, as manifested in reward sensitivity using the CARROT, partially accounts for the relationship between locomotion and improvement in positive affect. The results are only tentative because the direct effect of condition on positive affect difference scores was not significant as in prior studies. However, the indirect effect of approach motivation was significant. Given the effect of condition on positive affect change was only marginally significant, a larger sample size for this study might have been necessary to decrease statistical noise (resulting in a significant difference in positive affect change by condition) inherent in using such a field setting.

Given the statistical significance of the indirect effect of approach motivation, however, this study provides evidence that the *relative* boost in positive affect one receives from engaging in locomotion is in part impacted by the effect of locomotion on a person's state approach motivation. These results suggest that (1) there is a relationship between state approach motivation (when conceptualized as reward sensitivity) and positive affect, and (2) locomotion can cause people to become more momentarily sensitive to rewards.

This study had potential limits that suggest caution when attempting to draw firm conclusions. Even though participants and research assistants were both kept blind to the purpose of the study, there was a pointed lack of control over the experimental setting which, given the small sample size, might have impacted the results despite using random assignment. Additionally, the 5-item approach motivation index was completed by all participants immediately following receipt of \$3, which could have decreased any approach motivation, or nullified the differential impact of the locomotion manipulation on participants across conditions.

Study 2 was an attempt to bolster the mediational claim made in Study 1. Note that Study 2 was conducted simultaneously with Study 1. In Study 2, however, more control over the experimental setting was exerted, and a different conceptualization of approach motivation was used. Specifically, I used self-rated desire of objects varying in suspected desirability that were hypothetically offered to participants (e.g., a new car, fudge, cookies, rocks, furniture), in addition to the self-report of state approach motivation used in Study 1 (but without receipt of any monetary reward, a potential problem for this measure in that study). Additionally, a tightly controlled lab setting and a treadmill were used in Study 2.

Self-rated desire of objects conceptualizes approach motivation as “wanting” for rewarding experiences. This conceptualization was derived from Higgins’ (1997) promotion-focused self-regulatory motivation, namely sensitivity to the presence of reward outcomes. Key to self-regulation theory are the concepts of engagement and goal importance. As noted in the literature review section on affect, I ascribe to the conceptualization of positive affect as self-rated positive engagement with the environment. Locomotion is a robust facilitator of positive affect. Therefore, following this conceptualization I expected that after walking on a treadmill participants would feel more engaged with their environment and therefore indicate more desire for variably enticing objects – a presumed proxy for approach motivation. Presumably locomotion would cause participants to be more sensitive to more enticing stimuli as indicated by higher desirability ratings of more enticing objects, at least in comparison to objects that were less desirable.

CHAPTER 4. STUDY 2 METHOD, RESULTS, AND DISCUSSION

Study 2: Object desirability as a Mediator of the Influence of Locomotion on Positive Affect

Method

Measures. In Study 2 locomotion was the independent variable, positive affect was the dependent variable, and state approach motivation was the mediator measured by collecting (1) participant ratings of their desire for hypothetically offered objects as well as (2) participant responses to the 5-item state approach motivation scale used in Study 1. Figure 8 presents the basic Study 2 outline including the measures collected and the timing of the manipulation.

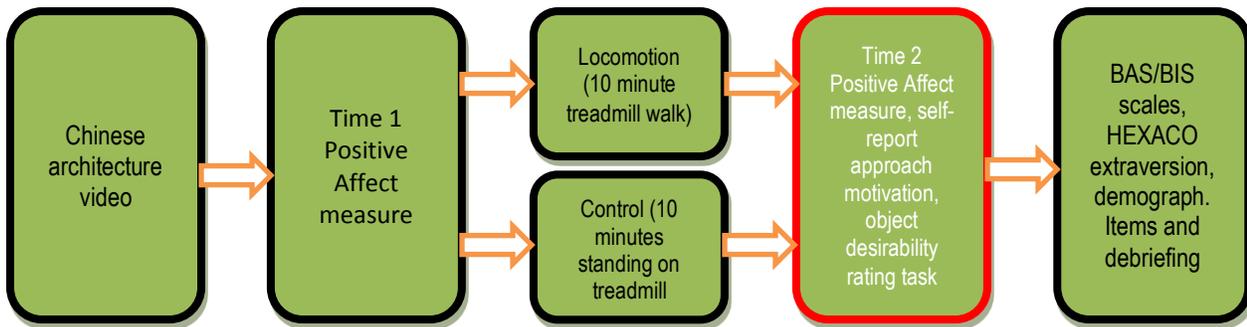


Figure 8. The basic flowchart for Study 2.

Participants and Power Analysis. As in Study 1, undergraduate students who were members of the Iowa State Psychology Department Research Participant Pool were recruited to participate in the experiment to earn partial course credit. Also as in Study 1, the effect of locomotion on PA in previous studies utilizing the proposed paradigm was known to be generally moderate to large, with standardized mean differences ranging from .57 to 1.19 (Miller & Krizan, 2014). However the effect of locomotion on approach motivation was still largely

unknown prior to the study as Study 2 was run concurrently with Study 1. Because of this I made the same estimates of the effect sizes of the critical meditational components as for Study 1.

Given the estimated moderate effect of locomotion on approach motivation, and assuming a small-to-moderate relationship between approach motivation (the mediator) and positive affect (the ultimate dependent variable) in this design, 54 participants were recommended for the best-case scenario (i.e., largest estimate of critical effects), $d = \sim.5$, while 115 participants were recommended for the scenario involving the smallest expected effects, $d = \sim.2$ -.3 (Fritz & MacKinnon, 2007). To this end, data were collected from 110 participants over 6 weeks to attempt to ensure sufficient power to detect the indirect effect.

Equipment and Cover Story. All data were again collected using Qualtrics on a netbook with an attached mouse. Drawing from a cover story used in prior research, participants were told they were participating in a study about how observing various kinds of environments presented visually interacted with proximity to exercise equipment to affect subsequent experiences and decision making (see Miller & Krizan, 2014, Study 3). Put another way, participants thought the researchers were interested in how watching certain kinds of television programming while being in an exercise facility affected them. Details regarding the expected outcome of the study were not provided to either participants or research assistants to guard against potential experimenter bias and experimental demand. Thus, the study was double-blind.

Procedure. Participants participated individually to guard against potentially unpredictable mere presence effects (Zajonc, 1965; Zajonc & Sales, 1966). Each participant met with a research assistant in a research lab on campus. After written consent was obtained, the research assistant said:

“Thanks for agreeing to participate in today’s study. We are interested in how experiencing various environments presented visually affects people’s experiences. You will primarily be working independently during this experiment using the netbook you see before you. I will be in the next room [behind a one-way mirror] while you are working and will not disturb you. I will occasionally look in to make sure you’re okay. Please let me know if you have any technical problems or difficulty understanding the instructions given to you on the computer.

