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Abstract

Theories currently used to understand, predict, and promote physical activity and exercise represent information-processing models of the mind. A fundamental assumption underpinning these theories is that human judgment and decision-making processes are rational. Thus, interventions derived from these models are aimed to enhance "data input" (e.g., provide complete, accurate, and compelling information about health benefits) with the expectation that the rational evaluation of these data will result in the desired behavioral "output." Given the modest effectiveness of interventions based on these models, we designed two experiments testing the validity of the assumption of rationality, focusing specifically on exercise-related judgments and decisions. In Experiment 1, exercise judgments were altered by shifting an arbitrary anchor, whose presence should have had no bearing on these judgments. In Experiment 2, the preference between a target exercise session and an alternative was increased by the mere addition of a third "decoy" exercise option. Together, these experiments demonstrate that important motivational variables, including the perceived desirability of exercise, affective attitude, intention, affective forecasts, and exercise choices can be manipulated in a predictable direction without providing any new relevant information, but by merely targeting specific, well-characterized heuristics. Therefore, these data provide evidence that the "bounded" nature of human rationality also manifests itself in exercise judgments and decisions. Researchers and exercise practitioners should consider incorporating heuristic processes within dual-process theoretical models of physical activity and exercise behavior.

Keywords: cognitivism, behavioral economics, heuristics, dual-process models, physical activity

Despite the well-established and well-publicized importance of physical activity (PA) for physical and mental health, most people in industrialized countries remain sedentary or inadequately active. The persistent inability of community interventions and social marketing campaigns to bring about reliable and sustainable change in behavior at the population level has led to the characterization of physical inactivity as the "biggest public health problem of the 21st century" (Blair, 2009, p. 1).

A possible reason why physical inactivity has proven so resistant to efforts to alter its course is that this problem seems to refute the postulates of the "rational educational" model (Weare, 2002), which has long been the cornerstone of public-health interventions. The "rational educational" model is based on the core assumption that, when provided with complete and accurate information, individuals will process this information in a rational manner and change their behavior accordingly. National survey data, however, suggest that this assumption is unlikely to hold in the case of PA. In the United States, for example, although 97% of adults consider the lack of PA a health risk factor (52% as "very important"; 37% as "important"; 8% as "somewhat important"; see Martin, Morrow, Jackson, & Dunn, 2000), 97% do less (objectively assessed) PA than the minimum level recommended for health promotion (Tudor-Locke, Brashear, Johnson, & Katzmarzyk, 2010). Similarly, in Britain, 89% of men and 91% of women believe that regular PA confers meaningful health benefits (O'Donovan & Shave, 2007) but 94% and 96%, respectively, fail to reach the minimum recommended level of PA (National Health Service Information Centre, Lifestyle Statistics, 2012).

Given this seemingly paradoxical situation, it may be prudent to propose that a critical reevaluation of the fundamental assumption of the "rational educational" model may be in order, especially as the model applies to the promotion of PA and exercise behavior. The proposal advanced in this article is that it may be fruitful for the field of PA promotion to contemplate the possibility of nonrational and nondeliberative modes of behavioral decision-making, a notion that has been gaining ground in behavioral economics (Thaler & Sunstein, 2008; Ariely, 2010; Dolan et al., 2012), psychology (Shafir & LeBoeuf, 2002), and medicine (Corrigan, Powell, & Michaels, 2015). Though a few innovative authors have applied nonrational and nondeliberative modes of behavioral decision-making to PA and exercise (Hofmann, Friese, & Wiers, 2008; Williams & Evans, 2014), the “rational educational” model persists as the dominant paradigm in exercise psychology.

So-called "dual-process" models suggest that, besides rational, deliberative, analytical processes, automatic, "heuristic" processes are also influential in driving behavioral decisions and underlying preferences. These have been described in the literature by a variety of labels, including, in perhaps one of the most widely known variations, "System 1" and "System 2," respectively (Kahneman, 2011). Recently, in an effort to bring coherence to this diverse literature, Evans and Stanovich (2013) proposed the labels "Type 1" and "Type 2," respectively. Type 1 processes are postulated to be evolutionarily more primitive, nonconscious, and independent of cognitive ability. In contrast, Type 2 processes are postulated to be evolutionarily more recent, conscious, and correlated with cognitive ability.

Are Human Health-Behavioral Decisions Fully Rational?

The main theories presently used in the study of PA and exercise behavior – namely the Theory of Planned Behavior (TPB; Ajzen, 1991), Social Cognitive Theory (SCT; Bandura, 2001, 2004), the Transtheoretical Model (TTM; Prochaska, 1979), and Self-Determination Theory (SDT; Deci & Ryan, 2000) – assume that behavioral decisions are made by collecting and cognitively appraising information. Inherent in this information-processing perspective is the fundamental assumption that the decision-making process is rational; that is, behavioral decision making relies solely on Type 2 processes. An essential hallmark of rationality is that, as long as people are provided with accurate and complete information, they will consistently opt for behaviors that are in their best interest and improve their welfare (Edwards, 1954; Elster, 2004). Corollaries are that (a) human cognitive capacity suffices for the mental operations required for rational decision-making in typical life dilemmas, and (b) people do not make "systematic mistakes" (Cartwright, 2011, p. 3) in a way that would cause their decisions to consistently deviate from rationality (i.e., make decisions that run counter to the promotion of self-interest).

