BEHAVIORAL DETERMINANTS OF EXERCISE MAINTENANCE

LESSONS FROM PAST & CURRENT ROWERS

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ABSTRACT

This paper examines the determinants of exercise maintenance through the lens of behavioral economics. I aim to explain the motivational differences between those who successfully maintain healthy exercise habits and those who do not. The implications of this paper inform rowers, athletes and non-athletes alike how to approach exercise from a perspective of long-term maintenance and health. Additionally, I briefly discuss policy implications addressed in some of the existing literature. Using an anonymous self-report survey, I collected data on numerous incentives for exercise maintenance (primary activity type, intrinsic and extrinsic motivations), and, primarily, their impact on hours of weekly exercise. I sampled 294 past and current university rowers (distinguishing between those who currently belong to a team with coached or compulsory practices) from the United States and the United Kingdom. I provide evidence that shows rowers differ from individuals described in the existing literature. Incentives for current exercise maintenance among both current and past rowers are primarily extrinsic. However, regression and ordered logit analyses indicate that parental influence at initiation has a persistent negative effect on current exercise levels, despite rigorous physical activity in the interim, among both current and past rowers.

Keywords: *Rowing, Crew, Exercise Maintenance, Time-inconsistent Preferences, Intrinsic Motivation, Extrinsic Motivation, Participation Motivation, Self-Efficacy, Physical Activity, Behavioral Economics*

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ROWING: A CONTEXTUAL BRIEF

> *“The paradox of rowing is that this most physically demanding of sports is about eighty percent mental, and the higher you rise in the sport the more important mental toughness becomes. Rowers have to face the grim consequences of starting a two-thousand-meter race with a sprint - a strategy no runner, swimmer, cyclist, or cross-country skier would consider using in a middle-distance event. Since rowers race with their backs to the finish line, the psychological advantage of being ahead in the race - where you can see your opponents but they can't see you - is greater than the physiological disadvantage of stressing the body severely so early in the race. If you get behind, something like “unswing” can happen: the cumulative effect of the group's discouragement can make the individuals less inspired. Therefore, virtually every crew rows the first twenty or thirty strokes at around forty-four strokes a minute (which is pretty much flat out) before settling down to around thirty-seven for the body of the race.*
>
> *As a result of this shock to the system, the rower's metabolism begins to function anaerobically within the first few seconds of the race. This means that the mitochondria in the muscle cells do not have enough oxygen to produce ATP, which is the source of energy, and start to use glycogen and other compounds stored in the muscle cells instead: they begin, as it were, to feed on themselves. These compounds produce lactic acid, which is a major source of pain. In this toxic environment, capillaries in the hardest-working muscles begin to dilate, while muscles that aren't working as hard go into a state of ischemia - the blood flow to them partially shuts down. Meanwhile, the level of acid in the blood continues to rise. Mike Shannon, a sports physiologist who works at the new Olympic training center, outside San Diego, told me that the highest levels of lactic acid ever found in athletes - as measured in parts per million in the bloodstream - were found in the blood of oarsmen, about thirty parts per million. "That's a tremendous amount of pain," he said.*
>
> *Marathon runners talk about hitting "the wall" at the twenty-third mile of the race. What rowers confront isn't a wall; it's a hole - an abyss of pain, which opens up in the second minute of the race. Large needles are being driven into your thigh muscles, while your forearms seem to be splitting. Then the pain becomes confused and disorganized, not like the windedness of the runner or the leg burn of the biker but an all-over, savage unpleasantness. As you pass the five-hundred-meter mark, with three-quarters of the race still to row, you realize with dread that you are not going to make it to the finish, but at the same time the idea of letting your teammates down by not rowing your hardest is unthinkable. Therefore, you are going to die.”*

- Seabrook, John. "Feel No Pain," The New Yorker, July 22nd, 1996, p. 32

CONTENTS

1 INTRODUCTION

It is a well-established fact that exercise leads to positive physical and mental health outcomes. Americans spend billions of dollars annually on diet books, exercise equipment and weight loss programs, indicating that people are interested in pursuing behaviors that improve their health (Charness & Gneezy, 2009). Equally well established is the fact that a large portion of the United States falls drastically short of the targets set in the Physical Activity Guidelines Advisory Committee Report (Department of Health & Human Services, 2008). What separates those who successfully maintain healthy exercise habits from those who do not? Are there certain behaviors or conditions that predict higher levels of exercise maintenance? An important distinction is made in the literature between maintenance (the continuation of previously established exercise behavior) and initiation (beginning new behaviors). Although examining incentives for exercise initiation are critical, the purpose of this paper is to determine why certain rowers maintain the behaviors they established compared to those who do not. Additional examples of initiation studies are discussed in section two. Another important distinction separates 'sport' from 'exercise' (Kilpatrick et al., 2005; Fitzpatrick et al., 1993). That is not to say the two are mutually exclusive. Indeed, participating in a sport, such as rowing, mandates that the individual complete some exercise. However, when differentiated, exercise refers to activities completed without the element of competition. Playing basketball with friends would be an example of a sport; going to the gym and using the recumbent bicycle would be an example of exercise. Although the distinction is more nuanced, the broad implications of whether a particular activity is sport or exercise should be clear.

In this paper, I will examine the behavioral determinants of exercise maintenance. I survey past and current rowers in the United States and United Kingdom, to elucidate the difference between those who maintained the exercise habits they established as athletes and those who did not. I synthesize three main parts of the economic conversation on physical activity, and provide evidence from a previously untested sample population. This paper is unique in its combination of the existing literature: several theories and explanations of physical activity and exercise are investigated to obtain an accessible, empirical illustration of the problem. Moreover, rowing has never been studied from this perspective, and the sport itself provides a distinguishing demand for fitness, social cohesion and skill development. As was alluded to in the contextual brief, rowing combines extreme aerobic and anaerobic respiration. Since the costs of pain and exhaustion are relatively high when compared to other physical activities, rowers may show higher levels of extrinsic motivation for exercise maintenance than other athletes, or non-athletes. Typically, intrinsic motives are better predictors of long-term exercise adherence. Further distinctions are made in the literature review (Bénabou & Tirole, 2003).

Briefly, it has been shown that exposure to exercise can increase beliefs about self-efficacy. That is, as you are exposed to or accomplish exercise goals, your belief that you will be able to accomplish future goals is reaffirmed (McAuley et al., 1993). By limiting the sample to past varsity high school rowers and current and past university rowers, we can reliably state that participants have been exposed to rigorous physical activity, which allows us to focus on maintenance in the long-term, as opposed to a difference between individuals who have never been regularly physically active and those who have been exposed to significantly differing levels of physical activity.

The results of this paper are important for anyone who is interested in maintaining healthy, long-term exercise habits. Interested past and current rowers will have the added benefit of being able to relate more directly to the participants. To the extent that this discussion could help improve interventions to increase exercise maintenance, the results serve an important policy debate. It has been established that obesity and being overweight can increase the likelihood of diseases that cost society a significant amount of resources (Paloyo et al. 2014; Bhattacharya et al., 2014). Long-term, healthy, exercise is, by definition, an effective combatant of obesity. Understanding the factors affecting maintenance is thus important in designing policies that improve, or at least address, the long-term motivations for exercise adherence.

Limitations of this paper and other restrictions will be reviewed in the discussion. The next section of the paper will review the existing literature and present a synthesis of the relevant economic theory. Section three will be a basic overview of rowing physiology and incentives; section four will describe the methodology; section five is where the results of the survey will be analyzed, and section six will be the conclusion and discussion.

2 SYNTHESIZED THEORY & LITERATURE

My interpretation of the literature is separated into two main sections. In the first, I explain the economic approach to physical activity, and explain the problem in the underlying decision mechanisms for an individual evaluating the costs and benefits of exercise. The second section will review the literature on incentives for exercise and the efficacy of various empirically studied interventions in response to the question "what behaviors lead to successful exercise maintenance?" I will attempt to summarize the literature as concisely and appropriately as possible. I have summarized my main findings below for convenience.

- Individuals will only exercise if they perceive it to be the best use of their scarce time, not for the entire duration it benefits their health i.e., only when the net marginal benefit of physical activity is greater than all other alternatives (Cawley, 2004)
- Individuals display time-inconsistent preferences (Bhattacharya et al., 2014), which causes them to bias present outcomes, overly discount the future, and under-consume exercise
- Many of the health benefits of exercise are accrued in the future, while the costs of exercise are very much experienced in the present.
- As such, there is a fundamental problem with the mechanisms used to evaluate the costs and benefits of exercise on an individual level
- Certain individuals who are aware of their time-inconsistency (sophisticated hyperbolic discounters) may use commitment devices to improve incentives for future selves (DellaVigna & Malmendier, 2006; Rogers et al., 2014; Bryan et al., 2010)
- Intrinsic motivations enhance self-determined feelings of autonomy, competence and relatedness (Deci & Ryan, 1993; Murcia et al., 2008)

- Extrinsic motivations are regulated, either by the individual or by a principal, especially in cases of market failure, which include irrational decision making (time-inconsistent preferences), information deficits (Cawley, 2004; Wansink, 2006) and negative externalities
- There have been several empirical investigations into which of these two types of motivation best predicts exercise maintenance
- In general, while extrinsic motivations can be used to cross a required “threshold” to form habits (McAuley et al., 1993; Gneezy et al., 2011), intrinsic incentives are more reliable predictors of long-term exercise maintenance
- However, the nature of the task involving physical activity, as well as the participant’s gender can have a significant impact on the levels of intrinsic and extrinsic motivation
- Individual sports participants report higher levels of intrinsic motivation than exercise participants, and women rate body- and appearance-related (extrinsic) motivations higher in importance than men (Kilpatrick et al., 2005; Frederick et al., 1993)
- Rowing is characterized by high levels of camaraderie (Cohen et al., 2015) and high aerobic and anaerobic physiological demands (Seabrook, 1932), providing a unique combination of intrinsic and extrinsic motivations
- Along with many other sports, rowing is a particular activity that has not been examined for levels of intrinsic and extrinsic motivation

2.1 DEFINING THE PROBLEM

Using the SLOTH model of time allocation (Appendix 1), John Cawley (2004) offers "an economic framework of human behavior with respect to physical activity and nutrition." In the context of maximizing lifetime utility, the economic discussion regarding exercise assumes that people are involved in the production of their own health. As such, economic frameworks focus on a given individual's incentives and motivations for exercise, in terms of marginal cost and marginal benefit. When a person has optimally allocated their time, the marginal benefit from the last hour of all activities is the same – this is called the "last hour rule." Individuals are willing to sacrifice health for "other things they value" (namely leisure, but also tobacco, alcohol and high-calorie foods), and these individuals may rationally choose to participate in an activity that increases morbidity and mortality (such as living at a higher body weight). People will only exercise when it is the best use of their scarce time, not for the entire time that it benefits their health (i.e., as long as their perceived marginal benefit from exercise is greater than any other alternative). Since individuals cannot choose their weight directly – it is affected through caloric intake, physical activity and metabolic rate (which is partially genetic) – they cannot observe the effect of different weights on their overall utility. Importantly, there is an indirect effect of weight on health in that, generally speaking, lower weight is associated with a lower risk of morbidity and mortality, which improves utility.

Unfortunately, individuals do not always evaluate decisions rationally. Bhattacharya, Hyde and Tu explain prospect theory in chapters 23 and 24 of their textbook, *Health Economics.* Originally developed by Daniel Kahneman and Amos Tversky in 1981, this theory explains how problems of framing, reference points, loss aversion and the endowment effect (Appendix 2) distort the editing stage of decision making, where people organize uncertain options to simplify the decision process. This compromises expected utility theory, and is important in the context of exercise because of time-inconsistent preferences. An individual is said to be time-inconsistent, or myopic, if their future selves would alter a plan that their current or past self found to be optimal. Discounting the future may be accurate and appropriate – utility tomorrow may not be as valuable as utility today (due to risk or inflation) – and we adjust utility appropriately using the discount factor, δ, which is raised to the power of the future time period. However, time-inconsistent individuals discount their utility in future periods in a hyperbolic manner: they overly discount subsequent periods with a "present bias" factor, β (Appendix 2).

Rather than thinking of time-inconsistency as an under-valuation of the future, let us consider it as an over-valuation of the present. Herein lies the problem with exercise – the majority of the health benefits of physical activity are accrued to future selves, who have no say over the activities of the present self, and who would otherwise have exercised more. Further, the costs of exercise (pain, exhaustion, possible injury, opportunity cost) are felt in the present, creating a realization gap between cost and benefit. This is why exercise is particularly susceptible to being undervalued - its benefit is irrationally discounted away, while its costs are exaggerated by the same present bias. As an example, consider you are faced with the decision of exercising, as soon as you finish reading this paper. Imagine that your present self knows that exercise is good (notably, an extrinsic incentive) for you and therefore you whish to do it. When you actually begin exercising however, you experience fatigue, and perhaps pain, and so you would prefer not to exercise. But two hours later, when you've finished working out, you feel a sense of achievement (and maybe endorphins) for having exercised, and stuck to your goals. In this chronological example, the second version of yourself is displaying time-inconsistent preferences, relative to your present self, and the two-hour post-workout self.

Welfare economics assumes that voluntary actions must improve an individual's utility, and that we are able to draw inferences about an individual's preferences from their actions. A hyperbolic discounter upends this assumption because their utility is no longer well defined: each of their selves has its own utility function. In addition to lack of rationality, there are two other main areas of market failure that justify interventions: information deficits, and externalities (Cawley, 120). In the case of personal exercise, we have all three. The fitness and "slim-food" industries have created a mass of advertising information that confounds the public's ability to navigate the facts. Processing the necessary information required to make a large number of comparisons takes time and energy, and people often ignore information if it is too difficult to digest (pun intended).

In his book, *Mindless Eating*, Brian Wansink explains how eating an extra 50-100 calories per day can result in several pounds of weight gain each year. Dubbed 'mindless,' this margin of extra calories is consumed not because we consciously decide to, but because we are unaware how much we are eating, and the way our brain approaches food in general. Advertising with descriptive wording or succulent images can cause the brain to signal hunger, regardless of how full an individual's stomach truly is. Out of dozens of experiments, Wansink's experiments with chicken bones and M&M packets best illustrate this concept. In the first, the author monitored the number of chicken wings consumed by a group of MBA students at a Super Bowl viewing party. For half of the students, the bones of discarded wings were left to pile up on their table, whereas the other half had their bowls of bones removed by waitresses. The results showed that those who had their bones removed regularly ate 28% more chicken wings than those who did not. In the M&M experiment, 40 adults at a PTA meeting were asked to watch a video and provide feedback. Each adult was given a bag of M&M's, weighing either a half-pound or one-pound, as a thank you.

Those who were given half-pound bags ate an average of 71 M&M's, while those who were given a one-pound bag ate an average of 137 M&M's – almost 100% (264 calories) more. These two studies show how exogenous factors (namely, portion awareness and portion sizing) can dramatically affect how much we 'decide' to consume.

Obese and overweight individuals may generate a negative externality for society, shifting the cost burden in public healthcare and insurance systems (Bhattacharya et al.; Cawley; Paloyo et al.) Early studies show that the external costs imposed on society by those with a sedentary lifestyle may be greater than those imposed by smokers, since the extra costs they impose on the health insurance pool are imperfectly adjusted for (Cawley, 122). However prevalent, problems of information and negative social costs of under-consumed exercise are secondary to the fact that time-inconsistency induces irrational decision-making. More simply, before trying to fix the macroeconomic problem, we must first examine the costs and benefits to the individual, to properly address the difficulty in successfully maintaining healthy exercise habits.

2.2 INCENTIVES TO EXERCISE & THEIR EFFICACY

2.2.1 INTRINSIC MOTIVATION

Intrinsic motivation is best thought of as a branch of self-determination theory. Initially developed by Edward Deci and Richard Ryan in 1985, "self-determination theory is a general motivation and personality theory, whose main idea consists of human behavior being motivated by three primary and universal psychological needs: autonomy, … competence, … and relatedness." (Murcia et al., 23) If an individual participates in physical activity for reasons of enhancing these feelings, we would say that that they are intrinsically motivated. Autonomy refers to an individual's self-governance, and the degree to which they control their actions; competence refers to one's ability or skill level (for example, at a particular task). These strands of self-determination theory are often examined under the measure of 'self-efficacy'

> "Self-efficacy expectations are the individual's beliefs in his/her capabilities to execute necessary courses of action to satisfy situational demands, and are theorized to influence the activities that individuals choose to approach, the effort expended on such activities, and the degree of persistence demonstrated in the face of failure or aversive stimuli" (McAuley et al., 218)

Self-efficacy is a well-established predictor of exercise adherence, but there is significant endogeneity between levels of physical activity and levels of self-efficacy. That is, exposure to even short, acute bouts of exercise can enhance self-efficacy, and high levels of self-efficacy lead to increased take-up and maintenance of exercise. McAuley et al. (1993) show this relationship very well. The authors document exercise maintenance and levels of self-efficacy in older adults, nine months after the end of a five-month-long, structured exercise program. During the program, self-efficacy assessments were conducted each week, before and after the given exercise test. In the first three months of the program, pre- and post-workout levels of self-efficacy were significantly different. However, for the following months, pre-workout levels were not significantly different from post-workout levels, suggesting that exposure to the exercise raised baseline levels of self-efficacy during the program. This serves as a basic structural example of initiating a positive habit: at first, initiation of the habit is best predicted by one's belief about their ability to execute the necessary functions (as described above), but after a sufficient "threshold" number of repetitions, this becomes less relevant, since the individual is no longer uncertain about their ability – they 'know from experience' they can complete it. At the nine-month follow-up, exercise testing was conducted on the available participants, and self-efficacy was again measured, pre- and post-workout. The results showed that pre-workout levels were significantly lower and post-workout levels were highly comparable to those found in final testing during the program. Additionally, pre-workout levels of self-efficacy at follow-up were best predicted by attendance in the program (i.e., adherence to exercise).

Relatedness describes how accepted the individual feels by their peers, as well as the extent to which they value others. Bénabou and Tirole (2003) endorse this theory, explaining that if a person's feelings of competence and self-determination are enhanced, their intrinsic motivation will increase. Murcia et al. (2008) investigate the influence of the motivational climate perceived in peers on intrinsic motivation and enjoyment in exercise. The authors survey 394 "non-competitive exercisers" who completed the Motivational Climate Perceived in Peers Scale, Scale of Motivational Mediators in Physical Activity, Behavioral Regulation in Exercise Questionnaire-2 and Physical Activity Enjoyment Scale. Following a correlation analysis, a confirmatory factor analysis and a structural equation analysis, their results show that tasks involving this peer-based motivational climate were positively and significantly related with intrinsic motivation for physical activity. In other words, daily contact with groups of friends was found to robustly influence motivation and sensations of enjoyment felt by 'sportspeople' while they are exercising. More specifically, "a climate in which peers place more emphasis on personal progress and effort will enable exercisers to enjoy the exercise sessions, as their basic psychological needs will be met and they will attain self-determined motivation." (Murcia et al., 29)

2.2.2 EXTRINSIC MOTIVATION

If high levels of self-determination mark intrinsic motivation, low levels of self-determination mark extrinsic motivation. According to Murcia et al., "Extrinsic motivation is broken down into several forms of regulation." External regulation is the least self-determined form, in which action is motivated by external rewards for the person. The next form is introjected regulation, in which actions reflect the avoidance of guilt, then identified regulation, in which the subject thinks the activity performed is important. Lastly, integrated regulation involves a principal who identifies and assimilates incentives for an agent to participate in an activity (Murcia et al., 23). This is the most self-deterministic – the agent participates because their incentives are most appropriately aligned by regulation. In essence, extrinsic motivations for exercise would include any incentives that provide benefits that are not for the purpose of enhancing self-determination. For example, health and fitness are considered to be extrinsic motivators – examples of identified regulation. Most typically, in economics, financial incentives, which fall under the category of external regulation, are regarded as extrinsic incentives.