First, you’ll be immersed in an unfamiliar environment by watching a video on the netbook. Please follow all instructions given to you explicitly and thoughtfully. The data you provide might be disqualified if you do not. When I have left the room you may begin.”

After receiving these instructions and when the research assistant left the room to take their position in a control room behind the one-way mirror, participants started the Qualtrics program. First, participants watched an informational video about ancient Chinese Architecture. The video was slow-moving, and the narrator spoke in a calm, even tone without much enthusiasm. The purpose of this video was to bring participants to relatively low levels of positive affect and physiological arousal, while maintaining the cover story regarding how particular types of visual stimuli affected experiences and decision making. This video was successful in this capacity in past studies (Miller & Krizan, 2014).

After viewing the calming video, the Qualtrics software instructed the participants:

“Please click ‘continue’ and complete the surveys you see so we can better understand your experiences after watching the video you just saw.”

First, participants completed filler items about their experience using exercise equipment that were meant to maintain the cover story. Participants then rated their positive affect using the PANAS-X (Appendix A) just as in Study 1.

After completing the pre-manipulation portion of the study, participants read:

“In next part of the study you will watch another video depicting another environment you are likely unfamiliar with, an art museum in London. Please click ‘continue’ on the screen and thoughtfully follow the instructions you are given.”

At this point the participants watched the same video participants in Study 1 watched initially, the silent Saatchi Gallery video. On the next screen, the participants were randomized into one of two conditions by the Qualtrics survey program. Participants were assigned to a *standing* (control) or a *walking* (locomotion) condition.

Participants randomized into the *standing* condition read:

“We would like you to watch the next video while mindful of the treadmill in the room. When you are ready, start the video and stand on the treadmill for the duration of the video. Don't start the treadmill. Rather, imagine you are at a gym waiting to start your workout, or in between workouts and are watching a video monitor there, as most modern workout facilities have such amenities.”

Participants randomized into the *walking* condition read:

“We would like you to watch the next video while using the treadmill in the room. When you are ready, start the video and walk on the treadmill for the duration of the video...”

[Information on how to operate the treadmill was then presented. Among other instructions participants were told to set the speed at "approximately 3.0 miles per hour – a brisk walking pace"] *“...Do not exceed a brisk walking pace. Imagine you are at a gym and are watching a video monitor there, as most modern workout facilities have such amenities.”*

Using this design, all the study participants spent roughly 10 minutes either standing on a treadmill relatively motionless or walking on a treadmill at a brisk pace (3 miles per hour) with

the research assistant in the other room unable to unintentionally impact the participant's session. The difference between the conditions, then, was limited to participants either simulating locomotion by walking on a treadmill or standing on a treadmill, with the exception that participants in the *walking* condition heard the noise of the treadmill. This design has been successful in past studies in significantly increasing positive affect in movement conditions but not in sedentary or standing conditions (e.g., standing or sitting on or near the treadmill). After completing the art gallery video and (for some) stopping the treadmill, participants completed the primary dependent measure – their post-activity affect ratings (PANAS-X, see Appendix A).

After a brief on-screen reminder that they were going to be asked to answer surveys and provide responses to inform the researchers about their experiences during the study, participants next completed an object desirability rating task. Participants were presented with pictures of twelve objects (Appendices D & E) randomly presented one at a time. Six of the twelve objects were chosen because they were likely to be desirable to the participants, and the other six were chosen because they were likely to be considered less desirable or neutral, but not repulsive. During the object rating task the participants first responded to a "yes/no/not sure" question about whether they wanted the pictured object or not. Then participants used a slider-bar to indicate their *desire* for the object (the critical dependent measure), and also two filler questions where they rated how "repulsive" and "useful" they thought the object was. For a sample of what participants were shown during each trial see Appendix E.

To confirm the suspected pattern of desirability for each object, ratings for each object were factor analyzed using principal components analysis with no rotation. It was expected that two factors would emerge, one representing desirable objects and one representing neutral, less desirable objects. The exploratory solution suggested three factors with eigenvalues greater than

1.0 that explained 57.8% of the cumulative variance. However, the third factor did not fit any sort of description upon post-hoc inspection and the two items that loaded onto the third factor also loaded onto the second extracted factor, so the decision was made to limit to number of factors to two, representing neutral and “enticing” objects (see Appendix F for the factor loadings in the two factor solution). Accordingly, and having obtained evidence that the twelve objects elicited the response each was chosen to elicit, the twelve original objects were aggregated into two 6-item indices with acceptable reliability, one representing "enticing" objects ($\alpha = .74$), and one representing "neutral" objects ($\alpha = .68$). Descriptive statistics for both indices are presented in the analyses of this section.

After the object desirability task participants completed the 5-item state approach motivation scale that was used in the first study (Figure 5). Responses to these items were factor analyzed and reliability of the aggregate was acceptable ($\alpha = .70$).

After completing the object desirability task and the state approach motivation scale, participants completed the dispositional BAS/BIS scales (Appendix B), the extraversion scale (Appendix C), and demographic items. After completing the measures, participants reported to the research assistant in the next room, received an oral debriefing, and were dismissed. The sessions lasted approximately 40 minutes.

Results

Compared to participants in the sedentary, *standing* condition, participants in the *walking* condition were expected to (1) receive a greater boost to their experience of positive affect (i.e., have a larger positive affect difference score), have higher positive affect post-manipulation, and (2) be more likely to self-report increased approach and reward-seeking. In addition, participants in the *locomotion* condition were also expected to rate the enticing objects presented to them as

more desirable overall. As in Study 1, it was expected that all critical measures would increase as a result of engaging in locomotion. Therefore, I used one-tailed significance tests in all analyses, and only two-tailed tests are specifically noted. Positive affect scores were computed by summing the scores for the ten positive affect scale items in the PANAS-X. Internal consistency reliability is reported for all scales and indices in Table 5 in this section. All analyses were performed using SPSS v22.0.

Participants. Undergraduate psychology research pool participants ($n = 110$) were recruited over 6 weeks during the Spring 2014 semester on the Iowa State University campus. Participants were 65.7% female with the remainder (34.3%) male. Self-reported ethnicity was 77.3% white/Caucasian, 12.7% Asian, 4.5% black or African-American, 2.7% Hispanic or Latino, and 2.7% either did not report or reported some other ethnicity not listed as a choice. 89.1% of participants identified English as their first language, 3.6% identified Mandarin Chinese, and 7.3% either did not report or reported some other first language, predominantly Spanish and additional East Asian languages or dialects. Demographic differences among participants did correlate with the dependent measures in either study condition.