Although this point is not commonly discussed in the exercise-psychology literature, the rationality assumption represents a crucial pillar of the aforementioned theories. For example, when introducing the reasoned-action framework, which formed the conceptual basis of the TPB, Fishbein and Ajzen (1975) theorized that a human being is "an *essentially rational* organism, who uses the information at his disposal to make judgments, form evaluations, and arrive at decisions" (p. 14, italics added, male pronoun retained from the original). Similarly, in the framework of the TTM, people are presumed to progress along the stages of behavior change on the basis of rational cost-benefit analyses. Acting in such rational fashion, "for most problem behaviors, people will decide that the pros of changing the behavior outweigh the cons before they take action to modify their behavior" (Prochaska et al., 1994, p. 44). Likewise, within the framework of the SCT, people are theorized to be constantly engaged in a cycle of data-collection and data-analysis. Their decisions ultimately depend on the outcomes of complicated probabilistic predictions about the possible future consequences of their actions and inactions. Rationality is a crucial precondition for the operation of this system. Because of the assumption of rationality, people are presumed to make decisions "likely to produce desired outcomes and avoid detrimental ones" (Bandura, 2001, p. 7).

Contrary to what these assertions would seem to imply, instances of human behavior that appear to violate the assumption of rationality are commonplace. In fact, it has been argued that poor behavioral decision-making is the leading cause of death (Keeney, 2008). Outside of the exercise-psychology literature, it seems more commonplace to acknowledge that health-related behavior is often related to nonrational decision-making. For example, delay discounting and myopia appear to be related to obesogenic behavior (Brogan, Hevey, O'Callaghan, Yoder, & O'Shea, 2011; Rasmussen, Lawyer, & Reilly, 2010; Scharff, 2009). Behavioral economics and models of decision-making that acknowledge nondeliberate, nonrational decision-making processes have been applied to help treat individuals with obesity (Liu, Wisdom, Roberto, Liu, & Ubel, 2014), patients with chronic diseases (Mogler et al., 2013), and people with psychiatric disabilities (Corrigan, Rüsch, Ben-Zeev, & Sher, 2014). The predominant theoretical frameworks used to explain and promote PA and exercise behavior, however, do not acknowledge such decision-making processes, potentially limiting their efficacy.

In the aforementioned information-processing theories, instances of nonrationality in human decision-making are explained solely by such factors as a lack of complete, accurate, or compelling information (primarily) and cultural or social environmental pressures and constraints (e.g., see Ajzen, 2011; Bandura, 1977, 1986). Accordingly, interventions based on information-processing theories generally rely on the provision of more – more complete or more convincing – information (e.g., about physical capability, anticipated benefits, or sources of social support). In other words, these models do not allow for the possibility that instances of human behavior exhibiting departures from rationality could be attributed to inherent limitations in human information-processing capacity or the presence of alternative modes of decision-making that may coexist and interact with rational, information-processing pathways.

Nobel laureate in economics Herbert Simon (1979) is credited with initiating research aimed at demonstrating the limits of rationality in information processing and proposing the notion of *bounded rationality* as a more realistic alternative. Simon argued that humans typically lack the reasoning ability required to make fully rational decisions, if the litmus test of rationality is a decision that maximizes utility. Instead, he argued that humans "satisfice" (a composite of the terms *suffice* and *satisfy*) rather than "optimize" (i.e., maximize utility). This means that, due to their limited information-processing capacity, stress, subconscious cues, or other environmental pressures, humans often make decisions that may be suboptimal when judged by strict criteria but are still "good enough" for getting through life.

Continuing this line of research, Tversky and Kahneman (1974) and later Ariely (2010) proposed that deviations from strict rationality may be predictable, as they stem from specific, identifiable "heuristics" (simplified "rules of thumb") and systematic "biases." The rationality debate is still far from settled and the innovative theorizing arising from behavioral economics continues to face resistance and skepticism (Etzioni, 2011). Nevertheless, empirical demonstrations of the influence of heuristics and biases that deviate from strict rationality are remarkably reliabile and, therefore, not easily discounted (Shafir & LeBoeuf, 2002).

It could be argued that, under the assumption of rationality, given the current level of awareness of the health benefits of PA, as well as extensive social marketing campaigns continuously reinforcing the PA message, PA *should* be the norm and sedentary behavior *should* be a rare exception. It is clear, however, that the reverse is the case (Blair, 2009; Tudor-Locke et al., 2010). Thus, after decades of research driven by information-processing theories of human behavior, it is crucial for exercise psychology to take stock of the progress made, begin a process of critical self-reflection, and decide whether an expansion of its theoretical perspective may be beneficial. Indeed, when surveying the numerous systematic reviews and meta-analyses, the overarching conclusion is that the aforementioned theories – namely the TPB (e.g., Armitage & Conner, 2001; Hagger, Chatzisarantis, & Biddle, 2002), SCT (Young, Plotnikoff, Collins, Callister, & Morgan, 2014), TTM (Marshall & Biddle, 2001), and SDT (Ng et al., 2012) – leave most of the variance in PA and exercise behavior unaccounted.