Paloyo et al. (2014) provide an excellent empirical review of financial incentives for weight loss. They seek to answer the question "can financial incentives induce weight loss, and if so, to what extent?" The authors focus on rigorous randomized control trials, emphasizing the reliability of the methodology. Of the 32 studies reviewed, only ten met the inclusion criteria. Jeffery et al. (1993) test different financial treatments on three different groups, against a control group, using a sample of 202 people. All groups were given a standard behavioral treatment (SBT) of weight loss advice, in meetings that were held each week for 20 weeks, and then once a month after that for 13 additional months. Treatment group two received free healthy meals, treatment group three received financial incentives, and treatment group four received both. They found that food provision had a significant effect on weight loss, but that financial incentives did not. Saccone and Israel (1978) test whether input or output-oriented incentives are more effective, and whether financial refunds granted by friends have different effects than those granted by external therapists. Using a sample of 49 overweight adults, who were randomly allocated into six treatment groups and a control group, they find a statistically significant decrease in weight for treatment. The results indicate that participants who received their rewards from friends had much higher levels of weight decrease, whereas those who received them from therapists were found to have no significant decreases in weight. Further, financial incentives did not result in maintenance of weight loss. Mahoney (1974) uses negative incentives in two of three randomized groups to address the issues of weight loss and maintenance. Subjects were required to give a deposit at the beginning of the program and two of the three groups were instructed to award themselves portions of their own weekly deposit of $35 for six weeks, depending on their achievement of weight-loss goals. They find small positive effects of financial incentives on weight loss, but this study has substantial limitations, failing to reach levels of significance.

Abrahms and Allen (1974) research the merits of behavioral-programming techniques for weight loss, including one treatment group with financial incentives. This study was particularly highlighted, despite finding insignificant effects of financial incentives in isolation, because the authors implemented a six-week baseline phase, a ten-week treatment phase, and an eight-week follow-up phase. Participants paid a deposit of $10 that they could recover at a rate of $1.35 per pound lost. After the 7.5 pounds of weight loss required to break-even, they were rewarded $2 for every pound lost. Their results suggest that a combination of different approaches may be more successful than isolated financial incentives. Volpp et al. (2008) monitor the weight of 57 participants randomly divided into two treatment groups and a control group. The first group deposited their own money, which was forfeited if their weight-loss goal of one pound per week for 16 weeks was not reached. If they reached their goal, they could earn up to $252 per month depending on their deposits. In the second group, participants qualified for a lottery with an expected bonus of around $90 per month. Members of both treatment groups were found to have lost significantly more weight than the control participants, with no significant difference between the two treatment groups. However, this could have been confounded by increased attention from the medical center administrators who measured their weight, limiting the certainty of their results.

Following their survey of the literature, Paloyo et al. conclude that the evidence points in multiple directions. Their study casts considerable doubts with respect to the sustainability of weight loss as a result of financial incentives. Kramer et al. (1986) explicitly analyze weight maintenance and provide evidence that people regain up to 40% of the weight they have initially lost and that negative financial incentives do not seem to prevent this phenomenon. However, others suggest that, whilst financial incentives may not be effective for sustained weight loss, they can certainly help initiate physical activity.

Gneezy et al., (2011) review *When and Why Incentives (Don't) Work to Modify Behavior*. In their paper, they discuss the mechanisms of financial incentives, and how extrinsic incentives can come into conflict with other motivations. Monetary incentives have a direct price effect, increasing the value of a given activity, and an indirect psychological effect, which in some cases, can crowd out intrinsic motivations for the behavior, especially in the long-term. Motivation to perform the task once the increased financial encouragements have been removed can be permanently reduced. However, incentive programs may provide the initial motivation for a behavior, and Gneezy et al. review empirical studies of the effects financial incentives have on education, pro-social behavior and healthy lifestyle habits. In terms of exercise, the authors conclude that establishing a habit requires multiple and frequent visits – especially for those who have little or no previous habit of exercising. For further evidence, Charness and Gneezy (2009) investigate the effect of paying people money to attend an exercise facility during a one-month period. The results show that the most significant effects were on those who had not attended the facility before, and, concurrent with the theory presented by McAuley et al., that visiting the facility multiple times may have surpassed a “threshold” level of initiation required to establish the habit. This is endorsed by DellaVigna and Malmendier (2006), who show that individuals who sign up for gym memberships, assuming that this will increase their reasons for going, display the sunk cost fallacy, attending fewer times than they would if they paid per visit.

2.2.3 COMMITMENT MECHANISMS

DellaVigna and Malmendier show that paying for gym membership does not work as a mechanism for increasing incentives for exercise. Economists refer to these mechanisms as ‘commitment devices.’ Returning to the discussion of hyperbolic discounting presented in Bhattacharya et al., we distinguish between two types of individuals who display this behavior. Naïve hyperbolic discounters are unaware of the fact that their future self is just as prone to present bias as their current self; sophisticated hyperbolic discounters are, and as a result, they may attempt to improve incentives for their future selves to engage in utility-maximizing behavior. Rogers et al. (2014) discuss the structure, potential and limitations of commitment devices. These mechanisms are said to have two basic features: people voluntarily elect to use them, and they associate consequences with people's failures to achieve their goals. Immutable consequences cannot be reversed by future choices, for example, an alcoholic who ingests disulfiram to increase the unpleasant effects of alcohol, whereas mutable consequences constrain future behaviors wile also allowing people to mitigate the severity of their decisions. Commitment devices are limited because of their low uptake, which prevents study of their efficacy.

Bryan et al. (2010) agree with this limitation in their review of the recent literature on commitment devices. They present evidence on formal and informal devices, including policy implications (sin taxes, consumer protection and device design). Their results argue that the welfare implications of commitment devices hinge critically on modeling assumptions, and that there is insufficient work to understand the demand for commitment devices.

2.3 GENDER & SPORT VS. EXERCISE

Intrinsic and extrinsic motivation have been shown to vary depending on the type of activity the individual is engaging in, as well as that individual's gender. Kilpatrick et al. (2005) compare motivations for sports participation and exercise among college students, sampling over 200 students volunteers from health and kinesiology classes at a university in the southeastern United States. They find that participants were more likely to report intrinsic incentives for sport and extrinsic motivations for exercise. Men tended to indicate higher levels of motivation from challenge, competition, social recognition, strength and endurance, with the largest difference for competition. Women were found to rate only weight management higher than men. Behavioral maintenance and adherence is most likely to occur when motivations are intrinsic rather than extrinsic in nature, suggesting that sport participation is linked to more desirable motivational strategies for a physically active lifestyle than is exercise.

Robinson et al. (1982) attempt to determine the personal and environmental factors associated with participants' decisions to either maintain affiliation with a competitive sport team, or to drop out. Their findings reveal a general pattern supporting the idea that individuals involved in group-based activities are more likely to resign from their teams if they are not recognized, appreciated or afforded positive feedback from their involvement. Those who have been socialized to approach competitive sport with a "win at all cost attitude" are less likely to receive meaningful and positive rewards.

Ryan et al. (1997) explore how different motivations for initiating a physical activity relate to sustained participation. They seek to address the gap in understanding of how various sport and exercise activities differ in terms of motivations, experiences and their accompanying outcomes. Specifically, the authors examine how the initial motivational focus of exercise participants predicts their subsequent attendance and adherence in two prospective studies. In the first, Tae Kwon Do and aerobics were compared, based on their participants' reported Motivation for Physical Activity Measure (MPAM). In the second, subjects joining a 'nautilus center' (aquatic center) rated their initial motives on a revised MPAM (MPAM-R), as well as post-workout levels of enjoyment. Results of the first study indicated that Tae Kwon Do participants were higher in 'enjoyment and competence' motives, lower in body-related motives and had better adherence than those pursuing aerobics. Adherence was mediated by enjoyment motives, whereas body-related motives were independent of adherence. This latter finding was supported by the results of the second study, which found that adherence was positively associated with motives of enjoyment, competence and social interaction (akin to the three facets of self-determination theory), but not with motives focused on fitness or appearance. Post-workout ratings of enjoyment also predicted adherence. It is clear from their work that different motives are associated with different types of physical activities, and that intrinsic motivation seems to be a key determinant in adherence to a program.

Sallis et al. examine predictors of adoption and maintenance of vigorous physical activity over time. A sample of more than 1700 randomly selected men and women reported their frequency of vigorous exercise in a mail survey at baseline, and were classified as sedentary, intermediate or active. Participants were asked "During a usual week, about how often do you do physical exercise in your free time for at least 20 minutes without stopping, which is hard enough to make your heart rate and breathing increase a large amount?" The same survey contained 25 potential determinants of physical activity based on a comprehensive learning model (Appendix 3). Two years later, 85% of the subjects were re-surveyed at follow up, and predictors of physical activity were identified. Of those sedentary at baseline, almost 60% reported no vigorous activity at follow-up. The results show that adoption of vigorous activity by sedentary men was predicted by self-efficacy, age and neighborhood environment, and adoption for women was predicted by education, self-efficacy, and friend and family support for exercise. Maintenance of vigorous activity was predicted by self-efficacy and age for men and by education for women. These results suggest an important difference in the factors that influence adoption and maintenance by gender.

Frederick et al. (1993) examine how participation motivation varies by sex of participant and type of activity, as well as the relations between motivational orientation and the levels of participation, using a survey of 376 adults. Few investigations have been done comparing the motivations for different types of activity within the same study, and the Frederick et al. study is particularly rigorous. The researchers constructed a scale to measure three prominent motivations: interest/enjoyment, competence and body-related motivation. Participants completed the MPAM and a participation measure, reporting the number of hours of activity per week as well as the number of days per week they had engaged in physical activity. They were then separated into four groups – an individual sports group, a fitness activity group, a team sports group and an "other" group. Only the first two groups had sufficient respondents to include in the study, and the authors ran regressions to determine correlations between the relevant variables.

Their results show that individual sports are generally motivated by intrinsic incentives while fitness activists tend to be motivated more by extrinsic (body-related) incentives. Motivational orientation was found to significantly differ as a function of activity type. Their findings also suggest that intrinsic or extrinsic motivational approaches in sport are influenced by sex of the participant. Intrinsic motivation is associated with continued activity participation and greater task enjoyment, while extrinsic motivation is associated with lower levels of freely chosen participation and lower task enjoyment. However, total hours of participation were predicted by interest/enjoyment for both groups, which speaks to its importance in promoting physical activity.

3 OVERVIEW OF ROWING

3.1 ORIGINS & ROWING TODAY

Rowing was originally used as a method of man-powered transportation, dating back to the ancient Egyptians and Greeks. Initially, oared vessels were used for transport, commerce, fishing and war, and, while there are few references to racing in classical texts, rowing primarily for exercise, recreation or competition was not common before 1800. The first reference to a race appears in Venetian documentation dating to 1274, and the first recorded water procession was held in London in 1454.

Today, rowing is an Olympic sport. Rowers are among some of the world's most hardened and enduring athletes, including Sir Steve Redgrave and Sir Matthew Pinsent, both of whom won gold medals spanning five consecutive Olympic games – the most of any Olympic athlete. However highly rowing is regarded within the realms of athletics, knowledge of the sport itself – the motion, racing, training – is mostly limited to its participants, their friends and their families.

In the context of physiology, rowers are examined much like a high-level power plant might be: in terms of their ability to convert the chemical energy in their body into kinetic energy, which propels the boat towards the finish line. As a result, training focuses on certain factors in the individual that affect the rate at which energy can be converted. However, before delving into the physiological discussion, a better understanding of rowing - in general - will clarify future points.

3.2 BASIC PHYSIOLOGY OF ROWING

3.2.1 MECHANICS OF THE STROKE, THE BOATS & THE CREW

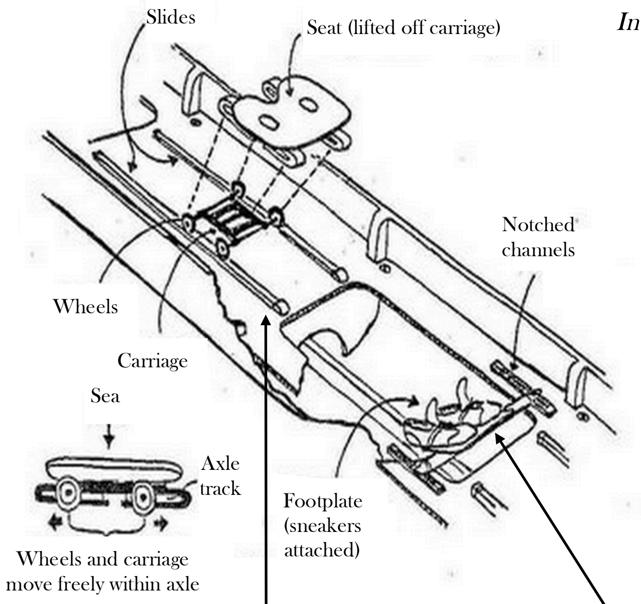


Figure 3.1
Individual rowing seat

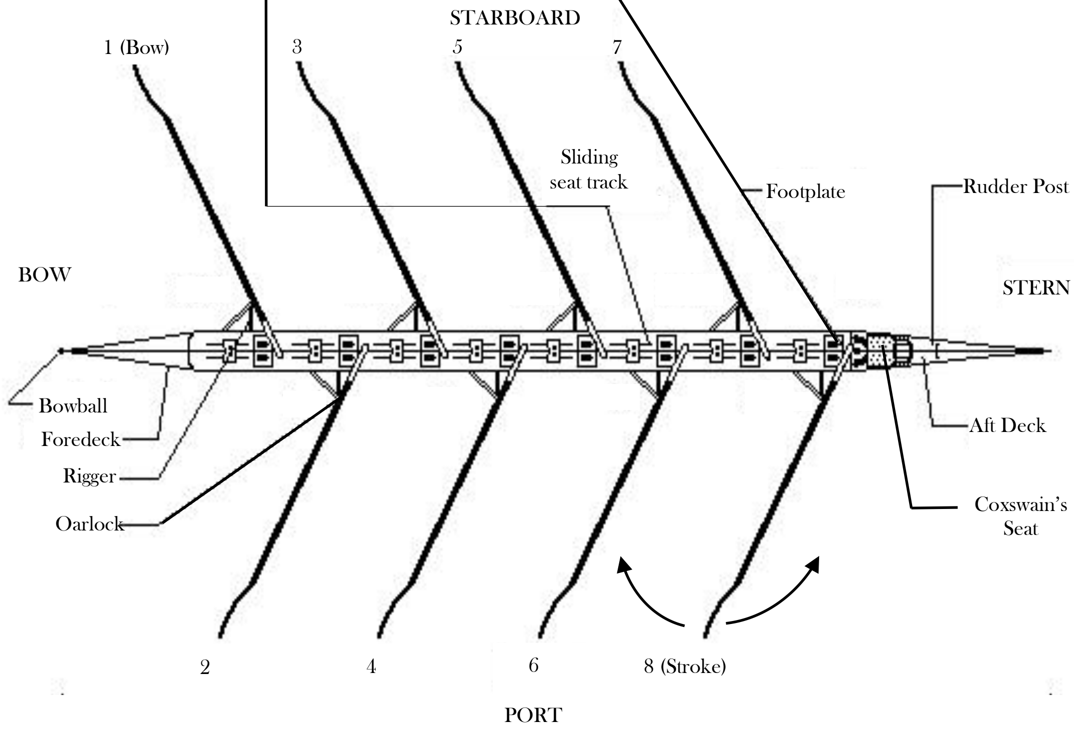


Figure 3.2
Overview of a racing eight

Rowers find themselves in the very unusual predicament of blind racing, facing the opposite direction to the one they are moving. As a result, they must rely on markers or announcements from the coxswain to track their progress through the race. Each oarsman sits on a wheeled seat. By bending or straightening their legs, rowers can move backwards and forwards on tracks ("slides") relative to a fixed footplate, where they strap their feet into shoes that never leave the boat. Each oar is placed into an oarlock (or gate) that has a fixed position relative to the boat, and pivots as the rower takes a stroke.

The stroke itself consists of two basic phases: the drive phase, where the rower has the oar (also called the blade) in the water and is exerting a positive directional force (that is, towards the finish line) on the boat, and the recovery phase, where the blade is out of the water and the rower is sliding forward, creating a negative directional force on the boat. Optimal technique focuses on maximizing the efficiency of this movement: providing the largest positive force possible during the drive, and timing the recovery so as to minimize the negative force (or check) on the boat.

Figure 3.3
A simplified diagram of the rowing stroke, as performed on a stationary ergometer

The start of the drive phase is called "the catch," because of the way the water catches on the face of the blade. In this position, the legs are fully compressed, with the shins forming close to a 90°-angle with the horizontal plane of the boat, and a small gap between the chest and the top of the legs. The body leans forward 20-40°; the arms and back are straight, and the rower's bottom is behind their shoulders. As the rower takes the catch, they lower the oar into the water, loading the weight of the stroke into their arms, while bracing with their core, back (primarily through the latissimus muscles) and shoulders. Ideally, when the weight is fully loaded into the upper body, the bracing of the torso allows the oarsman to push off the footplate with his quadriceps and gluteus muscles, lifting him a centimeter or so off the seat, and starting the prying of the boat through a particular point in the water.

Through the drive, the handle accelerates towards the chest – while the legs straighten, the body pivots 30-50° backwards, opening the upper torso. As the torso passes through the center of its pivot (i.e., when the body is vertically straight), the oarsman engages the arms, finishing the leg drive momentarily before the body swing, and the arm pull momentarily after that. With the handle pulled into their chest, their shoulder blades pinched together, the body leaned 20-30° backwards, and the legs flat, the rower has reached "the finish," where the oar is removed from the water by rolling the blade and lowering the hands ever so slightly. The recovery is essentially this process in reverse; from the finish, the arms are extended away, the body position is held until the elbows begin to straighten, and the handle passes over the oarsman's knees. Then, the body leans forward, with straight arms and legs. This position is referred to as "bodies over" in training. It is important to keep the body in a safe and consistent position as the legs bend towards and away from the catch – improper technique in this particular area is the reason why many amateur rowers suffer back injuries, with varying severity. If the back muscles "jerk" at the catch when the oarsman begins to take the weight, they may be overstrained and tear. A faulty body position is often the result of poor preparation in the recovery phase, so establishing a safe back position is absolutely essential.

In terms of the application of force over the stroke, a good analogy is the difference between kicking a soccer ball and attempting to move a very large rock with your body. The rowing stroke is much more akin to the latter – you would not simply run as fast as you can and slam into the rock: first you would lean into it, applying your body weight, before engaging the various muscles you would use to move it. Similarly, in rowing, it is important to sequence the loading of the weight onto the blade (which happens incredibly quickly, while the athlete is changing direction in the boat) with the application of power to the handle, timed with the movement of the boat along the water and in synchronization with the other oarsmen. The rower applies an equivalent of 40 - 45kg to the oar handle in each of the 220-250 strokes during a 2000m race (Nilsen, 30).