Scale and Index Reliabilities. (continues on next page)

Measure	Number of Items	α
State Approach Motivation	5	.70
Enticing Objects Desirability	6	.68
Neutral Objects Desirability	6	.74
PA-PANAS (pre-manipulation)	10	.91
PA-PANAS (post-manipulation)	10	.90
BAS Drive	4	.74

BAS Fun Seeking	4	.61
BAS Reward Responsiveness	5	.75
Extraversion-Friendliness	10	.88
Extraversion-Gregariousness	10	.89
Extraversion-Assertiveness	10	.82
Extraversion-Activity Preference	10	.66
Extraversion-Excitement Seeking	10	.84
Extraversion-Cheerfulness	10	.82

Table 5. Study 2 scale and index reliabilities.

Positive Affect. The ancient Chinese architecture video that was shown to all participants at the beginning of the study was meant to set a low-level of positive affect in both study conditions as measured pre-manipulation. To this end, there was no significant difference between the *standing* ($M = 1.87, SD = .66$) and *walking* ($M = 1.77, SD = .76$) conditions in pre-manipulation positive affect using a two-tailed test, $t(108) = .75, p = .47, d = .14$

As expected, the locomotion manipulation resulted in a significant difference in post-manipulation positive affect. Participants in the *walking* condition ($M = 2.04, SD = .64$) had significantly larger positive affect scores post-manipulation than participants in the *standing* condition ($M = 1.49, SD = 1.02$), $t(108) = 4.82, p < .001; d = .65$.

Note that positive affect *increased* significantly in the walking condition ($M = .28, SD = .68, t(53) = 2.98, p = .004; d = .41$), and *decreased* significantly the standing condition ($M = -.38, SD = .51, t(55) = -5.46, p < .001; d = -.75$); a clear difference in positive affect difference scores

between conditions in line with previous work using this paradigm $t(108) = 5.78, p < .001; d = 1.10$. The level of positive affect across conditions is presented in Figure 9.

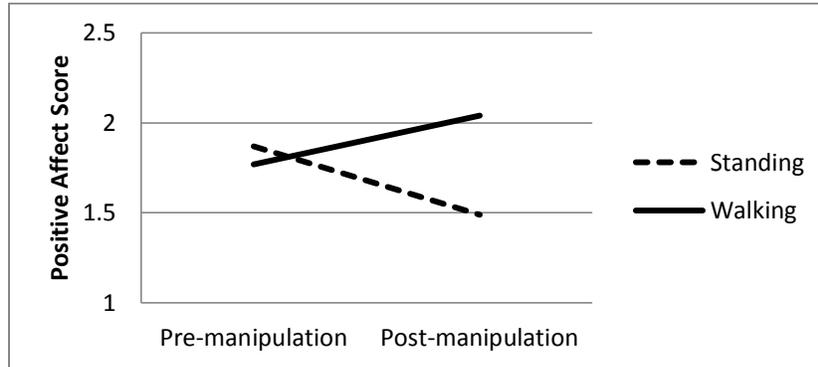


Figure 9. Study 2 positive affect change before and after manipulation by condition.

Object Desirability. Recall, the pictures of objects for which the participants rated their desire were factor analyzed and aggregated into two scales, one representing *enticing* objects, and one representing *neutral* objects. Objects in the *enticing* scale included a bar of gold, an Oreo cookie, a piece of fudge, a Ferrari automobile, a pizza, and a five dollar bill (\$5). Objects in the neutral scale included a 2-by-4 piece of lumber, a chair, a small stone, a boulder, a push-broom, and a puddle of rain-water. The slider-bar the participant used to rate the desirability of each object recorded a number from 0 to 100. The scale scores, therefore, were calculated by summing the scores for the 6 objects in each scale and dividing by 6. Across both conditions participants rated the *enticing* objects ($M = 68.89, SD = 18.50$) as much more desirable than the neutral objects ($M = 14.34, SD = 13.51$), $t(218) = 24.98, p < .001; d = 3.37$. However, there were no significant differences in desirability by condition for either *enticing* or *neutral* objects (see Table 6), nor for any individual objects. Similarly, objects of each type were not rated more *quickly* by condition regardless of their being *enticing* or *neutral*. Descriptive statistics for the

responses to the questions posed of participants by individual item and condition are shown in Appendix G.

Based on examination of these descriptive statistics it appears as though object desirability for hypothetically offered objects was *not* impacted by locomotion. Therefore, this was dropped from the subsequent analyses and was not investigated as a potential mediator of locomotion and positive affect.

Scale	Condition	Desirability	SD	$t(df), d$	Response Time	SD	$t(df), d$
Neutral Items	standing	14.35	14.23	$t(108) = .01, p = .99, d = .002$	12.05s	6.39s	$t(108) = .15, p = .88, d = .03$
	walking	14.32	12.85		11.88s	5.22s	
Enticing Items	standing	69.89	17.44	$t(108) = .58, p = .57, d = .11$	12.07s	4.51s	$t(108) = .05, p = .96, d = .01$
	walking	67.85	19.64		12.03s	4.08s	

Table 6. Study 2 Object desirability task summary for participant-rated desire and time to respond to the desirability question on each page, averaged for both scales.

State Approach Motivation Scale. As in Study 1, it was expected that locomotion would cause participants to self-report increased approach motivation using the 5-item index created for the study. Accordingly, participants in the *walking* condition ($M = 30.02, SD = 9.30$) reported a significantly higher level of state approach motivation than participants in the *standing* condition ($M = 26.25, SD = 9.11$), $t(108) = 2.15, p = .034, d = .41$. Therefore, the approach motivation scale was used to conduct mediational analyses in Study 2.

Mediation Analyses. As in Study 1, bootstrapping is the most appropriate method of performing mediational analyses for these data given the relatively small sample-size and target n determined from the study's power analysis (Preacher & Kelley, 2011; Fritz & MacKinnon, 2007). Due to the lack of a by-condition difference in the object desirability task for any item or

a sensible combination of items (see Table 6 and Appendix G), only the self-reported approach motivation was examined as the potential mediator of interest in Study 2.