Although devising functional amalgamations of select constructs from these theories may be one avenue for further progress (e.g., Hagger & Chatzisarantis, 2014), this process could be carried out in tandem with a critical reconsideration of the fundamental tenets of the information-processing perspective. Specifically, following the example of behavioral economics (Tversky & Kahneman, 1974), some domains of psychology (Shafir & LeBoeuf, 2002), and medicine (Corrigan et al., 2015), it would be prudent and potentially fruitful for exercise psychology to contemplate both the limits of the human information-processing capacity and the presence of alternative, non-fully-rational modes of behavioral decision-making.

Empirical findings that challenge the assumption of rationality and highlight the effectiveness of associated behavioral interventions have been reported in other scientific fields, where they have helped spur constructive debates and theoretical advances (e.g., see Behavioural Insights Team, 2014; Dolan et al., 2012, for relevant reviews). We suggest that, given the broad interest in developing effective public health policies focusing on PA and exercise, it is time to incorporate heuristic decision-making processes in both behavioral modeling and behavior-change interventions. Examples of such interventions include Charness and Gneezy (2009) on the – more traditional – role of financial incentives (also see Marteau, Ashcroft, & Oliver, 2009, for a discussion), Carrell, Hoekstra, and West (2011) on the impact of social networks, and Williams, Bezner, Chesbro, and Leavitt (2005) on the role of commitments.

The Present Studies

To help initiate this potentially paradigm-shifting process, we present two experiments as initial tests of the assumption of rationality within the specific context of exercise-related judgments and decisions. In particular, these tests challenge a crucial facet of the assumption of rationality, namely that the value of alternative choices is stable and should, therefore, remain unaffected by informational manipulations that bear no relevance to the alternatives themselves. Decisions that violate the expectation of "independence from irrelevant alternatives" cannot be deemed "rational" in a strict sense (Tversky, 1972; Tversky & Simonson, 1993). Instead, such decisions illustrate that the value of alternatives should be viewed as relative and malleable, rather than absolute and invariant.

It is important to underscore that, in challenging the fundamental assumption of rationality, the goal is not to question the decades of research conducted on the basis of information-processing models. Rather, the goal is to help stimulate a process of critical analysis that should result in the transition to dual-process theoretical models of PA and exercise behavior (Ekkekakis & Dafermos, 2012; Hofmann et al., 2008; Williams & Evans, 2014). In such models, human rationality is assumed to be "bounded" and the role of heuristic processes is recognized as influential. Our ultimate goal is to help initiate a conversation on how a behavioral science unconstrained by the assumption of rationality can be leveraged to improve PA rates.

Experiment 1

The purpose of the first experiment was to test the effects of "anchoring" and elaboration on affective attitude and intention towards exercise, as well as on the overall desirability of exercise. Anchoring is a classic heuristic, in which irrelevant and arbitrary initial values ("anchors") are shown to influence and bias judgment. While this heuristic can simplify judgments, it can also lead to systematic errors (Tversky & Kahneman, 1974).

In the seminal work of Tversky and Kahneman (1974), two groups were anchored to a "10" or a "65" by a spinning wheel. Subsequently, participants were asked to estimate the number of African countries in the United Nations. The group exposed to the high anchor (65) estimated 45 nations, while the group exposed to the low anchor (10) estimated 25. Since then, an extensive literature has evolved, demonstrating that decision-makers often use the anchoring heuristic (see Furnham & Boo, 2011, for a review). It is now well established that arbitrary, irrelevant, and random anchors that provide no additional relevant information can alter judgment (Ariely, Loewenstein, & Prelec, 2003; Englich, Mussweiler, & Strack, 2006; Green, Jacowitz, Kahneman, & McFadden, 1998; Kahneman & Thaler, 2006; Wilson, Houston, Etling, & Brekke, 1996). The anchoring effect can influence judgments even when the anchors are presented subliminally (Mussweiler & Englich, 2005).

In addition, anchoring has been found to alter reports of hedonic experiences. For example, Ariely et al. (2003) found that the minimum amount of money students were willing to accept to listen to annoying sounds could be influenced by arbitrary anchors. This suggests that people do not exhibit stable valuations of hedonic experiences. Exercise can be an exemplar of a hedonic experience. Thus, we hypothesized that judgments related to exercise can be influenced by arbitrary anchors.