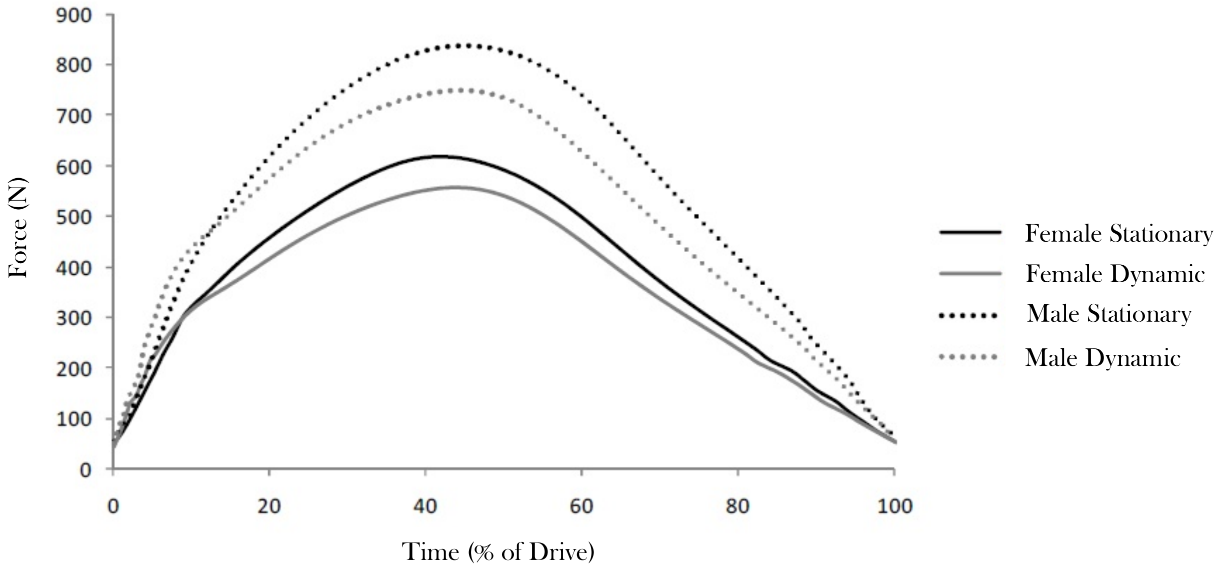


Figure 3.4
Graph of force application (in Newtons) during the drive phase, measured on stationary and dynamic ergometers – during the peak point (45-50% of the way through the drive), the arms, body and legs are all applying force on the water through the oar. This graph is useful for visualizing stroke sequencing.

There are two fundamental types of rowing – sculling, where oarsmen hold two blades, one in each hand, and sweeping, where each crewmember holds only one oar. While the specific mechanics of these two types vary slightly, the only notable distinction for the purposes of this paper are that single scullers (oarsmen who row a boat alone) do not have the same level of relatedness and social motivation in training and competition as those who row in crews. The boats themselves hold between one and eight rowers, and may also hold a coxswain, who provides not only invaluable information on the status of the race, but also tremendous motivation and a certain degree of steering.

SCULLING BOATS					
BOAT	**SYMBOL**	**ROWERS**	**OARS**	**LENGTH (ft.)**	**WEIGHT* (kg)**
Single	1x	One	2	27	14
Double	2x	Two	4	34	27
Quadruple	4x	Four	8	34	52
SWEEP BOATS					
BOAT	**SYMBOL**	**ROWERS**	**OARS**	**LENGTH (ft.)**	**WEIGHT* (kg)**
Pair	2-	Two	2	34	27
Coxless Four	4-	Four	4	44	50
Coxed Four	4+	Four	4	45	51
Eight	8+	Eight	8	62	96

Table 3.1
*A table of different rowing boats (*weight refers to the weight of an empty shell, without rowers or oars)*

Although 2000m races are typically a “straight-shot,” wind and power imbalances can cause the boat to veer left or right, causing the rowers to travel a greater distance and thus lose time on their competitors. The boat can be steered in one of two ways: by varying the pressure on a particular side (that is, either starboard or port), or by using the rudder underneath the hull. Coxing is an easily underestimated activity in the context of rowing: it is easy to see that in terms of physical exertion, the coxswain (or cox) is certainly nowhere near the level of the rowers pulling the boat. Nonetheless, the cox is at least as important as every other member of the crew, if not more so. Using an eight as an example, crewmembers are numbered one (bow) through eight (stroke), where bow is the oarsmen closest to the bow (the front of the boat), and stroke sits closest to the stern (the back of the boat). In an eight, the cox sits in the stern, facing the stroke and the direction of racing towards the finish line, while all eight rowers face the start line. The stroke (number 8, the oarsman closest to the stern) sets the rate, and he and the coxswain work together to ensure that the other seven members of the crew are being paced appropriately.

3.2.2 THE RACE

Almost all international and Olympic racing of note takes place over two kilometers (2000m). These races are called regattas, and typically have 2-8 racing lanes, with a single crew occupying each lane. Although longer racing on rivers takes place during training months, especially in the fall and winter, top oarsmen use the "2-k" race to guide their physiological training. The race itself can be split into three basic phases: the start, middle and finish.

The first 500m of the two-kilometer race sets rowing apart from all other sports: every crew uses a full-out sprint, with artificially high rates between 40 and 50 strokes per minute. These short, choppy, strokes get the boat moving quickly and in as short a time as is possible. No other endurance sport, (cycling, swimming, running) has a comparable start phase to that faced by rowers. Because the body rapidly changes states from being stationary to working at maximum capacity, the energy requirements of the muscles cannot be sufficiently satisfied through aerobic respiration alone. Therefore, the body engages in anaerobic respiration, breaking down glycogen stored in fats and sugars, and producing lactic acid waste, which causes the muscles to lock up, and the pH level of the cells to drop, resulting in an "all-around burning sensation."

At 500m (roughly 90 seconds in), crews lengthen their strokes and drop the rate to between 35 and 40 strokes per minute, beginning the middle phase of the race. During this middle phase, there are two important phenomena occurring in the muscles of the rower – first, the lactic acid and oxygen debt built up by the start phase continues to cause fatigue and pain, especially in the quadricep, hamstring and gluteus muscles; second, the lengthening of the stroke to a more manageable pace allows the rower to increasingly rely on aerobic respiration, using the oxygen intake to address the current energy requirements of the muscle cells. Unfortunately, because of the intense demands of the race, there is not enough oxygenation of the cells to remove the lactic acid built up at the start, despite the fact that lactic acid is no longer being actively produced. Although the claim of using "maximal effort" in the first 500m of a 2km race may seem incredulous, it is this feat precisely which so draws rowers together. Each member of the crew should, if they are racing correctly, be in such a state at 500m, that they have already pushed their body close to or beyond its known limits. How then, do they continue racing for the remaining three-quarters of the race? The fear of letting down the rest of your teammates is why the economic incentives of rowing may be different from so many other sports. I will elaborate on this decision analysis at the end of this section. Typically, rowers settle into a more "paced" mindset than the start: that is, although they are working tremendously hard each stroke, they are more focused on creating a consistent and maintainable boat speed, trading off between the importance of giving each stroke the appropriate amount of effort, and completely "burning out" before the end of the race. The middle phase is 1000-1200m long, beginning at the 500m and ending at 1500-1700m, before the cox calls for the finish sprint.

This final phase of the race is possibly the most excruciating, and certainly the most physiologically burdensome. For the last 300 - 500m, another sprint phase is initiated, this time without reducing the length of the strokes. The rate is raised, quite simply, by each rower increasing their level of work to as high as they possibly can. Again, the crew strikes a cadence of 40-45 strokes per minute, causing the body to begin respiring anaerobically, and lactic acid to start building up in the muscle cells. The idea is to accelerate all the way to the finish line, and at the highest levels of competition, oarsmen are encouraged to abandon the hope of "making it to the line intact."

From a psychological standpoint, there are only a few things to focus on during a race: how hard you are working, how well you have achieved cohesion and alignment with the other members of your crew, where the other crews are relative to your own, and the time and distance remaining in the race. It is the coxswain's responsibility to keep all these variables in check - the rower is simply expected to execute a race with maximum effort, and if necessary to ignore the latter two of the four factors listed above. It has been posited that the only significant difference between crews at the top level is their ability to tolerate pain. Indeed, many oarsmen report, "not remembering the last part of the race," due to exhaustion, fatigue and confusion, and some top-level rowers have immediately fallen unconscious upon crossing the finish line. I now turn to a more detailed discussion of the preparation that makes this sort of energy expenditure possible.

3.2.3 ENDURANCE CAPACITY & TRAINING

Endurance capacity refers to an individual's ability to endure physical activity at a given intensity over time. Rowing training focuses on the adaptations that improve the body's ability to convert energy efficiently and increase this capacity, both with and without the use of oxygen. In aerobic respiration, there are three main systems responsible for this energy conversion: the respiratory system, the circulatory system and the muscular system. Oxygen is absorbed from the air during breathing by the respiratory system, before diffusing through the alveoli in the lungs into the bloodstream. Then, the circulatory system carries the oxygen from the lungs to the heart, where it is pumped through arteries to the rest of the body (namely, the muscles being used in exercise) using hemoglobin in red blood cells. The arteries become smaller and smaller, branching off into thousands of capillaries, which are small enough to surround the individual muscle fibers (Nilsen, 33). Now in the muscular system, the oxygen diffuses through the walls of the capillaries into the muscle cells, where it is taken to the mitochondria and used to convert fuels (glycogen and chemical bonds) to energy.

There are five major components that affect oxygen transportation – lung capacity, the ability of the blood to carry oxygen, the strength and health of the heart, capillary density and the flow of blood to working muscles. However, these five components are not equally important in improving the rower's capacity for oxygen transportation. The respiratory system has been shown to deliver more oxygen to the circulatory system than can be transported in the blood. Thus, lung capacity is not considered a constraint to a rowing athlete's performance. In terms of the circulatory system, any type of exercise that loads the heart can produce an improvement in the blood flow, and thus in oxygen transportation. Within the muscles, the process of taking in and utilizing oxygen in the conversion of fuels to energy has been shown to improve significantly with training, and thus contributes to improved physiological capacity. Many exercise physiologists see the muscular system as having the greatest potential area for improving aerobic metabolism. Training should remain specific to rowing by loading the muscles that are principally used in competition, at a medium weight for a long duration. Aerobic respiration supplies 70-80% of the energy used during the race.

The remaining 20-30% of the energy used in the race is generated through anaerobic respiration. It is worth pointing out that aerobic respiration is 18 times more productive than anaerobic respiration, on average, and does not produce lactic acid. However, anaerobic respiration is necessary due to the combination of energy demands and the high velocity of muscle contractions at the start and finish (Nilsen, 30). During the initial seconds of the race, energy is provided by the chemical bonds stored in the muscle cells. Following these moments, aerobic respiration is simply not sufficient to meet the energy required by the muscle cells. As such the anaerobic metabolic system is initiated to support the high frequency and velocity of muscle contractions used in the process of converting chemical energy to kinetic energy. This is not to say that aerobic respiration does not also occur – the combination of the two is what enables the athlete to maximize the rate at which they convert energy and thus their power output. Training improves the rower's ability to tolerate the accumulation of lactic acid and the mechanism for its removal from the muscle cells (Nilsen, 39).

Following this simplified explanation of rowing physiology, training should target the components that were mentioned to be most limiting to performance and hold the greatest capacity to improve physiological and endurance capacity – the circulatory system, heart, and muscles. Interval training places a demand on the heart that causes it to enlarge and strengthen itself. It is a systematic procedure that alternates between short periods of extremely vigorous work and recovery. A typical example from a rowing session might be a 6 x 500m sprint (either on the ergometer or the water), with 250m paddling in between each piece, to form recovery. The result will be a higher cardiac output and therefore an increased capacity to pump oxygen to the muscles.

The goal in training the muscle cells is to increase the number and density of capillaries surrounding muscle fibers, which would allow for increased oxygen uptake and lactic acid removal by the muscular system. Long distance training utilizes long periods of work at medium to high levels of intensity, which increases the number of functional capillaries around the muscle fibers (Nilsen, 42). A typical example from a rowing session might be a 100-minute workout, starting on the ergometer, and alternating between the ergometer and the stationary bike every 20 minutes. Since the muscular system has the greatest potential for improvement, it makes sense to train this component of physiological performance most frequently. As a result, much of rowing training is very long, steady state sessions. An added benefit of this training is that it increases mental toughness, which, as John Seabrook mentioned, becomes increasingly important the higher you rise in the sport. Further, at the top level, the physiology of each rower is not significantly different: they are all within a comparable degree of physiological efficiency. It is not this but rather mental and physical toughness that distinguishes faster crews from slower ones. As such, long, steady sessions on the rowing machine comprise an increasing proportion of the total training.

3.3 EFFECTS OF ROWING ON EXERCISE INCENTIVES

3.3.1 EFFECTS OF RACING ON INCENTIVES

Sustained exposure to competitive racing can change the nature of the incentive structure for an individual. The 500m mark of the race illustrates how incentives in rowing can be primarily extrinsic, rather than intrinsic. At this point, the oarsman is experiencing fatigue, and the burning sensation of lactic acid all over the body. However, sitting directly in front of and/or behind him are two men experiencing the exact same cost, yet they continue to row. In that instant, it is economically rational to row as hard as you can only if the perceived net benefits of doing so exceed the net costs of the next alternative. In other words, you feel as though you owe it to yourself and the crew, to be contributing to the boat speed as much as you possibly can, to such an extent that the overwhelming physiological pain does not deter you. In economic terms, we have a decision model with asymmetric information: each rower knows how hard they are working, but can only guess at (or trust in) the level of effort invested by their teammates. Their potential benefit is a function of not only their own efforts, but also the entire crew's.

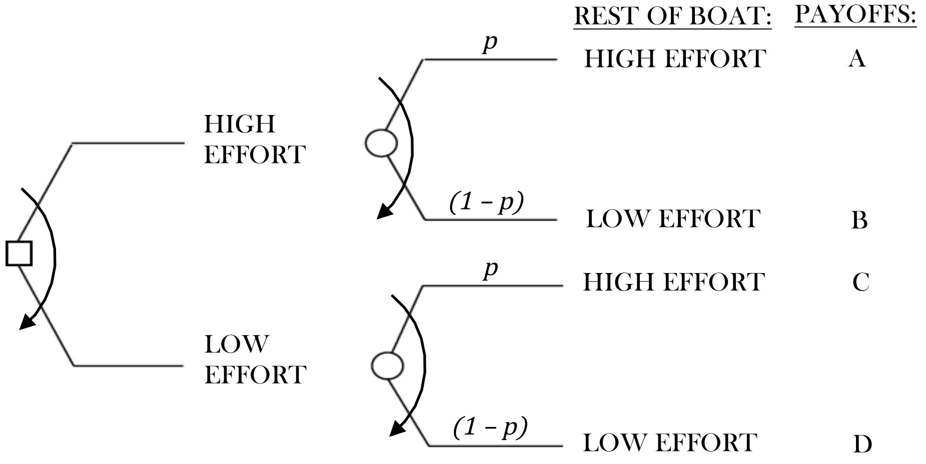


Figure 3.5
A simple decision tree illustrating the rower's decision at 500m, and the associated uncertainty of reciprocated effort on the part of the team

If, crossing 500m, you feel as though it is unlikely that your teammates will provide you with a level of support that justifies your extreme efforts (that is, p from Figure 3.5 above, is small), you are more likely to row with less effort. These group dynamics can be discussed at length, but the key takeaway point is that relatedness, cohesion and trust are essential parts of a rowing team's success, and may change the incentive structure of the rower as they are exposed to more competitive racing. In a rational decision maker, the expected utility of the payoffs from rowing with high effort must exceed the expected utility of the payoffs from rowing with low effort in order for high effort to be chosen. This varies from individual to individual, depending on the size and ordering of the payoffs, A, B, C, and D in Figure 3.5, (which could vary by importance of the competition, or the valuation of each other's success), as well as their preferences. Put simply, the condition for each rower, i, to rationally choose high effort is given as follows:

$$p(\, u_i(A_i)) + (1-p)(\, u_i(B_i)) > p(\, u_i(C_i)) + (1-p)(\, u_i(D_i)) \tag{3.1}$$

In addition, rather astoundingly, three-quarters of the race is extrinsically motivated: the agent (rower) is regulating their effort based on the obligations they feel to their teammates. Indeed, racing the last 1500m of the race could be seen to decrease intrinsic incentives derived from autonomy (the degree to which the individual feels they are conducting and executing activities based on their own endemic motivation, as opposed to that drawn from supporting others). The degree of success in racing can also affect the incentive structure. If you frequently win races, the brain is accustomed to associating the high levels of effort with the personal satisfaction derived from victory. It may be that future bouts of personal or individual exercise do not offer enough scope for achievement to motivate certain past rowers.

We see, then, that exposure to competitive racing alters perceived incentives. The level of intrinsic motivation can increase through relatedness (sharing in an experience that draws the team closer together and increases interrelation among the athletes), but can also be decreased by reducing feelings of autonomy. Further, long-term exposure to racing can increase the proportion of motivation that is extrinsic. Self-regulation of effort at 500m into the race serves as an illustration of this.

3.3.2 EFFECTS OF TRAINING ON INCENTIVES

Rowers experience tremendous amounts of pain during exercise, which has two notable effects on their perception of incentives. The first is to increase pain tolerance and familiarity, which lowers both the actual and perceived costs of future exercise. This effect could be indicated by increased beliefs about self-efficacy (McAuley et al.), and decreased reported barriers to exercise. The second effect is to associate exercise with being in pain, and to evaluate the success of a particular workout based on how close you were to achieving maximum energy expenditure. It is intuitive that if the base level of expected exercise duration, frequency and intensity increases, future exercise participation will be compared to the increased expected level. As a result, rowers, along with other endurance athletes, have a tendency to polarize their exercise expectations – they either exercise very intensely, at maximum capacity, or they simply do not exercise. Over time, these perceptions can be addressed either through conscious monitoring (i.e., awareness of the polarization, and self-regulating the duration, frequency and intensity of exercise) or through adjusted circumstantial factors, such as no longer being part of a competitive, high-level sports team. In any case, training as an Olympic rower is certainly not sustainable over an entire lifetime, and is definitely not the optimal way to achieve long-term, sustained exercise maintenance.

The entire purpose of training is to improve the efficiency of the physiological mechanisms responsible for converting muscle cells and glycogen into energy and power output. Training for many years usually results in the development of several adaptations within the three primary oxygen transportation systems, most notably in the muscular system, through an increase in the number and density of capillaries. The goal is to improve the maximum aerobic metabolic rate, called VO_2max, which is the difference between the oxygen proportion of inhaled air (which we know to be 20.9%) and exhaled air. VO_2max is measured in liters per minute (l/min) and has been observed at 6.2 l/min and 4.4 l/min for international heavyweight male and female rowers, respectively (Nilsen, 42). Successful training will reduce the physiological costs of exercise for each level of output. That is, for a given energy output, the body of a well-trained oarsman need not work as hard as an untrained one. This effectively reduces the physiological cost function of exercise for every energy level.

In her paper *Rowers' High*, Emma Cohen examines how behavioral synchrony among rowers in training can improve the levels of pain tolerance. Since measuring the levels of endorphins in the blood requires a highly invasive lumbar puncture to cross the blood-brain barrier (Cohen, 1) researchers investigated pain tolerance, as a proxy for 'opioidergic' endorphin surges from exercise. Using twelve Oxford University oarsmen, Cohen and her team used blood pressure cuffs to induce pain on the non-dominant arm of the athletes, measuring the pressure at which they asked the researchers to stop pre- and post-workout. The oarsmen were given a structured exercise program, with several independent 'solo' training sessions, and only a few group workouts. The results of the experiment showed that the differences in post-workout levels of pain tolerance across training styles (alone vs. with the team) were statistically significant: pain tolerance was shown to dramatically increase following training synchrony, as compared to training in isolation.

The psychological effects of training on incentives can be very different. What seems clear is that, during their participation in competitive rowing, participants derive their incentives primarily from extrinsic motivators, rather than intrinsic ones. Whilst initiation in the activity can be intrinsically motivated, the physiology of rowing clarifies that there is a tremendous cost of pain during intense training and racing, which suggests that time-inconsistent preferences come into play. The intrinsic motivation is crowded-out due to the irrational bias towards present events – the pain is overvalued and the benefits undervalued. However, the extrinsic motivation from the fear of letting down your team is crowded-in, allowing for sustained motivation to continue rowing. What is very much unclear is how the removal of these incentives (competition, relatedness, group mentality) affects the ways in which former rowers maintain their exercise habits.