Accordingly, the relationship between locomotion and positive affect difference scores across the manipulation was mediated by approach motivation, as represented by participants' self-reported approach motivation index scores. As Figure 10 illustrates, the unstandardized regression coefficient between locomotion and approach motivation was statistically significant, as was the unstandardized regression coefficient between self-reported approach motivation and positive affect change. The unstandardized indirect effect was -.031. The significance of this indirect effect was tested by computing unstandardized indirect effects for each of 10,000 bootstrapped samples. The 95% confidence interval was computed by determining the indirect effects at the 2.5th percentile and the 97.5th percentile. The bootstrapped unstandardized effect was -.031, and the 95% confidence interval ranged from -.087 to -.004. Thus, the indirect effect was statistically significant.

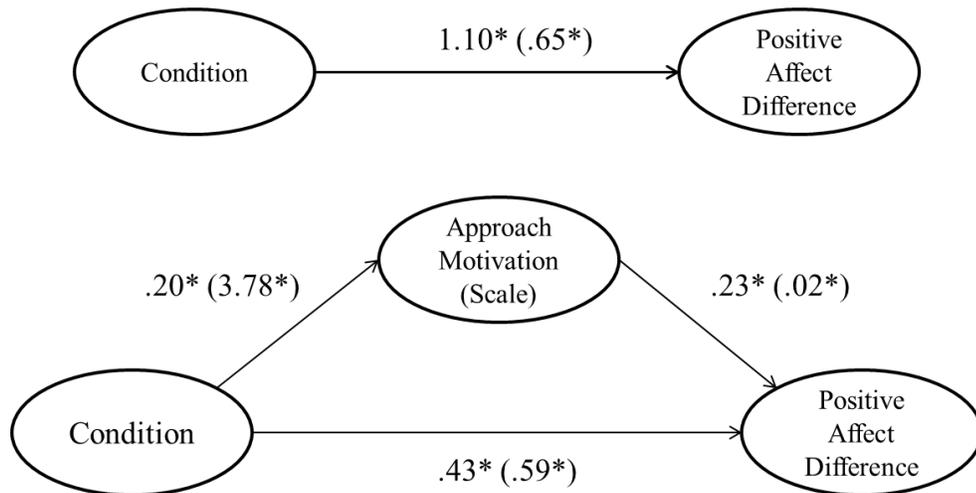


Figure 10. Study 2 results: Approach motivation (state approach motivation scale) accounts for the relationship between locomotion and positive affect change. The impact of the mediator was significant, resulting in partial mediation of the direct effect. (Note: The *standing* condition was coded as "0", and the *walking* condition was coded as "1".) * $p < .05$.

BAS and Extraversion. The exploratory hypotheses regarding the influence of personality traits on approach motivation were also examined. The correlations are presented in Table 7 following this section.

Unexpectedly, being in the *standing*, non-locomotive condition predicted higher extraversion. The BAS subscales were not predicted by condition, but the BAS subscales and extraversion were positively correlated, as expected. Critically, and in partial support of the hypothesis that dispositional reward responsiveness would predict increased desire for enticing objects based on Higgins' (1997) self-regulation theory, BAS reward-responsiveness predicted increased desirability of enticing objects, but not neutral items. Also, BAS drive and reward responsiveness predicted increased state approach motivation in both conditions, although given the content overlap in these measures this finding is not overly noteworthy.

Interestingly, post-manipulation affect levels predicted increased desirability for the neutral items, and *increased* response time when participants were presented with either neutral or enticing objects (see Table 7, column 3). The more positive affect participants felt post manipulation, the more desirable they found the objects overall and the more time they spent rating the objects regardless of their desire for the objects. This may reflect some combination of increased engagement or savoring among those high in post-manipulation positive affect.

Also, desirability for neutral objects predicted increased response time for the neutral objects. Similarly, desirability for enticing objects predicted increased response time for enticing objects. Desirability for either type of object did not predict desirability for the other type (i.e., enticing for neutral and vice versa), nor did desirability for either type of object predict response time for the other type. Taken together, these patterns suggest that the more desired an object was, the more time participants spent considering and savoring them.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Condition (0 = standing, 1 = walking)	1																
2. Five-item Approach Index	.20*	1															
3. PA difference	.48**	.32**	1														
4. Neutral items desirability	.00	.32**	-.02	1													
5. Enticing items desirability	-.06	.35**	.16	.05	1												
6. Neutral scale response time	-.02	.08	-.16	.45**	-.01	1											
7. Enticing Scale response time	.00	.01	-.10	.24*	-.08	.71**	1										
8. BAS drive	-.08	.25*	-.11	.14	.12	.06	-.12	1									
9. BAS fun seeking	-.10	.12	.04	-.06	-.01	-.19*	-.19	.38**	1								
10. BAS reward responsiveness	-.07	.21*	.03	.05	.28**	-.02	-.02	.34**	.36**	1							
11. Extraversion (full scale)	-.20*	.14	-.06	-.13	.01	-.09	-.16	.50**	.56**	.40**	1						
12. Extraversion friendliness	-.26**	.13	-.09	-.04	-.02	.05	-.04	.38**	.42**	.33**	.87**	1					
13. Extraversion gregariousness	-.19**	.08	-.07	-.19*	.05	-.14	-.20*	.45**	.45**	.29**	.89**	.76**	1				
14. Extraversion assertiveness	-.13	.05	-.10	-.10	.00	.06	-.14	.45**	.45**	.37**	.79**	.65**	.62**	1			
15. Extraversion activity preference	-.09	.03	-.10	-.06	-.07	.06	-.03	.43**	.18	.29**	.62**	.49**	.44**	.54**	1		
16. Extraversion excitement seeking	-.08	.19	.06	-.12	.03	-.18	-.28**	.39**	.68**	.24*	.75**	.51**	.70**	.45**	.22*	1	
17. Extraversion cheerfulness	-.18	.19	-.02	-.06	.03	.00	-.03	.24*	.41**	.39**	.75**	.63**	.55**	.48**	.41**	.50**	1

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

Table 7. Study 2 correlations among dependent measures, BAS subscales, and Extraversion scales.

Discussion

As in previous studies done using this double-blind, closed-session treadmill procedure, the positive affect manipulation produced results in which positive affect increased for participants who engaged in locomotion and decreased for participants who did not engage in locomotion (Figure 9). This divergent pattern in positive affect response, while ideal upon initial inspection, produced participants in one condition who became more engaged and participants in another condition who became less engaged, i.e., became more bored.