Tversky and Kahneman (1974) had originally suggested that the anchor might serve as a starting point for adjusting the estimate reflected in the subsequent absolute judgment. Strack and Mussweiler (1997), however, argued that the anchoring effect cannot be adequately understood by focusing on the numerical value of the anchors. Instead, based on three studies testing their *selective accessibility model*, they proposed that anchors serve to activate information through the initial comparative judgment (e.g., "is the Brandenburg Gate in Berlin taller than 150 meters?"), which then influences the subsequent absolute judgment (e.g., "how tall is the Brandenburg Gate?"). This mechanism is subject to certain constraints, such as the relevance and plausibility of the anchor in relation to the subsequent judgment. Similarly, Chapman and Johnson (1999) provided evidence that anchors may work by increasing the salience of information consistent with the anchor and, conversely, decrease the salience of information not consistent with the anchor. Chapman and Johnson also found that elaborating and expanding upon anchor-consistent information further strengthens the anchoring effect. Recognizing these findings, Kahneman (2011) speculated that rational and analytical processes could be biased by rapid, automatic processes like the anchoring heuristic because it makes "some information easier to retrieve" (p. 127). Applied to the present study, initially asking participants a "yes/no" question about exercise ("On a scale from 0 to 100, with 100 being the most desirable, is exercise more desirable than 90?") would increase the salience of information congruent with that anchor, without providing any information that was not already available to respondents.

The purpose of this study was to test the effects of anchoring and elaboration on the overall desirability of exercise and affective attitude and intention towards exercise. We hypothesized that judgments related to the hedonic experience of exercise would indeed be susceptible to anchoring and elaboration manipulations. Importantly, no new information was provided to participants. The anchoring and elaboration manipulations only affected the salience of the information used to make judgments. Under the assumption of rationality, the "value" of exercise (operationally defined by judgments of desirability and associated indices, such as affective attitude and intention towards exercise) should be stable. Rationality assumes that, in order to maximize utility and behave optimally, participants use all available information in making judgments (Edwards, 1954; Elster, 2004). Therefore, participants who receive no new relevant information should *not* alter their estimation of the "value" of exercise.

Methods

Participants. After receiving approval from the Institutional Review Board, 314 participants were solicited through Amazon Mechanical Turk™, an Internet marketplace in which registered volunteers perform interactive tasks for a small monetary compensation. Mechanical Turk™ is used extensively for social-science research, yielding data of satisfactory quality (Buhrmester, Kwang, & Gosling, 2011; Mason & Suri, 2012; Paolacci, Chandler, & Ipeirotis, 2010), with the added benefit of samples that are more diverse than typical samples of college students (Paolacci & Chandler, 2014). Results of studies collected using online methods have been found to be consistent with results collected in a laboratory setting (Lindhjem & Navrud, 2011; Nielsen, 2011).

All data were collected using the Qualtrics survey platform (Provo, UT). Participants were paid \$0.41 each for completing this experiment. In accordance with quality-control standards, responses that took less than 25 seconds were eliminated, to ensure that all participants invested adequate effort (Mason & Suri, 2012). This filtering resulted in the elimination of 19 respondents and an eventual sample size 295 participants (64.1% men, mean age: 30 ± 8 years). The timing data were not visible to the participants. Participants were randomly assigned to either a high-anchor group (*n* = 142, 64.8% men, mean age 30 ± 9 years) or a low-anchor group (*n* = 153, 64.4% men, mean age 30 ± 9 years).

Anchoring and elaboration manipulation. All participants reported their age and sex, and were provided with a Rating of Perceived Exertion chart for reference (Borg, 1998). In the first component of the manipulation, participants were asked a "yes/no" question before making a judgment of absolute value. Participants in the high-anchor group were asked: "On a scale of 0 to 100, with 100 being the most desirable, is 30 minutes of exercise at a Rating of Perceived Exertion of 13 (i.e., "Somewhat hard") more desirable than 90?" Participants in the low-anchor group were asked: "On a scale of 0 to 100, with 100 being the most desirable, is 30 minutes of exercise at a Rating of Perceived Exertion of 13 (i.e., "Somewhat hard") less desirable than 10?" A rating of 13 corresponds to moderate-intensity exercise (Garber et al., 2011). All participants then rated the desirability on a scale ranging from 0 to 100 (see *Desirability* below). The second component of the manipulation was designed to increase the salience of information already known to participants through elaboration (Chapman & Johnson, 1999). Specifically, participants in the high-anchor group were asked to describe their *best* exercise experience ever and the things they *liked* the most about exercise. Conversely, participants in the low-anchor group were asked to describe their *worst* exercise experience ever and the things they *disliked* the most about exercise.

Measures.

Desirability. After the initial component of the anchoring manipulation, which consisted of a "yes/no" question, participants entered a rating of the absolute desirability of exercise. They were instructed to move a slider to answer the question: "On a scale of 0 to 100, with 100 being the most desirable, how desirable is 30 minutes of exercise at a Rating of Perceived Exertion of

13?" This ensured that participants made an absolute judgment of the same exercise session that they evaluated in the anchoring manipulation. The slider was initially set at the midpoint (50).

Affective attitude. After participants listed and described their best (or worst) exercise experience and aspects of exercise that they liked (or disliked) the most, they were asked to report their level of agreement or disagreement with a series of seven statements. Three of these statements assessed affective attitude and four assessed intention towards exercise. Each statement was accompanied by a Likert-style response scale ranging from "Strongly disagree" (scored as 0) to "Strongly agree" (scored as 100). Responses could be entered by moving sliders, which were initially positioned at the midpoint (50). Although participants could respond with any integer from 0 to 100, the scales were marked in intervals of 10 for ease of reference.