3.4 SUMMARY OF RELEVANT POINTS

- Rowing is an Olympic sport characterized by high physiological demands arising from the rapid conversion of energy
- Aerobic respiration is used in conjunction with anaerobic respiration, the latter causing lactic acid buildup and a burning sensation in the muscles
- Success in rowing is primarily determined by mental fortitude and psychological pain tolerance, especially as the level of performance rises, since physiological adaptations differ less substantially among the highest level athletes
- Cohen (2015) has shown that behavioral synchrony in rowing training can lead to increased post-workout levels of pain tolerance, suggesting that relatedness and social trust are key drivers of success and thus exercise in rowers
- The sprint start in racing is what distinguishes rowing from other lifestyle endurance sports (swimming, running & cycling)
- As a result, roughly three-quarters of the race is extrinsically motivated by introjected regulation, as the idea of letting your teammates down fills you with guilt
- Training in rowing targets the heart and muscles in particular
- Training increases rowers' pain tolerance and familiarity, which can have massive impacts on their exercise intensity and physiological output
- However, this pain tolerance may also polarize rowers' attitudes towards exercise, measuring the success of a particular workout on the degree to which they met their maximum energy expenditure
- Literature has shown that predictors of exercise maintenance are primarily intrinsic incentives, whilst I believe incentives among rowers will be primarily extrinsic.

4 METHODOLOGY

4.1 APPROACHING THE PROBLEM: BENEFIT GAPS

Figure 4.1 illustrates how a given individual fails to account for their own optimal level of exercise, as well as the socially optimal level of exercise. The graphs are constructed to scale, with the exception that the vertical scale on the total benefit graph is halved (that is, the true gap between perceived TPB and TSB is in fact twice as large). Though these curves are simplifications of a complex system, the relationship above shows a systematic upward shift of the benefit curves. Each time a hyperbolic discounter evaluates a particular instance of exercise, they fail to capitalize on the welfare gains available, by an amount equal to the difference in peak height between the TSB and perceived TPB curves. Inactivity of these levels results in massive welfare losses to the individual and imposes significant costs on society.

It is clear from the literature review that there are, primarily, three reasons for the gap in socially optimal levels of exercise: time-discounting (irrationality), crowding-out of information by the "personal health" industry (information asymmetry) and the burden generated by obesity, which is erroneously allocated by the healthcare and insurance systems (negative externality). Given these 'market' failures, what behaviors separate those who successfully maintain healthy exercise from those who do not? Which of these behaviors are the leading predictors of exercise adherence? Empirical results support the idea that predictors of adherence tend to be intrinsic rather than extrinsic in nature. We also see that there are differences across gender, and the nature of the activity (sport or exercise) that alter the incentive structure: women tend to be motivated more by image and body-related incentives, whereas men tend to report higher levels of motivation from competition. Those playing sports tend to report higher levels of intrinsic motivation, whereas those completing exercise regimens lean towards extrinsic incentives.

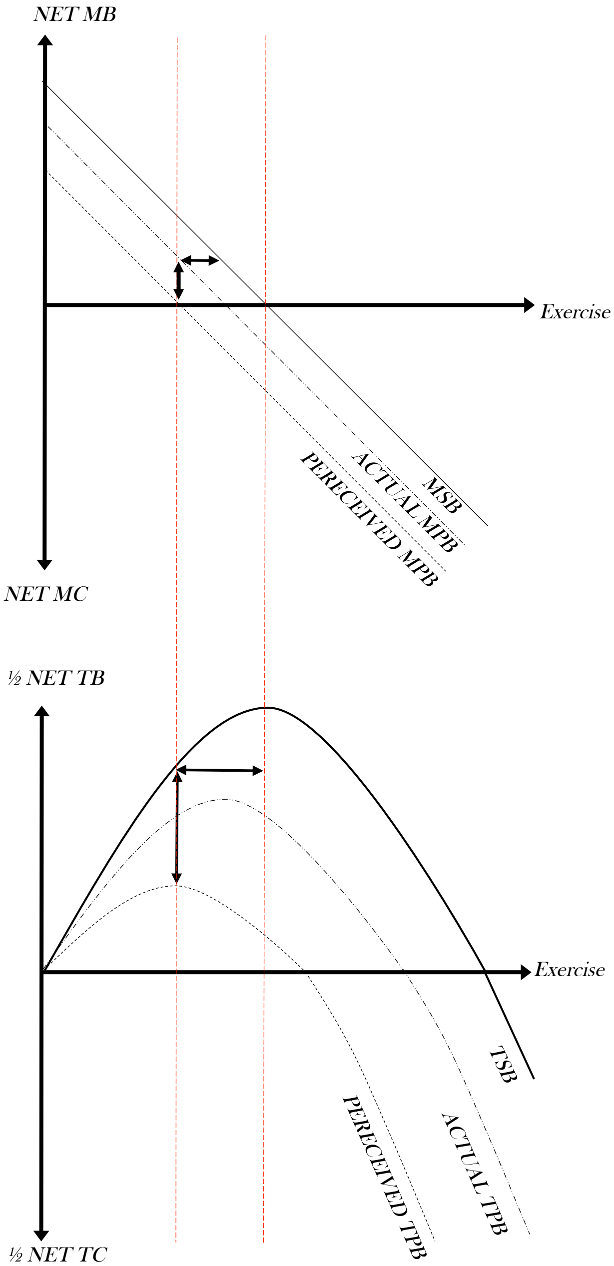


Figure 4.1. *Visualizing problems in the editing stage*

MARGINAL BENEFIT GAPS:

These three curves serve as a basic visualization of diminishing marginal returns to exercise. The first gap, between perceived and actual marginal private benefit (MPB) represents the gap in information and hyperbolic discounting due to time-inconsistent preferences. The second, between actual MPB and marginal social benefit (MSB) represents the externality: the difference between the optimal private level and optimal social level.

TOTAL WELFARE GAPS:

Negative gaps in marginal benefit translate to under-consumption of a given good. The welfare loss is the difference between the areas underneath the MSB and Perceived MPB curves. This is equivalent to the difference in peaks between the Total Social Benefit (TSB) curve and the Perceived Total Private Benefit (TPB) curve. The vertical scale on the Total Benefit graph is halved for spacing. That is, the true gaps are twice as large.

It seems that society distinguishes between certain sports (e.g. rowing, swimming, running, cycling) that focus much more on elements of performance, whilst others (e.g. basketball, baseball, tennis, rugby) focus on elements of a game. Because these activities are fundamentally different, it is reasonable to assume their motivational profiles (that is, the composition of their incentive structures) are also different. It would be strange, for example, to compare basketball and rowing in a one-dimensional analysis, such as "which is the better sport?" Answering this question requires the comparison of many different facets of each activity, and will likely result in an answer that is far from objective. Similarly, asking a professional basketball player "which sport do you prefer: basketball or rowing?" however redundant, would elicit a very different response from asking an Olympic rower the exact same question. Suppose you are fortunate enough to encounter an individual who meets either of these descriptions - it is hardly impossible to consider that each athlete would describe their respective sport as worthwhile, and perhaps 'better' for different reasons.

Further, if we expect athletes of different sports to have completely different motivational profiles, we would also expect athletes of sports that are similar in nature or intensity to have similar motivational profiles. However, it is just as straightforward to suppose that two individuals might enjoy doing the same thing for different reasons. The purpose of the analysis is to examine how different incentives for exercise predict maintained levels of physical activity. Rowing serves as an interesting point on the sport-exercise spectrum: the competition and camaraderie lend it to the world of sport, yet a large portion of the time spent as a rower includes behavior that better represent individual exercise practices. I surveyed current and former rowers in a cross-sectional inquiry of their incentives for physical activity, and will run regression and ordered logit analyses on both intrinsic and extrinsic motivators of exercise.

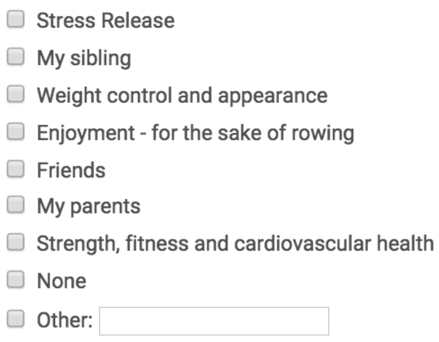
4.2 DESCRIPTION OF SURVEY, VARIABLES & DATA

Participants included current university rowers, and former high school and university rowers, aged 18 or older at the time of the survey. On February 17th, 2015, the survey was distributed via Google Forms to over 130 different coaches at US universities to pass on to members of their team, as well as any relevant former members of their team. Additionally, I was able to reach out to significant numbers of current and former rowers in the United Kingdom. Respondents maintained complete anonymity, in the interest of producing unbiased results. The survey contains 14 questions, some of which are separated into multiple parts (Appendix 4). In addition to the sections below describing the survey questions, basic circumstantial information (birth year, gender, undergraduate university, height and weight) was reported for each participant.

4.2.1 ROWING CAREER MEASURES

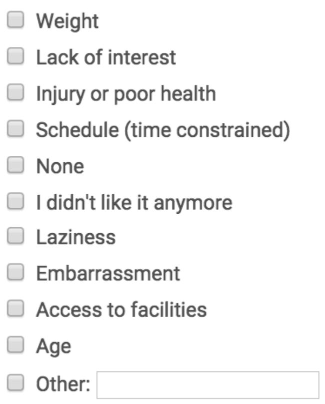
` Information was gathered on each participant's rowing career. Ages of initiation and cessation were recorded, which allowed me to deduce the number of years spent as a competitive rower. Respondents were also asked to indicate which factors, among a small selection, contributed to their decision to start rowing (Figure 4.2), as well as those that contributed to their decision to stop (Figure 4.3).

Figure 4.2. *Question 4(b) "Which of these, if any, contributed to your decision to start rowing?"*



☐ Stress Release
☐ My sibling
☐ Weight control and appearance
☐ Enjoyment - for the sake of rowing
☐ Friends
☐ My parents
☐ Strength, fitness and cardiovascular health
☐ None
☐ Other:

Figure 4.3. *Question 5(b) "Which of these, if any, contributed to your decision to stop rowing?"*

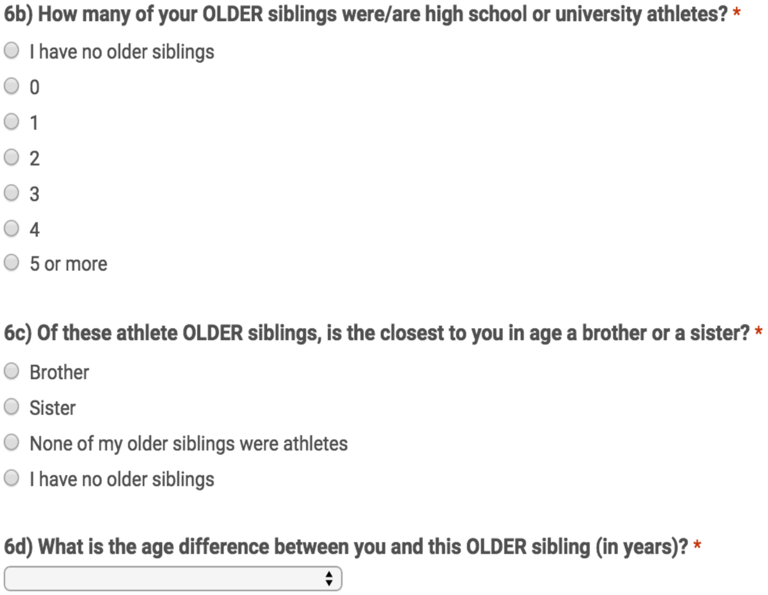


☐ Weight
☐ Lack of interest
☐ Injury or poor health
☐ Schedule (time constrained)
☐ None
☐ I didn't like it anymore
☐ Laziness
☐ Embarrassment
☐ Access to facilities
☐ Age
☐ Other:

These questions serve to address the conversation on incentives to exercise initiation and relapse into sedentary behavior. In terms of initiation, "Stress Release, Friends," and "Enjoyment – for the sake of rowing," relate to intrinsic motivations of autonomy, relatedness and competence. All others relate to regulatory extrinsic incentives. There could be cases made for "My Sibling" and "My parents," to be intrinsic incentives, since they may also represent feelings of relatedness. In my analysis, I will assume that these are extrinsic incentives relating to competition and regulation. I predict that current exercise levels will vary negatively with these extrinsic initiation incentives, and positively with the intrinsic ones.

Further, I believe that age of initiation and cessation, as well as the duration of an individual's rowing career should have an impact on their current exercise habits. I suspect that, for a particular respondent, younger age of initiation, older age of cessation and (as a result) greater duration of competitive exposure will all increase the probability of successful exercise maintenance. The intuition supporting these predictions is as follows: first, exposure to physical activity at a young age has a positive impact on beliefs about self-efficacy (McAuley et al., 1993), which in turn predicts increased physical activity levels. Second, repeated and sustained exposure to physical activity increases the probability of the individual developing habitual exercise behavior. (On the other hand, assuming a non-zero probability of injury, increasing the duration of rigorous physical activity certainly increases the likelihood of becoming injured over one's athletic career). Finally, it is assumed that older individuals are more likely to be aware of the importance of physical activity than younger individuals. Since these individuals have already successfully overcome the barriers to initiating and maintaining regular physical activity, an increased age of cessation is expected to be associated with a smaller information gap between perceived and actual benefits (see Figure 4.1, above). That is, an individual who stops rowing at an older age will maintain physical activity more effectively, because they are more likely to be informed on the importance of doing so than their younger counterparts. In the dataset, initiation and cessation variables were used as indicators, coded as 0 if left blank or 1 if the respondent made the selection.

4.2.2 FAMILY EFFECTS: PARENTS & SIBLINGS



6b) How many of your OLDER siblings were/are high school or university athletes? *

○ I have no older siblings
○ 0
○ 1
○ 2
○ 3
○ 4
○ 5 or more

6c) Of these athlete OLDER siblings, is the closest to you in age a brother or a sister? *

○ Brother
○ Sister
○ None of my older siblings were athletes
○ I have no older siblings

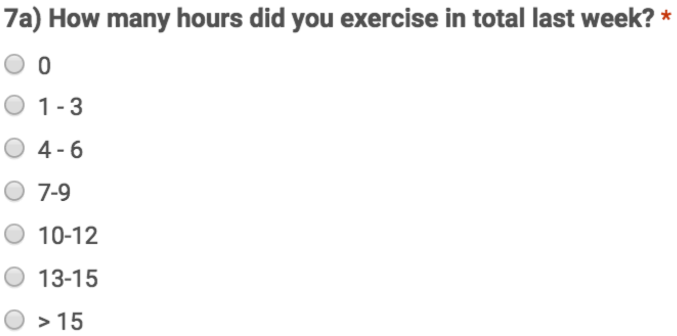
6d) What is the age difference between you and this OLDER sibling (in years)? *

Figure 4.4 *Question 6(a) asked, "How many of your parents were athletes at university?" Question 6(b)-(d) are repeated in questions 6(e)-(g), with the word OLDER replaced with the word YOUNGER, in the questions and response options.*

Question 6 - broken down into parts (a) through (g) – asks respondents to report relevant information about their parents and siblings. Specifically, I wanted to measure how the number of older or younger athlete siblings, or the number of athlete parents affected physical activity incentives, and current levels of exercise maintenance. For respondents with more sibling and parent athletes, I predict lower initiation ages, longer career durations and higher levels of current exercise, on average. I also anticipate that these effects will be exacerbated for respondents with siblings of the same gender, and siblings with smaller age gaps. Respondents who have older siblings or parents who were rowers are significantly more likely to be exposed to rowing at a younger age, or try it as a result of their sibling trying it.

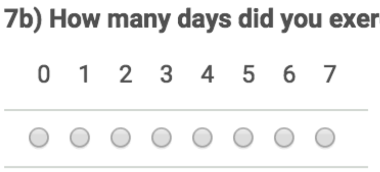
In the dataset, I created variables to measure whether or not siblings were the same gender as the respondent, coded as a 0 for respondents with siblings of different genders, and 1 for brother-brother and sister-sister pairs. In question 6a) “How many of your parents were athletes at university?” respondents were given the choices 0, 1, 2 or “I’m not sure.” In the analysis, statistics regarding the number of parent athletes are taken from the 284 respondents who listed 0, 1 or 2. Individuals who listed “I have no older/younger athlete siblings” were coded as 0, just like those who replied 0. In other words, I did not distinguish between those without siblings and those with siblings who were not athletes, in my analysis.

4.2.3 CURRENT EXERCISE



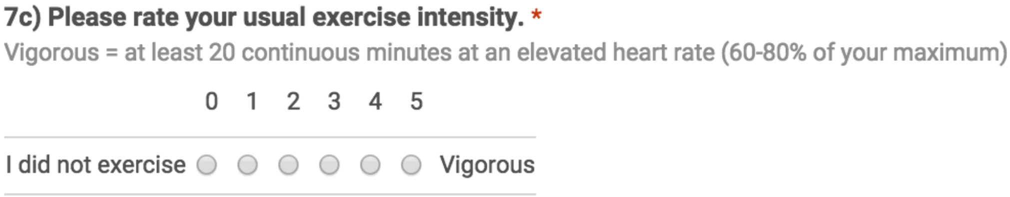
7a) How many hours did you exercise in total last week? *

○ 0
○ 1 - 3
○ 4 - 6
○ 7-9
○ 10-12
○ 13-15
○ > 15



7b) How many days did you exercise, last week? *

0	1	2	3	4	5	6	7
○	○	○	○	○	○	○	○



7c) Please rate your usual exercise intensity. *

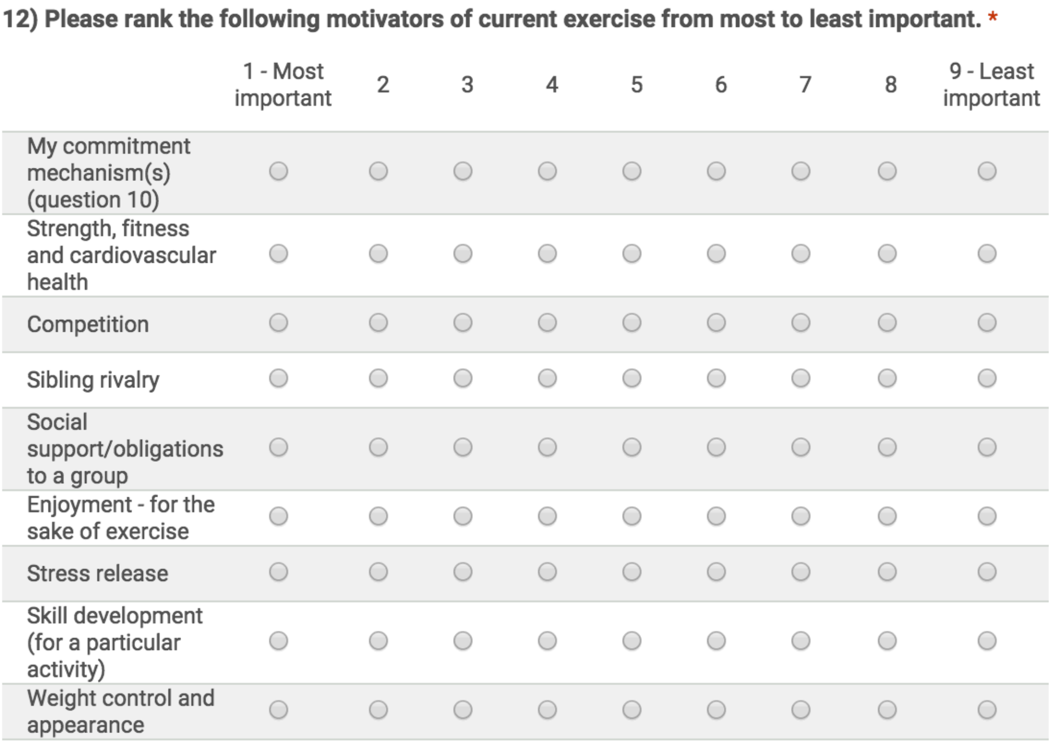
Vigorous = at least 20 continuous minutes at an elevated heart rate (60-80% of your maximum)

	0	1	2	3	4	5	
I did not exercise	○	○	○	○	○	○	Vigorous

Figure 4.5 *Measures of current exercise hours, frequency and intensity*

Questions 7 through 12 ask respondents to report information on their current exercise habits. Current weekly hours, days and intensity of exercise are measured in questions 7(a)-(c). In the dataset, these were recorded as *activity_class, exercise_frequency,* and *exercise_intensity,* and were coded as 0-6, 0-7 and 0-5, respectively. This is especially relevant for the ordered logit analysis, discussed in the next section. Question 7(d) asked “Was last week a typical week of exercise for you?" enabling respondents to indicate whether or not they usually exercise more or less than they did last week, the idea being to avoid recording information that is not representative of typical habits. Question 7(e) asked respondents to record their primary exercise activity, from a selection of rowing, biking, walking, running, swimming, none or "other," where they were able to enter another activity. Question 8 asked the respondent "Do you wish you exercised more or less?" to measure contentment with their current regime. These responses were coded between -5 (I wish I exercised a great deal less) and 5 (I wish I exercised a great deal more). Respondents were also asked to list "Which, if any, barriers prevent you from exercising currently?" in question 9, among a selection of barriers including age, weight, embarrassment, injury, lack of interest, laziness, schedule, access to facilities, "I dislike exercise," and "other."