I believe this pattern of positive affect results suggests that the disengaging, sedentary *standing* condition in this work was "too disengaging". By effectively anesthetizing the participants in the *standing* condition – a condition that was meant to be a control condition where positive affect remained stable rather than decreased (i.e., didn't change across the manipulation, a classic conceptualization of a "control condition") – an additional factor, reducing engagement, was introduced to the primary factor of interest, increasing engagement through locomotion. As in Study 1, the meditational model using affect difference scores provided evidence for mediation. However, in Study 2 evidence for mediation by approach motivation was also found using post-manipulation positive affect scores, likely due to the more stark difference in this measure ($d = .66$) by condition when compared to Study 1 ($d = .44$). Recall, in Study 1 positive affect increased in *both* the locomotion and control conditions across the manipulation, though with a larger increase in the locomotion condition. In Study 2 positive affect increased in the locomotion condition and *decreased* in the control condition. In a sense, a true control condition was never tested in either of these studies, and may have substantively constrained the tests of mediation.

On the other hand, given that evidence for partial mediation was found in both studies when using affect difference scores, with such divergent patterns of affect change in the control conditions across studies the mediational hypothesis gains further strength. The relationship between locomotion examined in the study and positive affect is a causal relationship. The effect of locomotion on positive affect is likely greater than the effect of locomotion on approach motivation, suggesting (in light of the partial mediation result) that locomotion impacts positive affect through additional mechanisms as well.

Regardless of the speculation regarding the possible impact of the nature of the control condition, the results of the mediation analyses based on both positive affect difference scores as well as post-manipulation positive affect scores^{1,2} with self-report state approach motivation as a mediator are a clear signal that approach motivation at least partially mediates the relationship between locomotion and subsequent positive affect. Otherwise, it seems that approach motivation operationalized as desire is not sensitive to locomotive movement (cf. Higgins, 1997). Examining Appendix G reveals there were no systematic differences by condition in desirability, response times, or any of the filler items. As reported, the desirability items hung together appropriately in the participants' responses, but they simply were not impacted by locomotion according to these data. This might have been due to the pictures of the items not serving as strong enough cues in comparison to the actual money placed in front of participants in Study 1.

In sum, the results of this study partially support the core hypothesis, the notion of mediation by self-reported state approach motivation. However, the results do not support that self-reported desire for specific rewarding objects or experiences is augmented by locomotion.

CHAPTER 5. CONCLUSIONS

Evidence from two experimental studies largely confirmed the hypothesis that approach motivation (partially) mediates the relationship between locomotion and positive affect. Specifically, locomotion – operationalized as walking – increased behavioral approach motivation (conceptualized as reward sensitivity, Study 1) and state approach motivation (Study 2), which in turn partially accounted for increases in positive affect. In this section I discuss (1) how these studies addressed the research questions identified in the introduction, (2) potential theoretical and policy implications, (3) study limitations and recommendations for improvement of future study procedures, and (4) future research directions.

Does Approach Motivation Account for the Impact of Locomotion on Positive Affect?

People spend a considerable amount of time engaged in locomotion, but are generally not aware of the impact such activity has on their subsequent behavior. Positive affect, thought to reflect positive engagement with the environment (Watson, 2002), is clearly impacted by even brief bouts of brisk locomotion even when people are not aware of this effect, are faced with negative consequences, or are engaged in a boring task (Miller & Krizan, 2014). Why does locomotion impact positive affect so reliably? In this work I proposed one possible solution, that locomotion embodies both positive affect and approach motivation, and I tested this idea across two studies.

Two critical questions were addressed in this research. First, does locomotion in the form of a brisk walk, a common form of locomotion that almost all people engage in regularly, increase approach motivation? In Study 1 participants were more sensitive to an offered reward as a result of locomotion. In Study 2 participants reported more motivation to make an effort to acquire rewards or engage in activity that was beneficial to them as a result of locomotion. Given that participants were blind to the purpose of the studies, it seems clear that unencumbered,

routine locomotion does increase approach motivation when approach motivation is operationalized as reward sensitivity and reward responsiveness.

The second research question involved the mediation of the already-known reliable impact of locomotion on positive affect. Do people feel more positive (i.e., engaging) feelings as a result of locomotion *because* locomotion causes them to be more reward sensitive and responsive (i.e., approach motivated)? This question was answered by performing mediational analyses over two conceptually similar studies. The results of these analyses reveal that divergent conceptualizations of approach motivation do partially mediate the impact of locomotion on positive affect and imply that the experience of approach motivation is partly responsible for the impact of locomotion on positive affect; pleasant feelings of engagement with one's environment. I next discuss implications of this research.

Implications

Theoretical Importance. This work carries important implications for understanding of motivation. Pause to consider the simple question: Why do we “feel” (anything at all)? Our emotions do not exist in the vacuum of space. Rather than treating emotion merely as a psychological state to which we have a response, the present research suggest that we should treat emotion, positive emotion in this case, as part of a dynamic process with real, intervening behavioral mechanisms. Moving around, generally considered to be utilitarian in nature, itself changes our behavior, and that behavioral response is crucial to our feelings.

Earlier I reviewed the relationship among dispositional positive emotionality, extraversion, and behavioral approach. In the current work, participants who were more dispositionally approach motivated reported more desire for hypothetically offered objects (Study 2), and more state approach motivation (Studies 1 and 2). Extraversion's excitement

seeking facet and the BAS scale's drive facet predicted a bigger positive affect boost among all participants in Study 1. Taken with the rest of the results, confirming the relationship among positive emotionality, extraversion, and behavioral approach is important for the motivation literature as a whole.

More importantly, it seems that momentary positive affect and approach motivation co-occur, just as their dispositional variants do. Whereas they are likely somewhat distinct concepts, their apparent ties through the dopaminergic systems cannot be ignored. As suggested by DeYoung (2013), dopamine drives exploration. Exploration is one of the fundamental facets of many conceptualizations of extraversion (McCrae & Costa, 1991). Exploration for most of human history has been done on foot; and while engaged in this form of transit we are most likely motivated to keep moving towards our goal by internal positive feedback in the form of positive emotions.

Real-World Implications. If one is about to engage in an activity where it might be useful to be very motivated, a brisk walk or something akin to a mild physical “warm-up” common in athletic competition might be beneficial. Similarly, in a world where medications with often unwanted side-effects are often the preferred method of combating clinical depression due to their relatively consistent effectiveness and ease of use, it seems that regularly scheduled walks might be just as effective. Patients with milder forms of diagnosable depression or disengagement might avoid subsequent dependence issues if locomotion was prescribed at the onset of treatment (see also Krogh, Nordentoft, Sterne, & Lawlor, 2011).