The three statements designed to assess affective attitude were: (1) "I look forward to exercising"; (2) "For me, exercise is fun and enjoyable"; and (3) "I would rather die than exercise." The last item (reverse-scored) was removed due to poor interitem correlations. After this removal, the internal consistency of the scale was satisfactory (Cronbach's $\alpha = .93$). Thus, the scores of two statements were averaged as a measure of affective attitude toward exercise.

Intention. Using the same "Strongly disagree" (0) to "Strongly agree" (100) response scale, the following four statements were used to measure intention toward exercise: (1) "In the next week, I intend to exercise for at least 30 minutes per day on at least 5 days at a 'moderate' intensity"; (2) "In the next week, I intend to exercise for at least 20 minutes per day on at least 3 days at a 'vigorous' intensity"; (3) "Compared to how much I currently exercise, I intend to exercise more in the future"; (4) "Compared to how much I currently exercise, I intend to exercise less in the future." The first two statements were chosen due to their specificity and relation to current exercise guidelines for healthy adults (ACSM, 2013). The latter two statements were included to make the assessment meaningful to all participants, regardless of their current level of exercise. The last statement (reverse-scored), however, was eventually eliminated due to poor interitem correlations. Following this elimination, the internal consistency of the scale was satisfactory (Cronbach's $\alpha = .71$). Thus, the scores of the three first statements were averaged to provide a measure of exercise intention.

Results and Discussion

Independent-sample *t*-tests were used to evaluate between-group differences for all outcomes. There were no differences for age ($p = .855$) or sex ($p = .804$). In the high-anchor group, participants reported significantly greater desirability of exercise (66.58 ± 22.04 vs. 60.12 ± 21.99, Cohen's $d = .29$), more positive affective attitude (65.02 ± 24.22 vs. 57.88 ± 27.81, Cohen's $d = .27$), and greater exercise intention (64.38 ± 20.93 vs. 58.99 ± 22.85, Cohen's $d = .25$) than participants in the low-anchor group. Each difference was statistically significant ($p = .012$, .019, and .036, respectively).

In support of our hypotheses, the anchoring manipulation altered judgments of the overall desirability of exercise and, coupled with elaboration (Chapman & Johnson, 1999), altered evaluations of affective attitude and intention towards exercise. These results demonstrate that, like other hedonic experiences (Ariely et al., 2003), judgments and valuations of exercise are malleable rather than stable, and may be influenced by anchoring and elaboration, presumably reflecting the operation of heuristic processes (Kahneman, 2011). In a second experimental test of the rationality assumption in the exercise domain, we investigated the effects of choice sets on preferences and judgments.

Experiment 2

According to the assumption of rationality, the value of and the preference for an option should be a function of only that option and should not "depend on comparisons drawn between it and other alternatives" (Brenner, Rottenstreich, & Sood, 1999, p. 225). This is because the alternatives provide no new information about the quality of the option in question. Allowing the context to alter the value of an option violates the principle of irrelevant alternatives (Tversky & Simonson, 1993). This further implies that people do not make consistent valuations, nor do they consider alternatives rationally when making judgments.

Experiment 2 was designed to ascertain the effects of alternative exercise options on *choice* among exercise sessions. Furthermore, we examined exercise-related affective forecasts (i.e., expected affective responses to the exercise sessions) as an additional dependent variable with potential motivational implications. Under the assumption of rationality, the addition of a new option in a choice set should not alter the probability of choosing a member of the original set. In particular, according to the *constant-ratio rule*, which is a corollary of the principle of independence from irrelevant alternatives, "the relative proportion of choices made between two options should be the same regardless of whether they are presented on their own or in the presence of a third, less preferred option" (Latty & Beekman, 2011, p. 308).

To challenge the constant-ratio rule, the hypotheses tested in Experiment 2 were derived from the *asymmetric dominance* phenomenon. According to Huber, Payne, and Puto (1982), "an alternative is 'asymmetric' if it is dominated by at least one alternative in the set but is not dominated by at least one other" (p. 90). Although this may seem counterintuitive, Huber et al. (1982) demonstrated that "adding such an alternative to a choice set can increase the probability of choosing the item that dominates it" (p. 90). In their scenario, a target and a competitor were shown, with neither one dominating the other (i.e., two stimuli that differed along two dimensions, with one being superior to the other on each dimension). Then, an "asymmetrically dominated" third option was introduced, as a "decoy" specifically selected to be inferior to the target but not the competitor. As hypothesized, the presence of the decoy increased the probability of choosing the target.

Since this initial demonstration, several studies have established that asymmetric dominance is a reliable phenomenon (Bateman et al., 2008; Bateson, Healy, & Hurly, 2003; Scarpi, 2011; Shafir, Waite, & Smith, 2014). An illustrative example offered by Ariely (2010) pertains to subscriptions to *The Economist*, a popular economic and political magazine. When the magazine was offering (a) a web-content-only subscription option for $59 and (b) a combined web-and-print-option for $125, 68% of subscribers chose option (a), whereas only 32% chose option (b). In this example, neither of the two options was clearly superior to the other, since one (the target: web-and-print option) offered more flexibility and convenience, whereas the other (the competitor: web-content-only) was cheaper. After the introduction of a "decoy," a print-edition-only option for $125, which was designed to be dominated by the target (offering fewer features for the same price), 84% of subscribers chose the target, 16% chose the competitor, and no one chose the decoy.