To measure self-efficacy, question 10 asked, "How strongly do you believe you will achieve the exercise goals that you set?" ranking the responses on a scale from 1 (lowest) to 10 (highest), which was recorded in the data numerically. Question 11 inquired about the commitment mechanisms used by the respondent to adhere to their exercise program. Answer choices included "workout communities (family and friends), workout reward apps, gym membership or workout classes, personal reward or punishment scheme, exercise schedule/fitness program, other" or "I don't use any mechanisms." In the dataset, these responses were coded as 0/1 indicators. Last, respondents were asked to rank incentives for current exercise in question 12:



12) Please rank the following motivators of current exercise from most to least important. *

	1 - Most important	2	3	4	5	6	7	8	9 - Least important
My commitment mechanism(s) (question 10)	○	○	○	○	○	○	○	○	○
Strength, fitness and cardiovascular health	○	○	○	○	○	○	○	○	○
Competition	○	○	○	○	○	○	○	○	○
Sibling rivalry	○	○	○	○	○	○	○	○	○
Social support/obligations to a group	○	○	○	○	○	○	○	○	○
Enjoyment - for the sake of exercise	○	○	○	○	○	○	○	○	○
Stress release	○	○	○	○	○	○	○	○	○
Skill development (for a particular activity)	○	○	○	○	○	○	○	○	○
Weight control and appearance	○	○	○	○	○	○	○	○	○

Figure 4.6
Question 12: ranking motivators of current exercise

The options "Enjoyment – for the sake of exercise," "Social Support/obligations to a group," and "Skill development (for a particular activity," serve as proxies for intrinsic incentives derived from self-determination theory - autonomy, relatedness and competence (Deci & Ryan, 1985). The remaining options, with the possible exception of stress release, are extrinsic in nature.

Consider three individuals who exercise not at all, a moderate amount and a great deal, who ranked "Competition" at 4, 6 and 8, respectively. For these variables, as the competition ranking increases in number, individuals would exercise more. In order to make the coding more intuitive, I multiplied the rankings by negative one.

4.3 ORDERED LOGIT METHODOLOGY

4.3.1 UNDERLYING FORMULAE

To measure the impact of these variables on current levels of exercise, I will use an ordinary least squares (OLS) regression, and an ordered logit analysis. The results of the OLS regression will be more accessible and widely understood than the ordered logit. However, since respondents were limited to a set of discrete choices, an ordered logit analysis may be more appropriate in determining the true effects of certain variables on activity class, exercise frequency and exercise intensity.

An ordered logit analysis is used in the case of a categorical, ordered dependent variable. Under these circumstances, the difference between the outcomes may not be uniform, even if they are coded numerically to distinguish between types. In this case, an ordered logit regression provides a superior prediction of the probability of an attribute than an OLS regression (Pohlman & Leitner, 2003). To approximate the dependent variable, the ordered logit assumes the following function, presented in general form:

$$y_i^* = \boldsymbol{x}_i'\beta_i + \varepsilon \tag{4.1}$$

In this equation, y_i^* represents the true outcome, which is predicted by some vector of the independent variables, $\boldsymbol{x}_i'$, multiplied by our desired vector of estimated regression coefficients, β_i. As a foreshadowing example, assume we are predicting the activity class of a particular respondent using the dependent variable, y_i:

$$y_i = j \ \text{ if } \alpha_{j-1} < y_i^* \leq \ \alpha_j \tag{4.2}$$

Here, $j = \{0, 1, 2, 3, 4, 5, 6\}$ and α indicates the threshold values for a particular category. In an ordered logit analysis where the dependent variable has n categories, there will be $n - 1$ threshold α values. Consider our respondent's answers to question 12, and permit the underlying assumption that activity class is predicted only by the autonomy, competence and relatedness rankings significantly. We are interested in finding out how information about their autonomy, competence and relatedness rankings can yield predictions about their level of physical activity. However, all we know is that their activity class can be one of seven categories, from zero to six. To estimate the probability that a particular respondent, i, is in category j, the ordered logit uses the function:

$$p(y_i = j) = p\left(\alpha_j < y_i^* \leq \alpha_{j-1}\right) = F\left(\alpha_j - \boldsymbol{x}_i'\beta\right) - F\left(\alpha_{j-1} - \boldsymbol{x}_i'\beta\right) \qquad (4.3)$$

Where F is the inverse logistic function: $F(z) = {e^z}/{(1 + e^z)}$ (4.4)

Suppose we wish to predict the probability that the respondent is in the second activity class, coded as one, since the first activity class is coded as zero. The underlying formulae for this prediction would be:

$$F(\alpha_2 - \boldsymbol{x}_i'\beta) - F(\alpha_1 - \boldsymbol{x}_i'\beta) \qquad (4.5)$$

Where $\boldsymbol{x}_i = \begin{pmatrix} autonomy_i \\ relatedness_i \\ competence_i \end{pmatrix}, \beta_i = \begin{pmatrix} \beta_{autonomy} \\ \beta_{relatedness} \\ \beta_{competence} \end{pmatrix}$

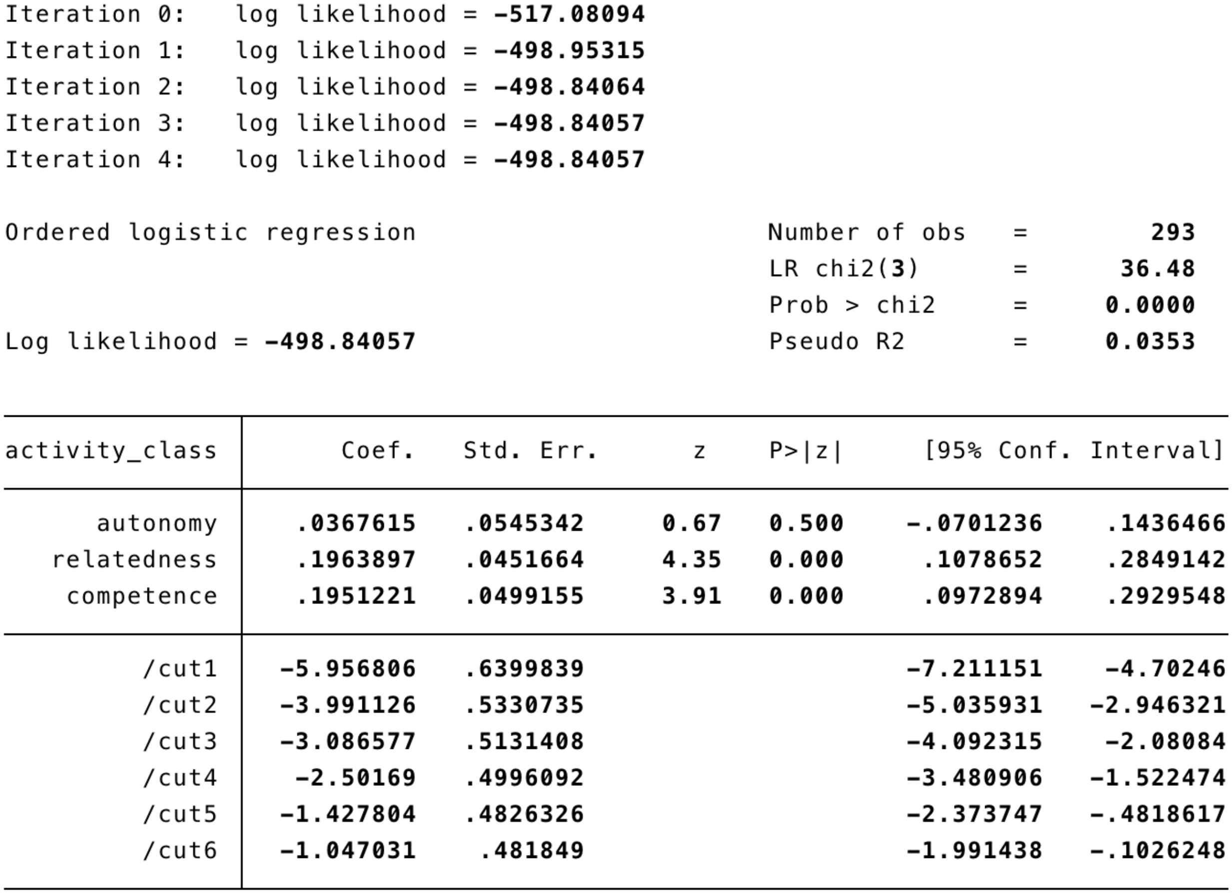
The value of α_2 is determined by the '/cut2,' value denoted in the STATA output as -3.991. The value of α_1 is shown to be -5.9557. So, the final inputs for the function $F(z)$ is:

$$z_2 = -3.991 - \begin{pmatrix} autonomy_i \\ relatedness_i \\ competence_i \end{pmatrix} * \begin{pmatrix} \beta_{autonomy} \\ \beta_{relatedness} \\ \beta_{competence} \end{pmatrix}$$

$$z_1 = -5.957 - \begin{pmatrix} autonomy_i \\ relatedness_i \\ competence_i \end{pmatrix} * \begin{pmatrix} \beta_{autonomy} \\ \beta_{relatedness} \\ \beta_{competence} \end{pmatrix} \qquad (4.6)$$

4.3.2 STATA OUTPUT & INTERPRETATION

To investigate the relationship between the reported intrinsic motivation rankings and the respondent's activity class, we would run the STATA command `ologit activity_class autonomy relatedness competence`, in the dataset. Figure 4.6 shows the raw output:



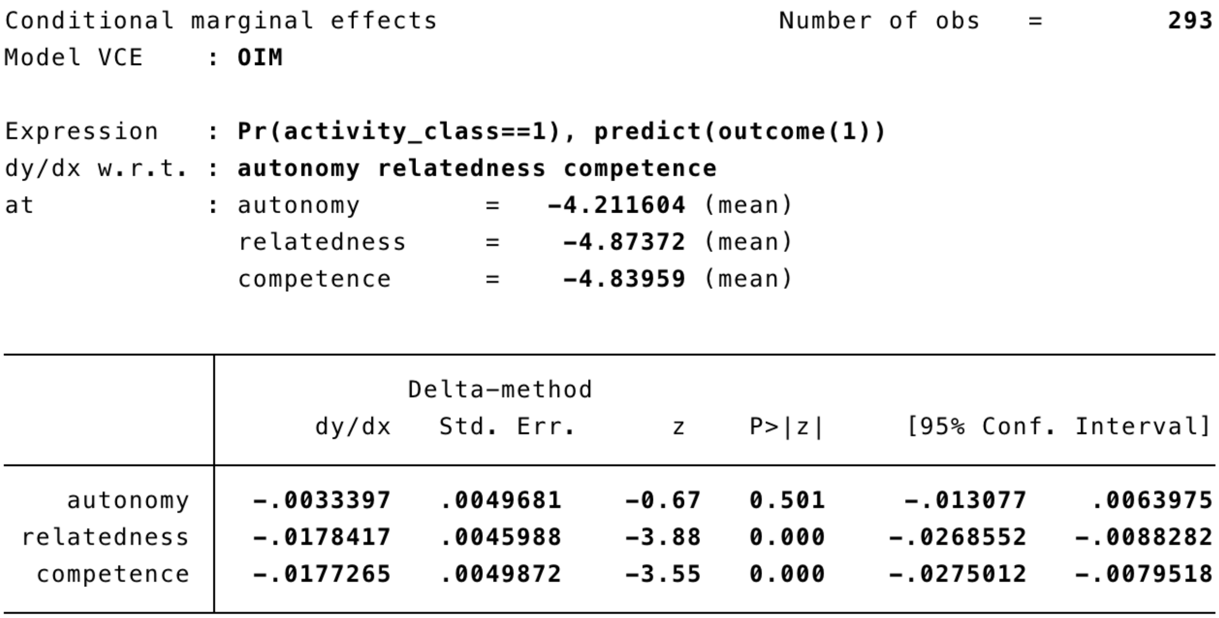
```
Iteration 0:   log likelihood = -517.08094
Iteration 1:   log likelihood = -498.95315
Iteration 2:   log likelihood = -498.84064
Iteration 3:   log likelihood = -498.84057
Iteration 4:   log likelihood = -498.84057

Ordered logistic regression                     Number of obs   =        293
                                                LR chi2(3)      =      36.48
                                                Prob > chi2     =     0.0000
Log likelihood = -498.84057                     Pseudo R2       =     0.0353

------------------------------------------------------------------------------
activity_class |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
---------------+--------------------------------------------------------------
      autonomy |   .0367615   .0545342     0.67   0.500    -.0701236    .1436466
   relatedness |   .1963897   .0451664     4.35   0.000     .1078652    .2849142
    competence |   .1951221   .0499155     3.91   0.000     .0972894    .2929548
---------------+--------------------------------------------------------------
         /cut1 |  -5.956806   .6399839                     -7.211151    -4.70246
         /cut2 |  -3.991126   .5330735                     -5.035931   -2.946321
         /cut3 |  -3.086577   .5131408                     -4.092315    -2.08084
         /cut4 |   -2.50169   .4996092                     -3.480906   -1.522474
         /cut5 |  -1.427804   .4826326                     -2.373747   -.4818617
         /cut6 |  -1.047031    .481849                     -1.991438   -.1026248
------------------------------------------------------------------------------
```

Figure 4.6 *STATA display for ordered logit regression*

The dependent variable, activity class, differs from the independent variables by a scale factor. As a result, the magnitude of the coefficients cannot be determined from this analysis, only the direction of their variation with the dependent variable (Katchova, 2013). Here we see that autonomy, relatedness and competence rankings vary positively with activity class. Examining the 'cut' values is important for determining whether the categories are significantly different, or whether they should be combined.

Suppose we wish to examine the marginal effects of the independent variables. That is, what is the change in $p(activity\_class_i = 1)$, for a one-point increase in the intrinsic motivation rankings. In STATA, we run the command `margins, dydx(*) atmeans predict(outcome(1))`, which gives the following predictions of marginal effects on the outcome probability, at the mean level for each independent variable:

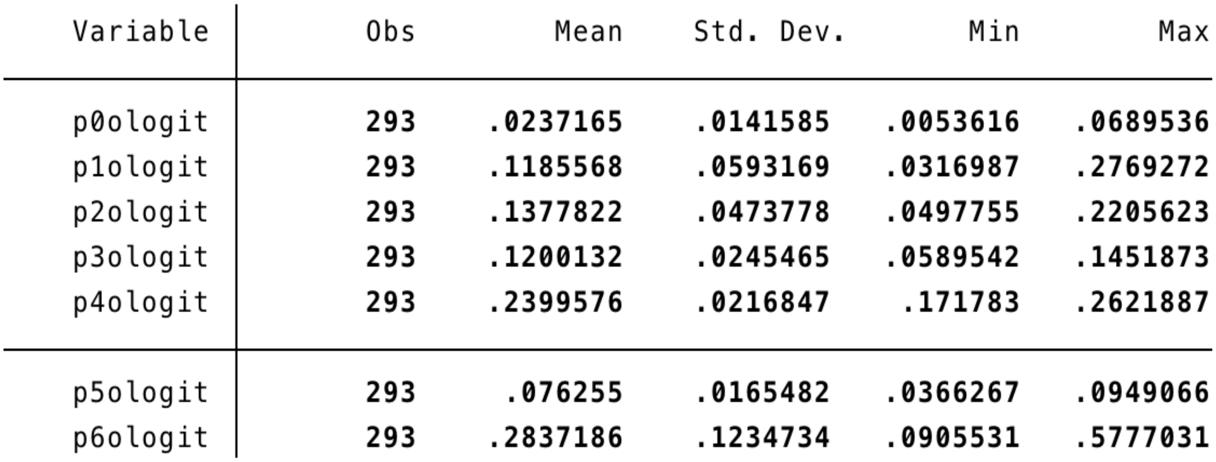
Figure 4.7 *STATA display for conditional marginal effects*



```
Conditional marginal effects                      Number of obs   =        293
Model VCE    : OIM

Expression   : Pr(activity_class==1), predict(outcome(1))
dy/dx w.r.t. : autonomy relatedness competence
at           : autonomy        =   -4.211604 (mean)
               relatedness     =    -4.87372 (mean)
               competence      =    -4.83959 (mean)

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    autonomy |  -.0033397   .0049681    -0.67   0.501     -.013077    .0063975
 relatedness |  -.0178417   .0045988    -3.88   0.000    -.0268552   -.0088282
  competence |  -.0177265   .0049872    -3.55   0.000    -.0275012   -.0079518
------------------------------------------------------------------------------
```

The output indicates the conditional marginal effects for an individual who is in activity class one, and has independent variable reports at the mean level across all $\boldsymbol{x}_i'$. For autonomy, a one-point increase at the mean results in a decreased probability that $p(activity\_class_i = 1)$ by 0.00334 points. To predict the probability for each activity class, we run:

```
predict p0ologit p1ologit p2ologit p3ologit p4ologit p5ologit p6ologit, pr,
summarize p0ologit p1ologit p2ologit p3ologit p4ologit p5ologit p6ologit
```



```
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
    p0ologit |        293    .0237165    .0141585   .0053616   .0689536
    p1ologit |        293    .1185568    .0593169   .0316987   .2769272
    p2ologit |        293    .1377822    .0473778   .0497755   .2205623
    p3ologit |        293    .1200132    .0245465   .0589542   .1451873
    p4ologit |        293    .2399576    .0216847    .171783   .2621887
-------------+---------------------------------------------------------
    p5ologit |        293     .076255    .0165482   .0366267   .0949066
    p6ologit |        293    .2837186    .1234734   .0905531   .5777031
```

Figure 4.8 *Predicted probabilities for each activity class*

Here the "Mean" column indicates the probabilities and p0-6ologit represent the variables for the ordered logit predicted probabilities for each activity class, 0-6. These probabilities sum to one. For example, the probability that a given individual is in activity class 1 in this example is 0.11856 or 11.86%.

5 ANALYSIS OF EXERCISE VARIABLES

5.1 SPECIFICATION & SUMMARY OF PREDICTIONS

To clarify the analysis, I have summarized the predictions put forward in the theory, and my own hypotheses. I investigate these predictions by separating the responses into past and current rowers and highly active[1] and relatively inactive individuals. This thesis was limited in scope: I do not assert a causal relationship – it is clear from the literature review that the precise methodology required to estimate a causal relationship between behavioral indicators and physical activity is beyond the complexity of this paper. As such, my goal is to use a synthetic analysis, investigating the behaviors displayed by those who remain highly active and those who do not, comparing those who are primarily involved in sport (current rowers) and those who are primarily involved in exercise (past rowers). Following comparison of the means and correlations, I will conduct a regression and ordered logit analysis for the dependent variables activity class, exercise frequency and exercise intensity. To avoid confusion, the analysis will be guided by the following predictions, drawn in part from the theory presented in the previous sections:

1. Physical activity and career duration will vary positively with the number of family members who were/are also athletes
   1.1. The effects will be greatest for parents, then older siblings, and then younger siblings
   1.2. The same effects will be stronger for respondents with siblings of the same gender, and for respondents with smaller sibling age gaps

---

[1] 'Active' refers to a particular respondent's exercise activity, as opposed to their rowing status. Active and inactive will be used to describe activity levels; current and past/former will be used to denominate rowing status.