The findings also suggest that placing more physically active, more extraverted, and more approach motivated employees in positions where tenacity and effort are required for the greatest success may be a wise managerial strategy. One could also recommend, in line with the notion of

“warm-ups” that managers of employees encourage scheduled bouts of locomotion in accordance with company and personal goal-salience activities to promote increased job productivity. Not only would their employees receive health benefits, they may also invest more effort in achieving their most desired goals.

Limitations

There were two important limitations across the studies. One was the lack of control over the experimental setting in Study 1, as previously discussed. This lack of control might have resulted in the collection of more “noisy” data in the study, ultimately resulting in a muted difference in positive affect change by condition (in comparison to previous work in this realm) where participants in both conditions experienced a significant increase in their positive affect levels after the manipulation phase. The detected significance of the indirect effect in Study 1, while meaningful empirically, might have more clearly supported the hypotheses of mediation by approach motivation with a difference in positive affect by condition more similar to Study 2. In future studies using the open-field design employed in Study 1, a dramatic increase in sample-size would be warranted, and data collection in Study 1 should have continued until the upper-end of the range suggested in the study-specific power analysis was achieved. The other important limitation in this work as was the lack of an impact of locomotion on object desirability in Study 2.

An additional limitation I previously mentioned was the lack of a “true” control condition in either study. This limitation is speculative given the results of each study generally bore-out the hypotheses. However, given that difference scores were the primary dependent measure used in the analyses, it bears discussion. The general paradigm used in this research usually involves participants being purposely bored by some initial activity, usually a dull video, and then

“activated” by a brisk walk either around the local area or on a treadmill. Participants likely experience a dynamic state of excitation in the experimental conditions, but the control participants generally remain in an unaroused state, or are put through an opposite dynamic state, one of increasing boredom. This does not seem to be problematic in the line of research, but future research should attempt to calibrate the procedure to have a true control condition, one where the lack of treatment does not have a measurable impact on the dependent measure.

Another limitation, possible self-selection of participants into Study 1, may have been present. Study 1 occurred outside of the research lab, at a workout facility on campus with a large indoor track. It took much longer to achieve the required number of participants for Study 1 than for Study 2. While no measurable differences between Study 1 and Study 2 participants were detected, the fact that positive affect increased in both conditions caused pause during analysis because the control condition activity was, essentially, sitting on a bench doing nothing – participants should not have experienced a boost in positive affect from this (non)activity. It is possible that the participants who made the decision to come to the recreation facility were different in some measurable way from the typical research participant pool individuals, but random assignment within the study likely minimized the impact of such differences on the findings.

Future Directions

Replication. First, given the novel nature of these results as well as the novelty of both the paradigm employed as well as the topic of this research, replications of these studies are necessary. Accordingly, although extrapolating from self-regulation theory (Higgins, 1997) about the impact of approach motivation on desire did not translate well in Study 2, other conceptualizations of approach motivation should be attempted during the replication process.

The Harmon-Jones, Harmon-Jones and Price (2013) definition of approach motivation – “movement towards” – along with the myriad other conceptualizations in the literature including drive, reward responsiveness, fun seeking, reward sensitivity, and motivational intensity, leave open a wide range of possibilities for quantifying approach motivation. Accordingly, research involving a delineation of these conceptualizations – all of which have empirical-backing – is warranted.

Towards a Meta-Theory of “Towards-ness”. Among the vast animal kingdom only humans have taken to applying a semantic interpretation to their current feeling states. Given the work in personality linking dispositional approach motivation, extraversion, and positive affectivity (Lucas et al., 2000) as well as animal research on dopamine and reward seeking behavior (Puryear et al., 2010), it seems that humans might truly have concocted several ways of describing the same general phenomenon: engagement with, or movement towards (something). What should be done in future research on this topic is to attempt to combine the manifestations of these highly-related concepts into one meta-theory of the "how" and "why" of human engagement with the environment, or to more carefully delineate the reasons *why* there need to be several related concepts reflecting approach motivation.

DeYoung's (2013) recent critical theorizing on the role of dopamine in all of these concepts (extraversion, positive affect, behavioral approach, and “wanting”) is critical to the advancement of our understanding of approach motivated behavior. As humans became more complex organisms, what was once a relatively simple role of dopamine became highly specialized and diverse. Dopamine production sites and receptors alike are located throughout the brain and respond to distinct classes of stimuli (DeYoung, 2013). However, when one part of the dopaminergic system responds, the entire network is aroused. This is important to understand

for the express purpose of understanding this work. Locomotion is likely only one of these "shadow-agitators" of the dopaminergic systems, yet an immensely important one.

Manipulating Positive Affect. The locomotion paradigms used in this study once again (cf. Miller & Krizan, 2014) reliably impacted positive affect. Another future direction involves comparing affect manipulations and their impact on approach behavior. I have argued that locomotion embodies positive affect. If someone was to give you money, or a treat, you would likely experience what would be measured as positive affect as well. Are these two manipulations similar in their effect on approach motivation? Recall the impact in Study 1 of measuring state approach motivation immediately after giving participants \$3 after sorting the cards in the CARROT task. There was no difference between conditions in their state approach motivation according to the self-report scale, but the overall mean in Study 1 for the scale was 33 while the overall mean for the scale in Study 2 – where the scale performed according to predictions – was 28. However, positive affect post-manipulation was much higher overall (just over one full scale point on the 5-point PANAS scale) in Study 1 as well, which might also have served to buffer state approach motivation. As a result, from these data one cannot tell for sure what happened between the studies, but the impact of what ended up being a \$3 “gift” to all the participants in Study 1 seems to be an additional candidate for causing the divergent data pattern between studies in regards to self-reported state approach motivation. This theorizing, as derived from noticing the effect the procedural misstep in Study 1, is supported and highlighted by recent challenges to the “Broaden and Build” theory of positive psychology, where all positive emotions are considered isomorphic (Fredericksen, 2001; Gable & Harmon-Jones, 2008; 2011; 2013). Tacit support also comes from suggested refinements to the structure of the PA-NA model in regards to what approach motivation and “positive” affect truly are, how they are

related, and what behaviors they should predict (Carver & Harmon-Jones, 2009; Watson et al., 1999). In practice, the effect on approach motivation of inducing positive affect through various means should be investigated. Locomotion, while extremely reliable in its production of *approach*-steeped, engagement-focused positive affect (Miller & Krizan, 2014) is rarely if ever used as an affect manipulation in examining subsequent behavior, despite the likelihood that locomotion might be the most frequent modifier of positive affect one encounters throughout the course of a day, if not the most significant or noticeable.