We tested the asymmetric dominance effect for the first time in the context of exercise. We did so by adding an exercise option presumed to be inferior (i.e., a decoy) to a set of two other exercise options. Of the two options in the original set, neither was clearly superior. Specifically, one (the target) was chosen to be of moderate intensity but longer duration and the other (the competitor) was chosen to be of vigorous intensity but shorter duration. The decoy was meant to increase the appeal of the target by matching it on one dimension (same intensity) but being inferior to it on the other (longer duration).

Methods

Participants. After obtaining Institutional Review Board approval, potential participants were offered $0.80 to complete a short questionnaire about exercise preferences on Amazon Mechanical Turk™. Data were collected using the Qualtrics survey platform (Provo, UT). A total of 615 participants completed the questionnaire. As with Experiment 1, only respondents who took at least 25 seconds to complete the questionnaire were included in the analysis, to ensure that all participants adequately read each item (Mason & Suri, 2012). As in Experiment 1, timing data were not displayed to the participants. Participants were required to report their Mechanical Turk™ user identification, as an additional incentive to provide meaningful responses (to avoid negatively affecting their user reputation on Mechanical Turk™). Furthermore, participants who chose the decoy option were eliminated from the analysis. This screening resulted in a final sample of 538 participants (54.5% men, mean age 31 ± 10 years).

Measures and procedures. Participants were randomized to either a binary-choice-set group (n = 290, 55.9% men, mean age 31 ± 10 years) or a trinary-choice-set group (n = 248, 52.8% men, mean age 32 ± 10 years). The binary-choice set did not include the asymmetrically dominated alternative ("decoy"). Participants were told that the modality of exercise would be up to them (e.g., biking, running, swimming, tennis).

First, participants were asked to choose their preferred option between "30 minutes of exercise at a Rating of Perceived Exertion of 13 (i.e., 'Somewhat hard')" and "20 minutes of exercise at a Rating of Perceived Exertion of 17 (i.e., 'Very hard')." A Rating of Perceived Exertion chart (Borg, 1998) was provided for reference; a rating of 17 corresponds to vigorous-intensity exercise (Garber et al., 2011). Next, participants made an affective forecast by moving an on-screen slider to indicate how they predicted each of the exercise options would make them feel. The slider was a visual analog scale ranging from "Very, very bad" (scored as 0) to "Very, very good" (scored as 100). The slider was initially positioned at the midpoint (scored as 50). Participants could see the verbal anchors but not the numerical scores.

The trinary-choice set was identical to the binary-choice set but included the additional, asymmetrically dominated choice of "90 minutes of exercise at a Rating of Perceived Exertion of 13 (i.e, 'Somewhat hard')." This asymmetrically dominated option functioned as a decoy to enhance the preference for the target option, namely "30 minutes of exercise at a Rating of Perceived Exertion of 13 (i.e., 'Somewhat hard')." This option was identical to the target option in terms of intensity (i.e., "Somewhat hard") but, assuming most people do not prefer 90-min exercise sessions, inferior to it in terms of duration. The similarity and yet inferiority to the target option were hypothesized to increase the preference for the target over the competitor, namely "20 minutes of exercise at a Rating of Perceived Exertion of 17 (i.e., 'Very hard')" (see Figure 1 for an illustration). Thus, we hypothesized that participants in the trinary-choice-set group would report stronger preference for the target option than participants in the binary-choice-set group.

Results and Discussion

The two groups did not differ in terms of either sex or age ($p = .480$ and $p = .153$, respectively). A chi-square analysis revealed that the presence of the decoy (i.e., 90 min at a Rating of Perceived Exertion of 13) increased the preference for the target option ($\chi^2 = 4.72$, $p = .03$), violating the constant-ratio rule. The likelihood of choosing the target option when the decoy was present was 58% greater than choosing the target option when the decoy was absent (Odds Ratio: 1.58; 95% CI: 1.04–2.42; $p = .03$). Additionally, the presence of the decoy enhanced the affective forecast associated with the target option. Participants in the trinary-choice-set group forecasted more pleasure resulting from 30 min of exercise at a Rating of

Perceived Exertion of 13 (71.36 ± 20.06) than participants in the binary-choice-set group (67.79 ± 20.69, t = -2.03 , p = .043, Cohen's d = .18).

General Discussion

Theoretical models commonly employed in exercise psychology to understand, predict, and change PA and exercise behavior assume that judgments and decisions result from collecting and evaluating relevant information. These models rely on the fundamental assumption of rationality. It is essential for the function of these systems to presuppose that their information-processing algorithms operate on the basis of an immutable fundamental principle, namely the promotion of self-interest and the satisfaction of individual preferences, thus maximizing utility (e.g., ensuring survival and optimizing benefits). Moreover, the theoretical models assume that the outputs of the information-processing algorithms (i.e., judgments, decisions, choices) follow, in a predictable manner, from informational inputs, obeying principles of reasoning considered "normative" (e.g., basic rules of logic and probability theory). Within this context, it is also assumed that each object being evaluated has a specific, fixed value, acquired through information or prior experience. This value is presumed to remain constant, unless new, pertinent information that changes this value is fed into the system. For example, in the case of exercise, information-processing models do not accommodate the possibility that the evaluation of an exercise option (e.g., its desirability, its affective attributes) can change, in a reliable and systematic fashion, without providing the individual with new information specifically pertaining to this option. In this sense, the phenomena identified in the present studies constitute "anomalies" that challenge the conceptual foundation of contemporary PA and exercise theories.