   1.3. I predict that age of initiation will be lower amongst respondents with more older sibling athletes and more parent athletes, and age of cessation will be earlier among those with younger sibling athletes
2. Those with longer careers will report increased maintenance and fewer barriers to exercise
   2.1. Lower age of initiation and higher age of cessation will, similarly, correlate with higher levels of current exercise maintenance
3. Due to the inherent mechanical nature of rowing, taller individuals will report higher physical activity levels and longer career durations
4. Although extrinsic motivations may be sufficient incentives for an individual to cross a required "threshold" level of physical activity (McAuley et al., 1993; Gneezy et al., 2011), current exercise maintenance will vary negatively with extrinsic initiation incentives
5. Inactive respondents will have higher reported commitment mechanism use, and will report wishing they exercised more than their current levels at a higher rate than physically active respondents. (DellaVigna & Malmendier, 2006; Rogers et al., 2014; Bryan et al., 2010)
6. Active individuals will report higher self-efficacy and intrinsic motivation levels for current exercise (McAuley et al., 1993; Murcia et al., 2008)
   6.1. Self-efficacy will be the leading predictor of reporting higher activity levels
7. Current rowers will have higher intrinsic motivation rankings (especially in relatedness) than past rowers and, thus, consistent with the theories presented on sport vs. exercise (Cohen et al., 2010; Kilpatrick et al. 2005; Frederick et al., 1993)
8. Image ranking will vary by gender; specifically, based on the data presented in Kilpatrick et al. (2005) and Frederick et al. (1993), women will report higher rankings for image than men on average.

5.2 PERSONAL & FAMILY CHARACTERISTICS

In this section, I present tables of means and standard deviations for the independent variables of interest, divided into two activity columns for each category of current and past rowers. 'Active' individuals included respondents who reported activity classes of three or higher, whereas those who reported activity classes of zero, one or two were categorized as 'inactive.' The goal is to examine what behaviors are most significantly different between activity groups. The division between rowers and past rowers splits respondents based on the assumption that incentives for sport differ from incentives for exercise. Following the comparisons within each category, I conduct comparisons between past rowers and current rowers overall.

5.2.1 PAST ROWERS (n = 102)

PERSONAL & FAMILY CHARACTERISTICS	**PAST ROWERS (n = 102)**			
	ACTIVE (n = 71)		**INACTIVE (n = 31)**	
INDEPENDENT VARIABLE	**MEAN**	**SD**	**MEAN**	**SD**
Year of Birth	1992.141	4.223	1991.742	7.335
Age	22.859	4.223	23.258	7.335
Female	26.8%	44.6%	25.8%	44.5%
Weight (kg)	75.608	11.909	72.874	13.147
Height (cm)	178.796	10.016	175.423	9.433
BMI	23.543	2.270	23.517	2.510
Athlete Parents	0.338	0.589	0.200	0.407
Athlete Older Siblings	0.521	0.892	0.387	0.715
Older Sibling Age Gap	3.115	2.286	3.556	2.506
Same Gender as Older Sibling	42.3%	50.4%	55.6%	52.7%
Athlete Younger Siblings	0.620	0.817	0.516	0.626
Younger Sibling Age Gap	2.853	1.844	3.857	2.349
Same Gender as Younger Sibling	0.647	0.485	0.500	0.519

Table 5.1 *Mean and SD values for personal and family characteristics, among past rowers*

Perhaps surprisingly, 70% of the former rowers sampled reported being physical active. Across activity groups, age and year of birth did not vary significantly. Active respondents were slightly younger than inactive ones, (0.399 years) on average. As predicted in point 7, physically active past rowers were 3.37 cm taller on average, and tended to have weights that are slightly higher (2.734 kg, or 4%). BMI hardly varied between active and inactive past rowers, as a result of the increase in both weight and height across groups. In terms of family effects, active individuals reported around 70% more parent athletes than inactive ones (0.338 compared to 0.2). Though this comparison does not translate well into reality, it is worth noting the percentage difference: it appears that among past rowers, the number of parent athletes is an appreciable distinguishing feature for physical activity. Active individuals reported an average of 0.521 older sibling athletes, with an average age gap of 3.115 years. Compared to inactive individuals, the number of older sibling athletes was 34.6% higher, but the slightly larger age gap (among those with older sibling athletes) for inactive individuals does not appear to be a substantial distinction. Further, a higher proportion of inactive past rowers share their gender with their nearest athlete sibling (55.6% compared to 42.3% for active respondents).

Active individuals reported a higher value for the number of athlete younger siblings than their inactive counterparts by about 20%. Additionally, the mean age gap for active individuals was 26% smaller than it was for those who reported being inactive. On average, among those with athlete younger siblings, active individuals reported gender matching with their younger sibling 29.4% more frequently. In the context of prediction 1, it appears that physical activity is positively associated with increased athlete family members. Prediction 1.1 also holds: the differences were greatest, in order, for parent athletes (69.1% higher for active respondents), then older sibling athletes (34.6% higher), and lastly, younger siblings (20.1%). Regarding gender matches, it appears that prediction 1.2 holds for younger sibling athletes, but not older sibling athletes: reported gender matching for older sibling athletes was higher among inactive past rowers than their active counterparts.

A key point in prediction 1 is that career duration will vary positively with the number of athletic family members. Among past rowers, the total number of athlete family members was weakly positively correlated with career duration (0.0076). Breaking this down into its components allows for a clearer understanding of the relationships. The number of parent athletes correlated negatively with career duration (-0.1562), positively with start age (0.1712) and negatively with stopping age (-0.0723). In other words, the number of parent athletes was correlated with a reduction in career duration on both ends. For athlete older siblings, there was a strong positive correlation with career duration (0.1583). This results from a weakly negative correlation on start age (-0.0566), as expected, and a strong positive correlation with the stopping age of the participant (0.1740). In other words, as the number of athlete older siblings increases, the reported start age of the respondent decreases on average, and the reported cessation age increases.

For respondents with younger sibling athletes, there was a weak negative correlation with career duration (-0.0437), driven by the negative correlation with cessation age (-0.0493). There was a weak negative correlation with the starting age (-0.0363), which is the main reason for the negative effect on career duration. Overall, then, our modification to prediction 1 would acknowledge these results: career duration has a strong negative correlation with the number of parent athletes, a weakly negative correlation with the number of younger athlete siblings, and a strong positive correlation with the number of older sibling athletes, among past rowers with athlete siblings. Age of initiation varied negatively with the number of athlete siblings (older and younger), and positively with the number of parent athletes. Cessation age varied negatively with the number of parent athletes, and the number of athlete younger siblings (which supports prediction 1.3), but positively with the number of athlete older siblings. In short, there is contradicting evidence surrounding the validity of prediction 1.3.

5.2.2 CURRENT ROWERS (n = 191)

PERSONAL & FAMILY CHARACTERISTICS	**CURRENT ROWERS (n = 191)**			
	ACTIVE (n = 140)		**INACTIVE (n = 51)**	
INDEPENDENT VARIABLE	**MEAN**	**SD**	**MEAN**	**SD**
Year of Birth	1992.786	3.369	1992.451	4.046
Age	22.214	3.369	22.549	4.046
Female	38.6%	48.9%	47.1%	50.4%
Weight (kg)	77.273	12.373	78.699	16.452
Height (cm)	182.176	9.337	178.049	9.473
BMI	23.173	2.496	24.668	4.010
Athlete Parents	0.401	0.600	0.327	0.555
Athlete Older Siblings	0.543	0.799	0.510	0.809
Older Sibling Age Gap	3.123	2.045	2.850	1.899
Same Gender as Older Sibling	57.9%	49.8%	45.0%	51.0%
Athlete Younger Siblings	0.500	0.694	0.451	0.730
Younger Sibling Age Gap	3.182	1.827	3.765	2.386
Same Gender as Younger Sibling	0.473	0.504	0.294	0.470

Table 5.2 *Mean and SD values for personal and family characteristics, among current rowers*

Within the subgroup of current rowers, 73% reported an activity class of three or higher. Age does not vary substantially between active and inactive individuals. An interesting point is that the percentage of female respondents is 8.5% higher for inactive rowers than it is for active ones. There is nothing in the literature, or in my own experience, to suggest that females are less active than males on average, which makes me believe that this result is not due to a particular attribute, but rather the nature of the survey. Once again, height for active respondents is slightly higher than for inactive ones (4.127 cm, or 2.3%), yet, in the case of current rowers, weight is slightly lower.

In the context of a physiological analysis, this makes sense. Current rowers are more likely to be operating at a weight that is below their natural resting body mass, due to the enormous daily energy demands they experience. As a result, when they go through periods of inactivity, their bodies repair and grow, and their metabolism converts some of the excess calories into body mass, rather than energy output.

Active rowers report a 22.6% higher value for the number of athlete parents; have roughly similar older sibling athletes, and 10.9% more younger sibling athletes on average, supporting prediction 1. The age gap between the average respondent and their nearest athlete older sibling is larger for active individuals than non-active ones, which contradicts prediction 1.2. Unlike the difference in the age gap for older siblings, however, for younger sibling athletes, the age gap is 15.5% smaller among active rowers, supporting prediction 1.2. Additionally, the number of sibling gender matches was 60.9% higher for active rowers, further backing this intuition. Engaging in extensive career duration analysis is not appropriate – we are unable to examine the effects of athlete family members on the cessation age of current rowers, since they continue to row.

5.3 CAREER FACTORS – INITIATION & CESSATION

5.3.1 PAST ROWERS (n = 102)

	INITIATION & CESSATION FACTORS	**PAST ROWERS (n = 102)**			
		ACTIVE (n = 71)		**INACTIVE (n = 31)**	
	INDEPENDENT VARIABLE	**MEAN**	**SD**	**MEAN**	**SD**
	Age Started	15.324	2.353	15.548	2.321
	Age Stopped	20.873	3.255	20.097	2.087
	Career Duration	5.549	3.913	4.931	3.070
INITIATION INDICATORS	Enjoyment	35.2%	48.1%	45.2%	50.6%
	Fitness	66.2%	47.6%	58.1%	50.2%
	My Parents	33.8%	47.6%	32.3%	47.5%
	My Sibling	16.9%	37.7%	22.6%	42.5%
	Friends	46.5%	50.2%	41.9%	50.2%
	Weight control & appearance	18.3%	39.0%	22.6%	42.5%
	Stress release	22.5%	42.1%	6.5%	25.0%
	None	1.4%	11.9%	0.0%	0.0%
CESSATION INDICATORS	Weight	9.9%	30.0%	6.5%	25.0%
	Lack of interest	16.9%	37.7%	12.9%	34.1%
	Injury or poor health	29.6%	46.0%	35.5%	48.6%
	Schedule (time constrained)	59.2%	49.5%	61.3%	49.5%
	I didn't like it anymore	35.2%	48.1%	29.0%	46.1%
	Laziness	9.9%	30.0%	9.7%	30.1%
	Age	5.6%	23.2%	0.0%	0.0%
	Embarrassment	0.0%	0.0%	0.0%	0.0%
	Access to facilities	26.8%	44.6%	12.9%	34.1%
	None	0.0%	0.0%	0.0%	0.0%

Table 5.3 *Mean and SD values for initiation & cessation factors, among past rowers*

For past rowers, initiation and cessation ages are comparably similar across activity groups. Notably, career duration is 12.5% longer for active rowers than inactive ones, supporting prediction 2. Among the initiation indicators, the greatest differences across groups occur for enjoyment, and stress release. 22.5% of active individuals indicated stress release as an initiation incentive, compared to only 6.5% of inactive respondents. 10% fewer active respondents indicated enjoyment as an initiation factor, and 8.1% more active respondents selected the fitness indicator. From prediction 2, I theorized that respondents with longer careers would report higher current levels of exercise maintenance, and decreased reported barriers to exercise. For past rowers, career duration had a positive (0.1076) correlation with reported activity levels, weakly supporting this prediction. The weakly negative correlation between total barriers indicated and career duration (-0.0067) is not significantly different from zero. As such, there is insufficient evidence to confirm or contradict prediction 2.

Examining cessation factors illustrates that the most sizeable difference reported across activity classes was for access to facilities. Active former rowers reported the "access to facilities" cessation indicator 13.9% more than inactive former rowers. Injury or poor health was listed 5.9% more frequently for inactive individuals than for active ones, and age was listed as a factor only for active individuals. In contradiction to prediction 3, running a correlation between height and career duration yields a negative result (-0.1284). In other words, among past rowers, taller respondents report shorter career durations, despite the fact that active individuals are taller on average.

5.3.2 CURRENT ROWERS (n = 191)

	INITIATION & CESSATION FACTORS	**CURRENT ROWERS (n = 191)**			
		ACTIVE (n = 140)		**INACTIVE (n = 51)**	
	INDEPENDENT VARIABLE	**MEAN**	**SD**	**MEAN**	**SD**
	Age Started	15.921	2.348	14.980	2.796
	Career Duration	6.293	3.600	7.569	4.451
INITIATION INDICATORS	Enjoyment	61.4%	48.9%	37.3%	48.8%
	Fitness	68.6%	46.6%	52.9%	50.4%
	My Parents	29.3%	45.7%	41.2%	49.7%
	My Sibling	12.9%	33.6%	17.6%	38.5%
	Friends	49.3%	50.2%	41.2%	49.7%
	Weight control & appearance	14.3%	35.1%	23.5%	42.8%
	Stress release	17.1%	37.8%	15.7%	36.7%
	None	0.7%	8.5%	2.0%	14.0%
CESSATION INDICATORS	Weight	0.7%	8.5%	0.0%	0.0%
	Lack of interest	1.4%	11.9%	2.0%	14.0%
	Injury or poor health	5.0%	21.9%	2.0%	14.0%
	Schedule (time constrained)	3.6%	18.6%	3.9%	19.6%
	I didn't like it anymore	1.4%	11.9%	0.0%	0.0%
	Laziness	1.4%	11.9%	0.0%	0.0%
	Age	0.0%	0.0%	0.0%	0.0%
	Embarrassment	0.0%	0.0%	0.0%	0.0%
	Access to facilities	0.7%	8.5%	0.0%	0.0%
	None	72.1%	45.0%	70.6%	46.0%

Table 5.4 *Mean and SD values for initiation & cessation factors, among current rowers*

Among current rowers, age of initiation is 6.3% higher for individuals who are more active. Similarly counterintuitive is the result that career duration is 16.9% shorter for active respondents. These results disprove predictions 2 and 2.1, and contrast the results from past rowers. Among active current rowers, respondents indicated enjoyment as an initiation factor 24.2% more frequently, fitness 15.6% more frequently, parental influence 11.9% less frequently, and image 9.2% less frequently. Other than fitness, the largest mean disparities between activity groups are consistent with prediction 4: intrinsic incentives at initiation tend to be associated with higher levels of current exercise, and extrinsic incentives for initiation tend to be associated with lower levels of current exercise.

Turning to the cessation factors, there appears to be almost no significant variation between groups. In any case, since these are currently active athletes, cessation factors are not as relevant as they are for past rowers. Of particular note are the differences in initiation incentives, especially enjoyment, and the somewhat intuitive result of the fitness indicator – I have previously discussed how rowing holds an interesting position on the sport-exercise spectrum, and how the incentive structure may lend itself towards extrinsic motivation relative to other sports. The next section reviews current incentives, barriers to exercise and commitment mechanisms.

5.4 CURRENT EXERCISE ANALYSIS

5.4.1 PAST ROWERS (n = 102)

	CURRENT EXERCISE FACTORS	PAST ROWERS (n = 102)			
		ACTIVE (n = 71)		INACTIVE (n = 31)	
	INDEPENDENT VARIABLE	MEAN	SD	MEAN	SD
	Activity Class	4.746	1.180	1.484	0.626
	Exercise Frequency	6.070	0.662	2.774	1.627
	Exercise Intensity	4.493	0.652	3.161	1.440
	Last Week Typical	-0.113	0.433	-0.226	0.717
	Contentment	0.408	1.879	2.774	1.746
	Self-efficacy	7.535	1.722	5.903	2.508
BARRIERS TO CURRENT EXERCISE	Age	0.0%	0.0%	0.0%	0.0%
	Weight	2.8%	16.7%	3.2%	18.0%
	Embarrassment	1.4%	11.9%	12.9%	34.1%
	Injury or poor health	12.7%	33.5%	25.8%	44.5%
	I dislike exercise	1.4%	11.9%	9.7%	30.1%
	Laziness	14.1%	35.0%	41.9%	50.2%
	Access to facilities	8.5%	28.0%	19.4%	40.2%
	Schedule (time constrained)	53.5%	50.2%	74.2%	44.5%
	Lack of interest	5.6%	23.2%	12.9%	34.1%
	None	36.6%	48.5%	9.7%	30.1%
CURRENT EXERCISE INCENTIVE RANKINGS	Autonomy	-3.958	2.080	-3.613	2.333
	Competence	-4.634	2.153	-6.000	1.633
	Relatedness	-4.648	2.456	-5.581	2.157
	Fitness	-3.042	1.982	-2.677	1.887
	Image	-5.535	2.304	-3.161	1.968
	Commitment Mechanism	-6.493	2.298	-6.387	2.028
	Competition	-3.606	2.233	-5.613	1.856
	Stress Release	-4.944	1.866	-3.806	1.973
	Sibling Rivalry	-8.141	1.759	-8.161	1.934
COMMITMENT DEVICES	Workout Communities (family and friends)	49.3%	50.4%	45.2%	50.6%
	Workout reward apps	1.4%	11.9%	6.5%	25.0%
	Gym membership/classes	15.5%	36.4%	32.3%	47.5%
	Personal reward/punishment scheme	18.3%	39.0%	16.1%	37.4%
	Exercise schedule/fitness program	50.7%	50.4%	25.8%	44.5%
	I don't use any mechanisms	28.2%	45.3%	29.0%	46.1%

Table 5.5 *Mean and SD values for current barriers and incentives to exercise and reported use of commitment devices, among past rowers*

Compared to the inactive individuals specified, active past rowers rated a 219.9% higher value for activity class, on average. Since we have already split the respondents based on their reported activity class, this is hardly a surprising result. It is worth noting the magnitude, however, to compare to the difference for current rowers. Similarly, exercise frequency and intensity were 118.8% and 42.1% higher, respectively. The "Last Week Typical" variable was coded as negative one if the respondent selected "I usually exercise more than I did last week," zero for "last week was pretty typical," and one for "I usually exercise less than I did last week." On average, then, both active and inactive past rowers indicated that they exercised more than they did last week, typically. As would be expected, active former rowers exercised about 50.1% more typically in the reported week than inactive respondents. For contentment, the variables ranged from "-5: I wish to exercise a great deal less," through "0: I exercise just the right amount," and up to "5: I wish to exercise a great deal more." In other words, in terms of absolute levels of contentment, the closer the value is to zero, the more content the respondent is. On average, active past rowers were 85.3% more content than their counterparts. Similarly, as explained by the theory and repeated in prediction 6, there is a considerable difference in the mean self-efficacy values between active and inactive past rowers, with active respondents reporting a 27.6% higher value for self-efficacy.