Conclusion

We spend much time engaged in locomotion during the day, but we rarely pause to consider the impact of such locomotion on our behavior. Since the hypothesized impact of locomotion on behavior was carefully hidden from participants in both studies, the results should be persuasive. As a result of merely walking briskly for ~10 minutes participants tried harder to get a reward on a sorting task (Study 1) and reported more preparation for reward obtainment (Study 2). The increased approach motivation in both of these studies seemingly drove the experience of positive affect.

The phrase “go getters” is a colloquial American expression that seems to have received some empirical backing from the present research, suggesting that people who engage in locomotion more frequently than others get more rewards through both effort (Study 1) and preparation (Study 2). The results suggest a strong relationship among locomotion, positive affect and approach motivation. While there are individual differences among people as to how intense of “go getters” they are, it seems that there are within person differences as well which can be predicted, and even managed to a certain extent with the simple act of going for a brisk, brief walk.

APPENDIX A**The Positive and Negative Affect Schedule - Expanded Form (PANAS-X)**

This scale consists of a number of words and phrases that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you have felt this way during the past few weeks. Use the following scale to record your answers:

- 1 very slightly
 2 a little
 3 moderately
 4 quite a bit
 5 extremely

_____ cheerful	_____ sad	_____ active	_____ angry at self
_____ disgusted	_____ calm	_____ guilty	_____ enthusiastic
_____ attentive	_____ afraid	_____ joyful	_____ downhearted
_____ bashful	_____ tired	_____ nervous	_____ sheepish
_____ sluggish	_____ amazed	_____ lonely	_____ distressed
_____ daring	_____ shaky	_____ sleepy	_____ blameworthy
_____ surprised	_____ happy	_____ excited	_____ determined
_____ strong	_____ timid	_____ hostile	_____ frightened
_____ scornful	_____ alone	_____ proud	_____ astonished
_____ relaxed	_____ alert	_____ jittery	_____ interested
_____ irritable	_____ upset	_____ lively	_____ loathing
_____ delighted	_____ angry	_____ ashamed	_____ confident
_____ inspired	_____ bold	_____ at ease	_____ energetic
_____ fearless	_____ blue	_____ scared	_____ concentrating
_____ disgusted	_____ shy	_____ drowsy	_____ dissatisfied
with self			with self

(end of scale, documentation/scoring follow)

General Dimension Scales:

Negative Affect (10): afraid, scared, nervous, jittery, irritable, hostile, guilty, ashamed, upset, distressed

Positive Affect (10): active, alert, attentive, determined, enthusiastic, excited, inspired, interested, proud, strong

Basic Positive Emotion (BPE) Scales:

Joviality (8): happy, joyful, delighted, cheerful, excited, enthusiastic, lively, energetic

Self-Assurance (6): proud, strong, confident, bold, daring, fearless

Attentiveness (4): alert, attentive, concentrating, determined

APPENDIX B

The BAS/BIS Scales

Each item of this questionnaire is a statement that a person may either agree with or disagree with. For each item, indicate how much you agree or disagree with what the item says. Please respond to all the items; do not leave any blank. Choose only one response to each statement. Please be as accurate and honest as you can be. Respond to each item as if it were the only item. That is, don't worry about being "consistent" in your responses. Choose from the following four response options:

- 1 = very true for me
- 2 = somewhat true for me
- 3 = somewhat false for me
- 4 = very false for me

1. A person's family is the most important thing in life.
2. Even if something bad is about to happen to me, I rarely experience fear or nervousness.
3. I go out of my way to get things I want.
4. When I'm doing well at something I love to keep at it.
5. I'm always willing to try something new if I think it will be fun.
6. How I dress is important to me.
7. When I get something I want, I feel excited and energized.
8. Criticism or scolding hurts me quite a bit.
9. When I want something I usually go all-out to get it.
10. I will often do things for no other reason than that they might be fun.
11. It's hard for me to find the time to do things such as get a haircut.
12. If I see a chance to get something I want I move on it right away.
13. I feel pretty worried or upset when I think or know somebody is angry at me.
14. When I see an opportunity for something I like I get excited right away.
15. I often act on the spur of the moment.
16. If I think something unpleasant is going to happen I usually get pretty "worked up."
17. I often wonder why people act the way they do.
18. When good things happen to me, it affects me strongly.
19. I feel worried when I think I have done poorly at something important.
20. I crave excitement and new sensations.
21. When I go after something I use a "no holds barred" approach.
22. I have very few fears compared to my friends.
23. It would excite me to win a contest.
24. I worry about making mistakes.

(end of scale, documentation/scoring follow)

BAS/BIS scoring:

Items other than 2 and 22 are reverse-scored.

BAS Drive: 3, 9, 12, 21 (ext)

BAS Fun Seeking: 5, 10, 15, 20 (imp)

BAS Reward Responsiveness (Sensitivity): 4, 7, 14, 18, 23 (ext)

BIS: 2, 8, 13, 16, 19, 22, 24

Items 1, 6, 11, 17 are fillers.

The fact that there are three BAS-related scales and only one BIS-related scales was not planned or theoretically motivated. The factors emerged empirically, from an item set that was intended to capture diverse manifestations of the BAS, according to various theoretical statements. It is likely that a broader sampling of items on the BIS side would also have resulted in more than one scale. I do not encourage combining the BAS scales, however, because they do turn out to focus on different aspects of incentive sensitivity. In particular, Fun Seeking is known to have elements of impulsiveness that are not contained in the other scales.

APPENDIX C

Extraversion Scale and Instructions

Please use the rating scale below to describe how accurately each statement describes *you*. Describe yourself as you generally are now, not as you wish to be in the future. Describe yourself as you honestly see yourself, in relation to other people you know of the same sex as you are, and roughly your same age. So that you can describe yourself in an honest manner, your responses will be kept in absolute confidence. Please read each statement carefully, and then fill in the bubble that corresponds to the number on the scale.

Response Options

- 1: Very Inaccurate
- 2: Moderately Inaccurate
- 3: Neither Inaccurate nor Accurate
- 4: Moderately Accurate
- 5: Very Accurate

E1: FRIENDLINESS (.87)

- + keyed Make friends easily.
 Warm up quickly to others.
 Feel comfortable around people.
 Act comfortably with others.
 Cheer people up.
- keyed Am hard to get to know.
 Often feel uncomfortable around others.
 Avoid contacts with others.
 Am not really interested in others.
 Keep others at a distance.

E2: GREGARIOUSNESS (.79)

- + keyed Love large parties.
 Talk to a lot of different people at parties.
 Enjoy being part of a group.
 Involve others in what I am doing.
 Love surprise parties.
- keyed Prefer to be alone.
 Want to be left alone.
 Don't like crowded events.
 Avoid crowds.
 Seek quiet.