Whether these "anomalies" constitute evidence that human reasoning and decision-making systems are *irrational* has been a controversial and hotly debated topic for philosophers, psychologists, cognitive scientists, and economists for decades (e.g., Shafir & LeBoeuf, 2002; Stein, 1996). Detractors and skeptics have countered that these phenomena represent nothing more than "mere mistakes" or "momentary lapses." This position is easily refutable, however, since, unlike the randomness of errors, these phenomena are systematic, predictable, and remarkably robust to variations in experimental conditions (Stanovich & West, 2000). Denial of reliable and systematic deviations from the tenets of strict rationality implies that there is no need to rethink the information-processing models of judgment and decision-making that remain popular in psychology, cognitive science, and economics. On the other hand, acknowledging that these anomalies constitute *bona fide* phenomena would entail that current theoretical models must be modified to accommodate alternative mechanisms within a dual-process system (Dolan et al., 2012; Hofmann et al., 2008; Williams & Evans, 2014; Stanovich, 2010). In other words, this acknowledgment would require a shift away from the presently dominant cognitivist paradigm.

Experiment 1 tested the anchoring and elaboration effect within the domain of exercise, showing that the desirability of exercise, affective attitude, and intention to exercise could be influenced in a predictable fashion. This was accomplished by simply having the respondents answer a "yes/no" question, namely whether a 30-min bout of exercise at a Rating of Perceived Exertion of 13 is "more desirable than 90" or "less desirable than 10" on a 0-to-100 scale, and then complete an elaboration task. Since this manipulation provided no new relevant information to participants, it would be implausible to argue that the changes in the dependent variables resulted from a rational deliberative process.

The mechanisms underlying the anchoring heuristic remain unclear. Epley and Gilovich (2001) suggested that, when anchors are self-generated rather than provided by someone else (such as an investigator in a research study), the anchoring effect is the result of insufficient adjustment away from the anchor when making an absolute judgment. In Experiment 1, however, the anchors were given by the experimental manipulation. Thus, the effect might have been due to the increased salience of anchor-congruent information (Mussweiler & Englich, 2005; Mussweiler & Strack, 1999; Strack & Mussweuer, 1997). The high and low anchors might have made the more-positive and less-positive aspects of exercise more salient to analytical and deliberative processes, thus allowing those aspects to exert a stronger influence on judgments than they would have in an anchor-absent situation. An additional possibility, however, is that the participants interpreted the high (or low) anchor and elicitation of positive (or negative) past experiences and characteristics of exercise as the socially desirable response. Therefore, the results of Experiment 1 should be interpreted with this alternative explanation in mind.

The findings of Experiment 2 suggest that adding an inferior (or superior) exercise option to a choice set can enhance (or detract from) the desirability of other exercise options. Similar to Experiment 1, the preference for exercise options – presumed to be absolute and invariant – was shown to be easily malleable without providing participants with any new relevant information. Experiment 2 demonstrated that choices between two exercise options could be altered by adding an alternative designed to increase the preference for a target option. In addition to theoretical implications, Experiment 2 raises the possibility that exercise professionals could alter the desirability of an exercise prescription without altering the prescription itself, by merely juxtaposing the intended prescription to an aversive or less desirable option. The added option would not be meant to be chosen, but could simply be engineered to enhance the desirability of the original prescription. Thus, Experiment 2 demonstrated that preferences for exercise options can be altered without altering any of the characteristics of the exercise options. This again constitutes a violation of the assumption of rationality.

The experimental evidence provided in these studies may have implications for exercise professionals seeking to increase PA and exercise participation levels. Anchoring, for example, has been found to lead to behavior change (Cervone & Peake, 1986) and could be used in this setting to allow people to generate more positive views about exercise and endorse the anchor-congruent information. To individuals receiving an anchoring manipulation, the information is seen as self-retrieved and may, therefore, be endorsed more readily or more strongly than if it was provided by a health or exercise practitioner. The simplicity and minimalist nature of anchoring manipulations make them highly practical for interventions. Exercise professionals can also change important motivational constructs, such as the perceived desirability of exercise or affective forecasts, by presenting specifically engineered alternatives without providing any new information about the exercise options under consideration. Changing attitude and judgments towards PA and exercise, of course, do not necessarily translate into a change in actual behavior. It remains to be seen whether behavioral interventions such as these can nudge people to leave their sofas or increase their PA and exercise frequency to recommended levels.