Neither party reported age as a barrier to current exercise, and the greatest difference in barrier averages is for laziness – active past rowers indicated laziness as a barrier to current 27.9% less frequently. There was also a large difference in the proportion of individuals who reported not experiencing any barriers to current exercise – active respondents indicated "None" 26.9% more than inactive respondents. Time constraints were perceived as a barrier to exercise 20.7% more frequently amongst inactive past rowers

Examining the reported rankings of motivators for current exercise indicates the following difference between active and inactive former rowers:

RANK ORDER OF MOTIVATORS	ACTIVE PAST ROWERS	INACTIVE PAST ROWERS
1	Fitness	Fitness
2	Competition	Image
3	Autonomy	Autonomy
4	Competence	Stress Release
5	Relatedness	Relatedness
6	Stress Release	Competition
7	Image	Competence
8	Commitment Mechanism	Commitment Mechanism
9	Sibling Rivalry	Sibling Rivalry

Table 5.6 *Rank orders of current exercise motivators among past rowers*

As was posited in prediction 7, these results indicate that the primary motivators for current exercise levels are extrinsic, among past rowers. In comparing the incentive rankings from initiation with those for current exercise, I have assumed that an increased proportion of respondents selecting a particular initiation incentive indicates wider consensus on that incentive. Although some of the initiation indicators vary slightly in meaning from the motivators of current exercise, it is clear that the ranked order stayed roughly the same for active respondents, but was substantially modified for inactive former rowers, with the exception that fitness was both the highest ranked initiation and maintenance motive. It appears that, among past rowers, the incentives for exercise changed between initiation and the time of the survey, possibly causing the decrease in physical activity. These results contradict prediction 6, indicating that extrinsic incentives appear to be ranked higher for both active and inactive former rowers.

Prediction 8 says that image ranking will be higher for women than for men, on average. This was certainly true among the past rowers surveyed (mean image rankings for inactive women were a full 0.9 points higher than for men), but it may be due to the differences between active individuals and inactive individuals, rather than a difference in genders. Indeed, for active past rowers, the difference is insignificant. This is further reinforced by the difference in mean image ranking for current rowers: there was no significant difference for either active or inactive current rowers, between genders. Despite this, across activity types, there was significant variation, with inactive current rowers of both genders ranking image higher than active current rowers.

Interestingly, reported use of commitment mechanisms was very similar between activity groups. Only "Exercise schedule/fitness program" and "Gym membership/workout classes" differed between activity classes. The differences in reported use were large: active former rowers report using gym memberships as a commitment device 16.8% less, and report using a schedule or fitness program 24.9% more than inactive cohorts. This result follows the theory of DellaVigna & Malmendier posited in prediction 5: reported use of gym membership is negatively related to activity levels. However, this prediction is not quite accurate: reported use of commitment mechanisms is not substantially different between activity groups, even though the difference in reported gym membership is extensive. The proportion of respondents indicating "I don't use any mechanisms" was virtually the same between the two groups. Overall, there is more evidence to reject the idea that use of commitment devices varies between activity groups than there is to accept prediction 5.

Continuing with this prediction, I calculated correlations between the total number of indicated commitment mechanisms and contentment levels. Since contentment varies around an ideal value of zero, I focused only on inactive individuals who wished they exercised more (responses with a contentment value greater than zero, in the dataset). Among inactive past rowers who wish to exercise more, as the total number of commitment mechanisms increased, the contentment value decreased. In other words, it gets closer to zero, upending the second half of prediction 5. Among active past rowers, I found a positive correlation, suggesting that rowers may be better able to execute commitment mechanisms than the average individual reported in the literature, since these results indicate the efficacy of such mechanisms.

5.4.2 CURRENT ROWERS (n = 191)

Among current rowers, active participants reported 250.6% higher values for activity class, on average. Reported exercise frequency and intensity were also 88.3% and 40.3% higher for active cohorts. In terms of typicality, physically active rowers reported 61.2% more typicality than past rowers, although both groups reported exercising more than last week, typically. Relative to inactive respondents, active respondents reported a contentment value much closer to zero, and a 28.6% higher value for self-efficacy.

Analyzing current barriers to exercise, the most substantial result is the high levels of reported schedule constraints across both groups, with active rowers indicating this barrier 34.6% less frequently than inactive rowers. Following this, only 3.9% of inactive respondents indicated "None," compared to 32.9% for active current rowers. Further still, active participants indicated "Laziness," as a barrier 27.1% less frequently. For current rowers, prediction 2 does not hold: longer career duration was positively correlated with increased barriers to current exercise. This could be a result of the increased exposure to injury, or the fact that access to facilities becomes increasingly difficult after leaving university.

	CURRENT EXERCISE FACTORS	**CURRENT ROWERS (n = 191)**			
		ACTIVE (n = 140)		**INACTIVE (n = 51)**	
	INDEPENDENT VARIABLE	**MEAN**	**SD**	**MEAN**	**SD**
	Activity Class	4.743	1.134	1.353	0.658
	Exercise Frequency	5.871	0.847	3.118	1.785
	Exercise Intensity	4.621	0.556	3.294	1.238
	Last Week Typical	-0.114	0.381	-0.294	0.642
	Contentment	0.536	1.732	3.020	1.816
	Self-efficacy	8.143	1.477	6.333	2.075
BARRIERS TO CURRENT EXERCISE	Age	0.0%	0.0%	0.0%	0.0%
	Weight	0.0%	0.0%	5.9%	23.8%
	Embarrassment	1.4%	11.9%	7.8%	27.2%
	Injury or poor health	18.6%	39.0%	15.7%	36.7%
	I dislike exercise	2.9%	16.7%	7.8%	27.2%
	Laziness	20.0%	40.1%	47.1%	50.4%
	Access to facilities	5.7%	23.3%	21.6%	41.5%
	Schedule (time constrained)	53.6%	50.1%	88.2%	32.5%
	Lack of interest	2.1%	14.5%	13.7%	34.8%
	None	32.9%	47.1%	3.9%	19.6%
CURRENT EXERCISE INCENTIVE RANKINGS	Autonomy	-4.521	2.194	-4.078	1.948
	Competence	-4.486	2.147	-5.392	2.164
	Relatedness	-4.400	2.495	-6.059	2.240
	Fitness	-3.314	1.831	-2.706	1.869
	Image	-5.500	2.255	-3.431	2.300
	Commitment Mechanism	-5.971	2.384	-6.569	2.326
	Competition	-3.107	2.056	-5.373	1.949
	Stress Release	-5.529	2.079	-3.667	1.829
	Sibling Rivalry	-8.171	1.779	-7.725	2.070
COMMITMENT DEVICES	Workout Communities (family and friends)	47.9%	50.1%	19.6%	40.1%
	Workout reward apps	1.4%	11.9%	0.0%	0.0%
	Gym membership/classes	14.3%	35.1%	25.5%	44.0%
	Personal reward/punishment scheme	20.7%	40.7%	27.5%	45.1%
	Exercise schedule/fitness program	49.3%	50.2%	31.4%	46.9%
	I don't use any mechanisms	22.9%	42.1%	43.1%	50.0%

Table 5.7 *Mean and SD values for current barriers and incentives to exercise, as well as reported use of commitment devices, among current rowers*

The table below shows the rankings for current exercise incentives:

RANK ORDER OF MOTIVATORS	**ACTIVE CURRENT ROWERS**	**INACTIVE CURRENT ROWERS**
1	Competition	Fitness
2	Fitness	Image
3	Relatedness	Stress Release
4	Competence	Autonomy
5	Autonomy	Competition
6	Image	Competence
7	Stress Release	Relatedness
8	Commitment Mechanism	Commitment Mechanism
9	Sibling Rivalry	Sibling Rivalry

Table 5.8 *Rank orders of current exercise motivators among current rowers*

Referring back to prediction 7, I hypothesized that current rowers would have higher intrinsic motivation rankings than past rowers, especially in relatedness. It is clear, from the table, that the leading incentives for both active and inactive current rowers are extrinsic, rather than intrinsic, providing substantial evidence to reject this prediction. Furthermore, the data indicate that between current and past active rowers, rankings for intrinsic motivations are largely similar, with the exception of autonomy, which is ranked higher for past rowers. Active cohorts list competition as the most important incentive for current exercise maintenance. This suggests a stark distinction between both active and inactive current rowers, as well current and past rowers. If current, active rowers are primarily motivated by competition, the removal of competitive sport will cause a significant decrease in their incentives for exercise.

Comparing these rankings to the initiation variables indicated by the average respondents shows a roughly consistent incentive structure from initiation for active current rowers, and a large increase in importance of extrinsic incentives (primarily stress release and image) for inactive current rowers. This result is consistent with the observation across activity groups for former rowers, adding further evidence to the theory presented by Cawley (2004), that changes in dietary patterns and physical activity are a result of changes in the incentive structure people face.

Active current rowers indicated use of commitment mechanisms at higher rates than inactive current rowers. Among inactive current rowers who wished they exercised more, the total number of indicated commitment mechanisms - excluding "None" – was negatively correlated (-0.0464) with the numerical value of contentment, contradicting the results in prediction 5. That is to say, as the number of total commitment mechanisms indicated increases, contentment levels improve for inactive current rowers. The reverse is true for active current rowers, and the effect is much stronger (0.1146).

5.5 REGRESSION & ORDERED LOGIT ANALYSES

I am primarily interested in three dependent variables: weekly exercise hours, marked by activity class, weekly exercise frequency, marked by reported days of exercise, and exercise intensity. To determine which independent variables to use in the regression equations, I began by examining the factors that appeared to have the greatest difference in means, between active individuals and inactive individuals. For each dependent variable, I examine the regression relationship on the sample population, then on past rowers, then on current rowers. I will also use an ordered logit analysis to mitigate the errors caused by discrete categorical dependent variables, and examine the marginal effects of each coefficient by category. The results are presented here and discussed in the next section.

5.5.1 WEEKLY EXERCISE HOURS – ACTIVITY CLASS

To determine the regression specification, I began with the variables in the dataset that yielded the largest percentage difference between active and inactive cohorts, across rowing statuses. I combined this with theory from the literature on incentives and rowing physiology, to reach a combination of statistically significant coefficients, given by the equation:

$$activity\_class_i = \\ \alpha + \beta_1(prim\_rowing) + \beta_2(start\_parents) + \beta_3(mech\_social) + \beta_4(parent\_athletes) + \\ \beta_5(contentment) + \beta_6(competition) + \beta_7(image) + \beta_8(self\_efficacy) + \beta_9(stress\_release) + \\ \beta_{10}(relatedness) + \varepsilon_i \qquad (5.1)$$

In this equation, *prim_rowing* is one if the respondent selected rowing as their primary form of physical activity, and zero if they selected swimming, biking, running, walking, other or none, in response to question 7(e). *Start_parents* is the initiation indicator for "My Parents," in response to question 4(b) "Which of these, if any, contributed to your decision to start rowing.

Mech_social is an indicator for whether or not the respondent selected "Workout communities (friends and family)" in their answer to question 11 ("Do you use any techniques or strategies to hold yourself to your exercise regimen? Check all that apply.") *Parent_athletes* is the number of parent athletes reported by the given respondent. *Contentment* is a measure of how happy the respondent is with their current regime, yielding a number between one and five if they would rather exercise more, or between negative five and negative one if they wished the exercised less. *Competition, image, stress_release* and *relatedness* are ranked incentives for current exercise, equal to the numerical rank (from one to nine) picked by the respondent for "Competition," "Weight control and appearance," "Stress release" and "Social support/obligations to a group," in response to question 12, multiplied by negative one in the dataset. The standard OLS model also includes the normally distributed error term. *Self_efficacy* is respondent *i*'s self-efficacy beliefs, measured by question 10 "How strongly do you believe you will achieve the exercise goals that you set?"

The regression is run over the entire sample, then only past rowers, then only current rowers. Regression over the entire population leads to statistically significant effects at the 5% level for all regressors in the equation. Further, *prim_rowing*, *start_parents*, *contentment*, *competition* and *image*, are all significant at the 1% level. Of the 293 respondents, there were only nine missing values, split between four missing past rowers and five missing current rowers. The results for each dependent variable will be reported, and discussed in the conclusion. The coefficients for the activity class regression are shown below:

Figure 5.1 β *– coefficients from the activity class regressions, given by equation (5.1)*

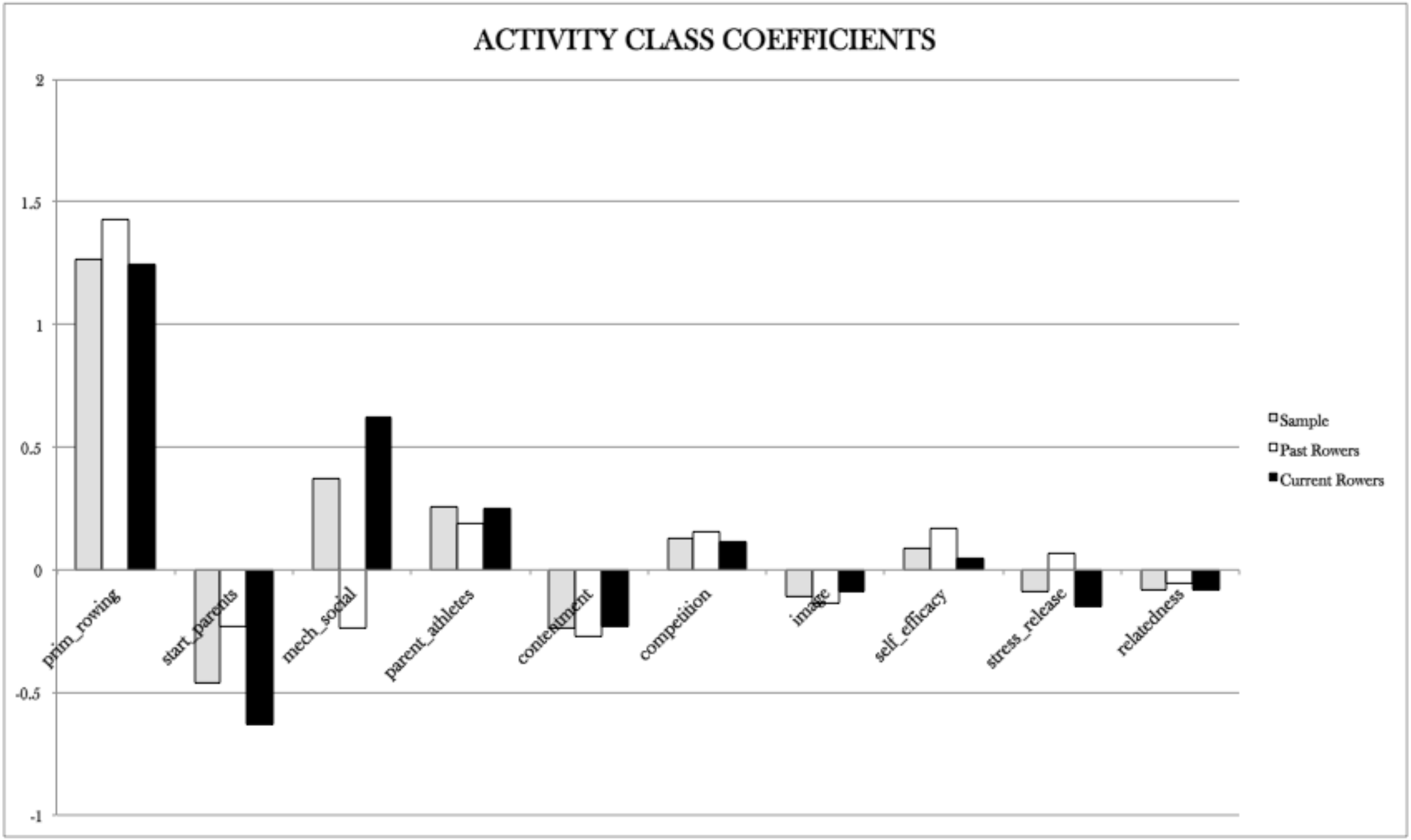


Table 5.9 *β – coefficients from the activity class regressions, given by equation (5.1)*

	Entire Sample	Past Rowers	Current Rowers
	activity_class	activity_class	activity_class
prim_rowing	1.265	1.427	1.246
	(6.60)**	(4.06)**	(5.40)**
start_parents	-0.462	-0.230	-0.632
	(3.04)**	(0.88)	(3.37)**
mech_social	0.370	-0.240	0.621
	(2.51)*	(0.91)	(3.44)**
parent_athletes	0.260	0.188	0.250
	(2.12)*	(0.83)	(1.71)
contentment	-0.238	-0.268	-0.234
	(5.93)**	(3.73)**	(4.76)**
competition	0.130	0.152	0.115
	(3.61)**	(2.49)*	(2.56)*
image	-0.109	-0.135	-0.087
	(3.22)**	(2.33)*	(2.06)*
self_efficacy	0.089	0.172	0.045
	(2.25)*	(2.79)**	(0.85)
stress_release	-0.087	0.070	-0.147
	(2.21)*	(0.98)	(3.08)**
relatedness	-0.081	-0.058	-0.082
	(2.41)*	(0.98)	(2.00)*
_cons	1.755	2.162	1.797
	(3.42)**	(2.41)*	(2.86)**
R^2	0.60	0.63	0.61
N	284	98	186

* $p<0.05$; ** $p<0.01$

The results for the ordered logit are as follows:

```
Iteration 0:   log likelihood = -502.92238
Iteration 1:   log likelihood = -391.89341
Iteration 2:   log likelihood = -379.68226
Iteration 3:   log likelihood = -379.45287
Iteration 4:   log likelihood = -379.45245
Iteration 5:   log likelihood = -379.45245
```

Ordered Logistic Regression

n 284
LR Chi^2 (10) 246.94
Prob > Chi^2 0.0000
Log likelihood: -379.4524
Pseudo R^2 0.2455

activity_class	Coef.	SE	z	P>|z|	[95% Conf. Interval]	
prim_rowing	1.8953	0.3230	5.8700	0.0000	1.2623	2.5283
start_parents	-0.7068	0.2414	-2.9300	0.0030	-1.1799	-0.2338
mech_social	0.5657	0.2382	2.3700	0.0180	0.0988	1.0326
parent_athletes	0.4872	0.2006	2.4300	0.0150	0.0941	0.8803
contentment	-0.4099	0.0714	-5.7400	0.0000	-0.5499	-0.2700
competition	0.2184	0.0594	3.6800	0.0000	0.1020	0.3348
image	-0.1645	0.0551	-2.9900	0.0030	-0.2724	-0.0565
self_efficacy	0.1624	0.0673	2.4100	0.0160	0.0305	0.2944
stress_release	-0.1574	0.0651	-2.4200	0.0160	-0.2851	-0.0298
relatedness	-0.1478	0.0544	-2.7200	0.0070	-0.2544	-0.0412
/cut1	-2.3708	0.8859			-4.1072	-0.6344
/cut2	0.1044	0.8322			-1.5268	1.7355
/cut3	1.7102	0.8489			0.0464	3.3740
/cut4	2.8551	0.8616			1.1664	4.5437
/cut5	4.6521	0.8797			2.9280	6.3762
/cut6	5.2353	0.8853			3.5001	6.9704

Table 5.10 *Ologit coefficients, indicating the directions of variation and significant differences in the cut values*

:

Table 5.11 *Ologit marginal effects for each activity class*

For activity_class = 0	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5599	-0.0057	0.0027	-2.1000	0.0360	-0.0110	-0.0004
start_parents	0.3204	0.0021	0.0012	1.8200	0.0690	-0.0002	0.0044
mech_social	0.4331	-0.0017	0.0010	-1.6500	0.0980	-0.0037	0.0003
parent_athletes	0.3521	-0.0015	0.0009	-1.6700	0.0950	-0.0032	0.0003
contentment	1.1796	0.0012	0.0006	2.1500	0.0310	0.0001	0.0023
competition	-3.8697	-0.0007	0.0003	-1.9600	0.0510	-0.0013	0.0000
image	-4.9613	0.0005	0.0003	1.8100	0.0700	0.0000	0.0010
self_efficacy	7.4894	-0.0005	0.0003	-1.7800	0.0760	-0.0010	0.0001
stress_release	-4.8662	0.0005	0.0003	1.6600	0.0970	-0.0001	0.0010
relatedness	-4.8380	0.0004	0.0003	1.7400	0.0810	-0.0001	0.0009