E3: ASSERTIVENESS (.84)

- + keyed Take charge.

- Try to lead others.
- Can talk others into doing things.
- Seek to influence others.
- Take control of things.
- keyed Wait for others to lead the way.
- Keep in the background.
- Have little to say.
- Don't like to draw attention to myself.
- Hold back my opinions.

E4: ACTIVITY LEVEL (.71)

- + keyed Am always busy.
- Am always on the go.
- Do a lot in my spare time.
- Can manage many things at the same time.
- React quickly.
- keyed Like to take it easy.
- Like to take my time.
- Like a leisurely lifestyle.
- Let things proceed at their own pace.
- React slowly.

E5: EXCITEMENT-SEEKING (.78)

- + keyed Love excitement.
- Seek adventure.
- Love action.
- Enjoy being part of a loud crowd.
- Enjoy being reckless.
- Act wild and crazy.
- Am willing to try anything once.
- Seek danger.
- keyed Would never go hang gliding or bungee jumping.
- Dislike loud music.

E6: CHEERFULNESS (.81)

- + keyed Radiate joy.
- Have a lot of fun.
- Express childlike joy.
- Laugh my way through life.
- Love life.
- Look at the bright side of life.
- Laugh aloud.
- Amuse my friends.
- keyed Am not easily amused.
- Seldom joke around.

APPENDIX D

Study 2 Object Pictures



APPENDIX E

Study 2 Sample Trial

IOWA STATE UNIVERSITY



Do you want this chocolate fudge?

- Yes
- No
- Not sure

Assuming this chocolate fudge was available for you to take, and considering how you feel right now...

not at all

somewhat

extremely

How desirable is it?	<input type="range"/>
How repulsive is it?	<input type="range"/>
How useful is it?	<input type="range"/>

APPENDIX F

Factor loadings for the enticing and neutral items in Study 2.

Non-rotated, PCA analyses. Retained items for which the factor loadings exceeded .450. Assigned the title “enticing (objects)” to factor 2, and “neutral (objects)” to factor 1. ***Note: ”fudge” and “pizza” (and arguably “Oreo cookie”) loaded on a third factor during the initial exploratory factor analysis suggesting participant-ratings based on enticing food. These, however, were placed along with the other enticing items when a forced 2-factor solution was computed.

Object	Component	
	1	2
gold bar	.189	.469
piece of wood	.801	-.034
push broom	.619	.033
Oreo cookie	-.027	.751
<i>fudge</i>	-.070	.641
five dollar bill	.044	.628
Ferrari (automobile)	.245	.586
chair	.463	.380
small stone	.769	-.168
<i>pizza</i>	-.313	.558
boulder	.823	-.064
puddle of rainwater	.609	-.013

APPENDIX G

Study 2 (Individual) Object Descriptive Statistics – Item-Level

Object	Condition	Yes/No/ Not-Sure	Desirability	Repulsiveness	Usefulness	Response Time
	standing	.82 (.58)	83.52 (27.66)	8.36 (23.39)	85.11 (28.01)	2.49 (2.72)
<i>bar of gold</i>	walking	.87 (.48)	88.63 (17.79)	10.81 (26.22)	85.76 (23.02)	2.61 (2.53)
	standing	-.80 (.48)	9.41 (14.96)	12.68 (20.65)	31.02 (30.58)	2.45 (1.35)
piece of wood	walking	-.87 (.44)	7.43 (13.69)	10.78 (22.63)	24.67 (30.67)	2.54 (1.68)
	standing	-.59 (.76)	16.68 (23.85)	12.75 (20.29)	48.00 (34.02)	2.98 (1.79)
push broom	walking	-.48 (.84)	20.61 (23.18)	11.20 (18.49)	51.17 (34.03)	2.97 (1.93)
	standing	.54 (.83)	56.41 (32.69)	13.38 (22.89)	31.30 (30.40)	2.05 (1.13)
<i>Oreo cookie</i>	walking	.35 (.93)	57.48 (35.81)	13.63 (25.63)	24.02 (27.50)	2.24 (1.41)
	standing	.41 (.89)	55.16 (32.56)	14.59(24.70)	26.57 (25.96)	2.73 (1.75)
<i>fudge</i>	walking	.26 (.95)	49.19 (35.68)	16.91 (25.97)	20.50 (25.14)	2.53 (1.67)
	standing	.95 (.30)	73.54 (25.64)	6.77 (17.8)	77.86 (25.42)	2.17 (1.85)
<i>Five dollar bill</i>	walking	.94 (.30)	75.20 (28.53)	5.69 (13.70)	83.17 (22.53)	2.30 (2.64)
	standing	.86 (.48)	85.50 (25.71)	9.29 (22.00)	71.52 (27.55)	2.30 (1.32)
<i>Ferrari</i>	walking	.69 (.70)	79.74 (28.35)	9.24 (22.16)	70.69 (30.90)	2.86 (3.21)
	standing	-.09 (.92)	33.00 (28.21)	7.75 (16.18)	55.91 (33.48)	3.27 (2.20)
chair	walking	-.17 (.89)	29.31 (27.02)	4.19 (8.97)	55.81 (30.10)	3.54 (3.04)
	standing	-.84 (.46)	7.25 (15.62)	13.70 (21.68)	8.05 (16.54)	2.85 (2.42)
small stone	walking	-.87 (.48)	7.28 (15.06)	8.67 (15.93)	6.43 (13.42)	2.47 (1.61)
	standing	.61 (.73)	65.21 (29.03)	11.96 (19.59)	47.45 (33.78)	2.06 (1.37)
<i>pizza</i>	walking	.26 (.96)	56.85 (35.47)	17.56 (24.33)	40.20 (32.98)	2.35 (1.62)
	standing	-.84 (.46)	9.43 (17.81)	13.66 (21.87)	7.14 (14.76)	2.46 (1.77)
boulder	walking	-.94 (.31)	6.41 (13.24)	10.65 (18.72)	4.24 (7.44)	2.91 (2.55)
	standing	-.84 (.46)	10.36 (19.33)	26.55 (30.36)	11.30 (23.01)	3.12 (2.40)
puddle of water	walking	-.58 (.78)	14.87 (26.45)	18.13 (26.74)	9.13 (15.20)	3.80 (3.13)

Items in the *enticing* index are italicized. The “Yes/No/Not-Sure” column was constructed by averaging a numerical value for each of the three responses across all participants: 1 = Yes, 0 = Not Sure, and -1 = No.

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