The present studies were designed as "proof of concept" experiments, aimed to illustrate the limits of the assumption of rationality in the particular context of exercise. As such, the experimental manipulations were neither intensive nor protracted. Thus, the associated effects were generally small. The effect size of Experiment 2 was consistent with or larger than other experiments in the asymmetric dominance literature. Huber et al. (1982), for example, found that the addition of a decoy increased the selection of a target by 9.2%. In Experiment 2, the addition of the decoy increased the selection of the target by 58%. The anchoring index (i.e., a measure of anchoring effect size) of Experiment 1, however, ranged from 5.9% to 7.93%, which is much smaller than "typical" (i.e., 55%, see Kahneman, 2011, p. 124). This may be due to the outcome measure used in Experiment 1. Participants were asked to adjust an on-screen slider from a default midpoint value of 50, as opposed to responding without a preset value. It is possible that the default value acted as an anchor itself, attenuating the effect of the experimental manipulation. Similarly, the manipulation in Experiment 2 had a small effect on affective forecasts, but it is possible that the default midpoint value of 50 acted as an anchor that attenuated the effect.

In addition, the experiments were limited to single instances of exercise-related judgments and choices. Although these caveats must be taken into account in evaluating the theoretical implications of these results, readers should also consider the remarkable robustness of these phenomena across a range of diverse contexts, as reported in the psychological, economic, and other research literatures. Nevertheless, prudence precludes any grand claims of generalizability since sampling from the population was not random and did not follow procedures, such as stratification, to ensure representativeness; the samples consisted entirely of volunteers with specific characteristics (i.e., mTurk workers).

With the aforementioned limitations in mind, the findings of Experiments 1 and 2 suggest that desirability, affective attitude, intention, and choice within the domain of PA and exercise depend on context. Further, these data suggest that people do not have stable valuations of objects, a characteristic that can lead to nonoptimal behavior (Bykvist, 2010). Attitudes toward PAs appear inconsistent and malleable without changing any information about the attributes of the activities being evaluated. Transiently allowing contextual factors to influence valuations of leisure-time activities suggests that humans use comparative valuation techniques and do not always make fully rational decisions that maximize utility (Tversky & Simonson, 1993). Latty and Beekman (2011) suggested that using comparative valuation techniques might be a feature of decision making that has been favored by natural selection because of its efficiency over thorough, rational analysis.

Theories of human behavior built on the assumption of a singular system of reasoning and decision-making cannot account for systematic mistakes and biases, the use of heuristics (such as the anchoring heuristic demonstrated in Experiment 1), or the often nonoptimal comparative valuation strategies demonstrated in Experiment 2. Our goal in illustrating these phenomena in the context of PA and exercise is to stimulate a long-overdue critical reappraisal of the assumptions underlying the information-processing theories currently used in the study of PA and exercise behavior. In turn, future theorizing should contemplate a transition of the field of exercise psychology to dual-process models (Evans & Stanovich, 2013; Hofmann et al., 2008; Williams & Evans, 2014) that incorporate intuitive, affect-driven, potentially biased, nonoptimal, and nonrational processes leading to exercise-related judgments and decisions (Ekkekakis & Dafermos, 2012). These developments should eventually lead to experimental tests of the cost-effectiveness of interventions based on dual-process models in the context of PA and exercise behavior.

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FigureCaption

Figure 1

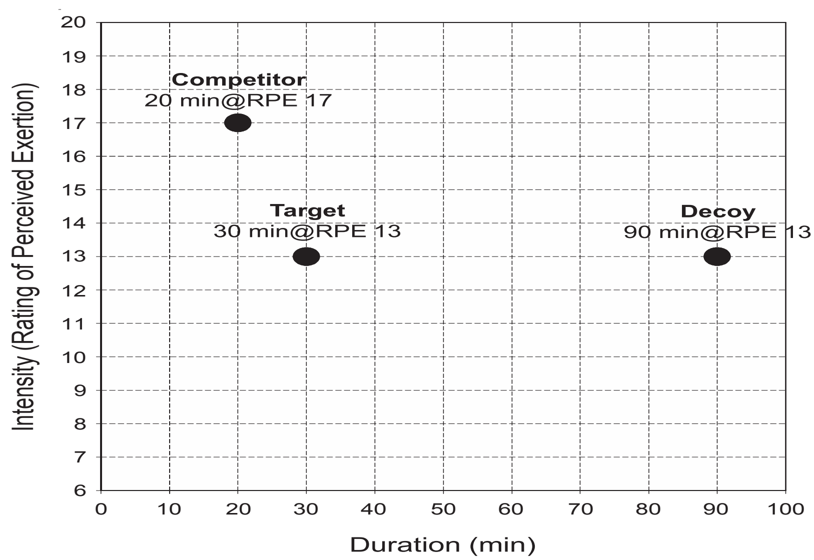

Figure 1. Graphical representation of the experimental manipulation used in Experiment 3. The decoy was absent in the binary-choice set but present in the trinary-choice set. Note that the decoy option is identical to the target option in terms of one dimension (intensity), but inferior to the target option in terms of the other dimension (duration). This relation to the target option was hypothesized to enhance the preference for the target option when the decoy was present (i.e., the trinary-choice set) compared to when the decoy was absent (i.e., the binary-choice set).