For activity_class = 1	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5599	-0.0575	0.0154	-3.7400	0.0000	-0.0876	-0.0273
start_parents	0.3204	0.0214	0.0087	2.4500	0.0140	0.0043	0.0386
mech_social	0.4331	-0.0172	0.0081	-2.1100	0.0350	-0.0331	-0.0012
parent_athletes	0.3521	-0.0148	0.0069	-2.1500	0.0310	-0.0282	-0.0013
contentment	1.1796	0.0124	0.0034	3.6700	0.0000	0.0058	0.0191
competition	-3.8697	-0.0066	0.0022	-2.9500	0.0030	-0.0110	-0.0022
image	-4.9613	0.0050	0.0019	2.5700	0.0100	0.0012	0.0088
self_efficacy	7.4894	-0.0049	0.0023	-2.1700	0.0300	-0.0094	-0.0005
stress_release	-4.8662	0.0048	0.0022	2.1600	0.0310	0.0004	0.0091
relatedness	-4.8380	0.0045	0.0019	2.3600	0.0180	0.0008	0.0082

For activity_class = 2	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5599	-0.1800	0.0390	-4.6200	0.0000	-0.2564	-0.1036
start_parents	0.3204	0.0671	0.0247	2.7200	0.0070	0.0187	0.1156
mech_social	0.4331	-0.0537	0.0242	-2.2200	0.0270	-0.1012	-0.0062
parent_athletes	0.3521	-0.0463	0.0201	-2.3100	0.0210	-0.0856	-0.0070
contentment	1.1796	0.0389	0.0091	4.2800	0.0000	0.0211	0.0568
competition	-3.8697	-0.0207	0.0064	-3.2400	0.0010	-0.0333	-0.0082
image	-4.9613	0.0156	0.0057	2.7600	0.0060	0.0045	0.0267
self_efficacy	7.4894	-0.0154	0.0071	-2.1700	0.0300	-0.0294	-0.0015
stress_release	-4.8662	0.0150	0.0065	2.3100	0.0210	0.0023	0.0276
relatedness	-4.8380	0.0140	0.0055	2.5400	0.0110	0.0032	0.0249

Table 5.11 *Ologit marginal effects for each activity class*

For activity_class = 3	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5599	-0.1929	0.0482	-4.0000	0.0000	-0.2873	-0.0984
start_parents	0.3204	0.0719	0.0274	2.6200	0.0090	0.0182	0.1256
mech_social	0.4331	-0.0576	0.0262	-2.2000	0.0280	-0.1089	-0.0062
parent_athletes	0.3521	-0.0496	0.0222	-2.2400	0.0250	-0.0930	-0.0061
contentment	1.1796	0.0417	0.0103	4.0400	0.0000	0.0215	0.0619
competition	-3.8697	-0.0222	0.0073	-3.0500	0.0020	-0.0365	-0.0080
image	-4.9613	0.0167	0.0064	2.6300	0.0090	0.0043	0.0292
self_efficacy	7.4894	-0.0165	0.0074	-2.2300	0.0260	-0.0310	-0.0020
stress_release	-4.8662	0.0160	0.0072	2.2100	0.0270	0.0018	0.0302
relatedness	-4.8380	0.0150	0.0061	2.4500	0.0140	0.0030	0.0271

For activity_class = 4	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5599	0.1017	0.0468	2.1700	0.0300	0.0100	0.1934
start_parents	0.3204	-0.0379	0.0201	-1.8900	0.0590	-0.0772	0.0014
mech_social	0.4331	0.0304	0.0181	1.6800	0.0930	-0.0051	0.0658
parent_athletes	0.3521	0.0261	0.0152	1.7200	0.0850	-0.0036	0.0559
contentment	1.1796	-0.0220	0.0101	-2.1700	0.0300	-0.0418	-0.0022
competition	-3.8697	0.0117	0.0060	1.9600	0.0490	0.0000	0.0234
image	-4.9613	-0.0088	0.0047	-1.8900	0.0580	-0.0180	0.0003
self_efficacy	7.4894	0.0087	0.0055	1.6000	0.1100	-0.0020	0.0194
stress_release	-4.8662	-0.0084	0.0049	-1.7400	0.0820	-0.0180	0.0011
relatedness	-4.8380	-0.0079	0.0044	-1.8100	0.0700	-0.0165	0.0006

For activity_class = 5	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5599	0.1034	0.0272	3.8100	0.0000	0.0502	0.1566
start_parents	0.3204	-0.0386	0.0154	-2.5100	0.0120	-0.0687	-0.0084
mech_social	0.4331	0.0309	0.0143	2.1500	0.0310	0.0028	0.0590
parent_athletes	0.3521	0.0266	0.0122	2.1700	0.0300	0.0026	0.0506
contentment	1.1796	-0.0224	0.0059	-3.7800	0.0000	-0.0340	-0.0108
competition	-3.8697	0.0119	0.0040	2.9500	0.0030	0.0040	0.0198
image	-4.9613	-0.0090	0.0035	-2.5500	0.0110	-0.0159	-0.0021
self_efficacy	7.4894	0.0089	0.0040	2.2200	0.0260	0.0010	0.0167
stress_release	-4.8662	-0.0086	0.0040	-2.1600	0.0310	-0.0164	-0.0008
relatedness	-4.8380	-0.0081	0.0034	-2.3700	0.0180	-0.0147	-0.0014

Table 5.11 *Ologit marginal effects for each activity class*

For activity_class = 6	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.560	0.2309	0.0429	5.3800	0.0000	0.1467	0.3150
start_parents	0.320	-0.0861	0.0308	-2.8000	0.0050	-0.1465	-0.0257
mech_social	0.433	0.0689	0.0301	2.2900	0.0220	0.0100	0.1278
parent_athletes	0.352	0.0593	0.0252	2.3600	0.0180	0.0100	0.1086
contentment	1.180	-0.0499	0.0100	-5.0100	0.0000	-0.0695	-0.0304
competition	-3.870	0.0266	0.0075	3.5300	0.0000	0.0119	0.0414
image	-4.961	-0.0200	0.0070	-2.8500	0.0040	-0.0338	-0.0062
self_efficacy	7.489	0.0198	0.0083	2.3700	0.0180	0.0034	0.0361
stress_release	-4.866	-0.0192	0.0082	-2.3300	0.0200	-0.0353	-0.0031
relatedness	-4.838	-0.0180	0.0069	-2.6200	0.0090	-0.0315	-0.0045

Table 5.12 *Ologit predicted probabilities for each activity class*

Prb. activity_class =	Obs.	Mean	Std. Dev.	Min	Max
0	284	0.0241	0.0580	0.0000	0.4162
1	284	0.1095	0.1564	0.0002	0.5498
2	284	0.1452	0.1387	0.0011	0.3812
3	284	0.1293	0.0871	0.0028	0.2787
4	284	0.2341	0.1328	0.0062	0.4213
5	284	0.0764	0.0528	0.0006	0.1448
6	284	0.2814	0.2750	0.0007	0.9568

These tables are discussed in more detail in section six.

5.5.2 WEEKLY EXERCISE FREQUENCY – EXERCISE DAYS

Although frequency is related to weekly exercise hours, it is interesting to examine how the predictors of exercise frequency differ from the total hours exercised each week, to determine a more accurate profile of the respondents' physical activity behaviors. Following comparison of mean values, the regression specification for exercise frequency is:

$$exercise\_days_i =$$

$$\alpha + \beta_1(prim\_rowing) + \beta_2(start\_parents) + \beta_3(mech\_none) + \beta_4(contentment) +$$

$$\beta_5(self\_efficacy) + \beta_6(stress\_release) + \beta_7(bmi) + \beta_8(image) + \varepsilon_i \tag{5.2}$$

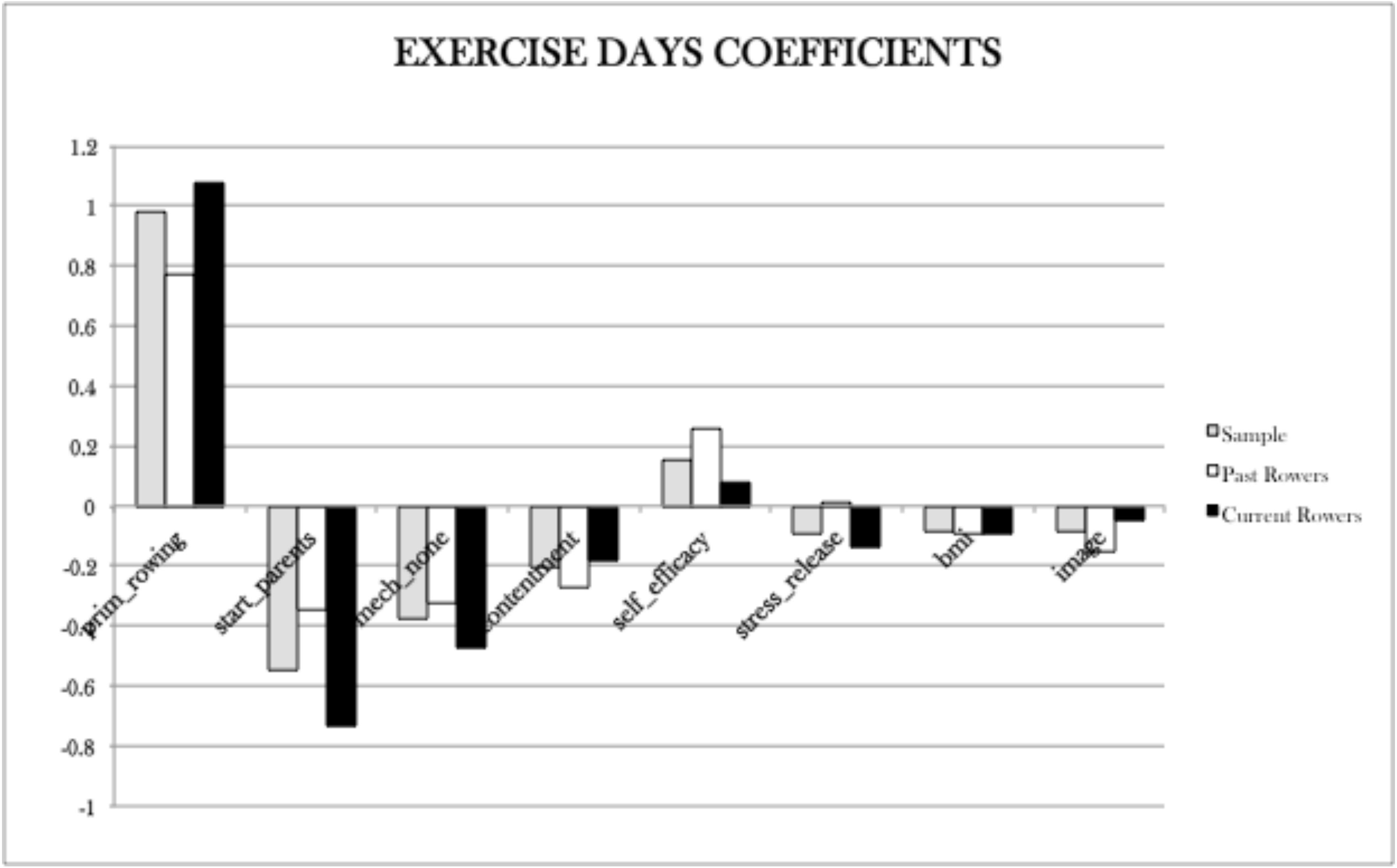
BMI and the ranking of the image motivator predict frequency over hours significantly. The results of the regression analysis across the entire sample, then by rowing status are:

	Entire Sample	Past Rowers	Current Rowers
	exercise_days	exercise_days	exercise_days
prim_rowing	0.977	0.770	1.075
	(5.07)**	(2.08)*	(4.78)**
start_parents	-0.548	-0.345	-0.733
	(3.46)**	(1.14)	(3.99)**
mech_none	-0.375	-0.326	-0.472
	(2.25)*	(1.04)	(2.41)*
contentment	-0.202	-0.269	-0.185
	(4.84)**	(3.38)**	(3.79)**
self_efficacy	0.156	0.258	0.076
	(3.93)**	(3.88)**	(1.50)
stress_release	-0.092	0.015	-0.139
	(2.40)*	(0.19)	(3.19)**
bmi	-0.084	-0.092	-0.093
	(3.19)**	(1.54)	(3.24)**
image	-0.082	-0.150	-0.049
	(2.47)*	(2.32)*	(1.27)
_cons	5.061	4.835	5.805
	(6.73)**	(3.06)**	(6.74)**
R^2	0.50	0.49	0.54
N	293	102	191

* $p<0.05$; ** $p<0.01$

Table 5.13 *β – coefficients from the exercise frequency regressions, given by equation (5.2)*

Figure 5.2 *β – coefficients from the exercise frequency regressions, given by equation (5.2)*



The results of the ordered logit regression for exercise frequency are:

Iteration 0: log likelihood = -477.43315
Iteration 1: log likelihood = -399.90571
Iteration 2: log likelihood = -390.58417
Iteration 3: log likelihood = -390.50637
Iteration 4: log likelihood = -390.50634

Ordered Logistic Regression		n	293
		LR Chi^2 (8)	173.85
		Prob > Chi^2	0.0000
Log likelihood:	-390.50634	Pseudo R^2	0.1821

exercise_days	Coef.	SE	z	P>|z|	[95% Conf. Interval]	
prim_rowing	1.724188	0.3267712	5.28	0	1.083728	2.364647
start_parents	-0.8155877	0.2449237	-3.33	0.001	-1.295629	-0.335546
mech_none	-0.4325239	0.2654678	-1.63	0.103	-0.9528313	0.0877835
contentment	-0.2685629	0.0659367	-4.07	0	-0.3977964	-0.1393293
self_efficacy	0.1596426	0.0646415	2.47	0.014	0.0329475	0.2863376
stress_release	-0.1273473	0.0599887	-2.12	0.034	-0.2449231	-0.0097715
bmi	-0.0913621	0.0416651	-2.19	0.028	-0.1730242	-0.0097001
/cut1	-4.889648	1.264275			-7.367581	-2.411714
/cut2	-3.697331	1.208956			-6.066842	-1.32782
/cut3	-2.627107	1.194434			-4.968154	-0.2860602
/cut4	-1.77612	1.195707			-4.119662	0.5674217
/cut5	-0.9315441	1.199565			-3.282649	1.41956
/cut6	-0.1313953	1.202524			-2.4883	2.225509
/cut7	3.126706	1.214117			0.7470807	5.506332

Table 5.14 *Ologit coefficients, indicating the directions of variation and significant differences in the cut values*

Table 5.15 *Ologit marginal effects for each exercise frequency*

For exercise_days = 0	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5597	-0.0082	0.0039	-2.1100	0.0350	-0.0159	-0.0006
start_parents	0.3276	0.0039	0.0020	1.9200	0.0550	-0.0001	0.0079
mech_none	0.2833	0.0021	0.0015	1.3800	0.1690	-0.0009	0.0050
contentment	1.1741	0.0013	0.0006	2.0200	0.0430	0.0000	0.0025
self_efficacy	7.4437	-0.0008	0.0004	-1.7600	0.0790	-0.0016	0.0001
stress_release	-4.8805	0.0006	0.0004	1.5700	0.1160	-0.0001	0.0014
bmi	23.5590	0.0004	0.0003	1.5900	0.1110	-0.0001	0.0010
image	-4.9010	0.0005	0.0003	1.5200	0.1270	-0.0001	0.0012

For exercise_days = 1	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5597	-0.0183	0.0069	-2.6700	0.0080	-0.0318	-0.0049
start_parents	0.3276	0.0087	0.0039	2.2400	0.0250	0.0011	0.0163
mech_none	0.2833	0.0046	0.0032	1.4400	0.1490	-0.0017	0.0109
contentment	1.1741	0.0029	0.0012	2.4600	0.0140	0.0006	0.0051
self_efficacy	7.4437	-0.0017	0.0009	-1.9900	0.0470	-0.0034	0.0000
stress_release	-4.8805	0.0014	0.0008	1.7400	0.0820	-0.0002	0.0029
bmi	23.5590	0.0010	0.0006	1.7400	0.0820	-0.0001	0.0021
image	-4.9010	0.0011	0.0007	1.6900	0.0900	-0.0002	0.0025

For exercise_days = 2	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5597	-0.0465	0.0136	-3.4200	0.0010	-0.0731	-0.0198
start_parents	0.3276	0.0220	0.0085	2.5900	0.0100	0.0054	0.0386
mech_none	0.2833	0.0117	0.0078	1.5000	0.1340	-0.0036	0.0269
contentment	1.1741	0.0072	0.0024	2.9600	0.0030	0.0024	0.0120
self_efficacy	7.4437	-0.0043	0.0020	-2.1300	0.0330	-0.0083	-0.0004
stress_release	-4.8805	0.0034	0.0018	1.9000	0.0580	-0.0001	0.0070
bmi	23.5590	0.0025	0.0013	1.9100	0.0570	-0.0001	0.0050
image	-4.9010	0.0029	0.0016	1.8400	0.0660	-0.0002	0.0060

Table 5.15 *Ologit marginal effects for each exercise frequency*

For exercise_days = 3	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5597	-0.0794	0.0213	-3.7300	0.0000	-0.1211	-0.0377
start_parents	0.3276	0.0375	0.0138	2.7200	0.0060	0.0105	0.0646
mech_none	0.2833	0.0199	0.0131	1.5200	0.1290	-0.0058	0.0457
contentment	1.1741	0.0124	0.0040	3.0600	0.0020	0.0044	0.0203
self_efficacy	7.4437	-0.0073	0.0035	-2.1200	0.0340	-0.0141	-0.0006
stress_release	-4.8805	0.0059	0.0030	1.9500	0.0510	0.0000	0.0118
bmi	23.5590	0.0042	0.0021	1.9900	0.0460	0.0001	0.0083
image	-4.9010	0.0049	0.0026	1.9000	0.0570	-0.0002	0.0100

For exercise_days = 4	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5597	-0.1253	0.0325	-3.8600	0.0000	-0.1890	-0.0617
start_parents	0.3276	0.0593	0.0208	2.8500	0.0040	0.0186	0.1000
mech_none	0.2833	0.0314	0.0201	1.5600	0.1180	-0.0080	0.0709
contentment	1.1741	0.0195	0.0061	3.2000	0.0010	0.0075	0.0315
self_efficacy	7.4437	-0.0116	0.0053	-2.1800	0.0300	-0.0221	-0.0012
stress_release	-4.8805	0.0093	0.0047	1.9800	0.0480	0.0001	0.0184
bmi	23.5590	0.0066	0.0032	2.0500	0.0400	0.0003	0.0130
image	-4.9010	0.0078	0.0040	1.9500	0.0510	0.0000	0.0156

For exercise_days = 5	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5597	-0.1196	0.0351	-3.4100	0.0010	-0.1884	-0.0508
start_parents	0.3276	0.0566	0.0206	2.7500	0.0060	0.0162	0.0969
mech_none	0.2833	0.0300	0.0193	1.5500	0.1200	-0.0078	0.0678
contentment	1.1741	0.0186	0.0060	3.1200	0.0020	0.0069	0.0303
self_efficacy	7.4437	-0.0111	0.0050	-2.2200	0.0260	-0.0208	-0.0013
stress_release	-4.8805	0.0088	0.0046	1.9300	0.0540	-0.0001	0.0178
bmi	23.5590	0.0063	0.0032	2.0000	0.0450	0.0001	0.0125
image	-4.9010	0.0074	0.0039	1.8900	0.0580	-0.0003	0.0151

Table 5.15 *Ologit marginal effects for each exercise frequency*

For exercise_days = 6	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5597	0.2941	0.0641	4.5900	0.0000	0.1685	0.4197
start_parents	0.3276	-0.1391	0.0444	-3.1300	0.0020	-0.2262	-0.0521
mech_none	0.2833	-0.0738	0.0462	-1.6000	0.1110	-0.1644	0.0168
contentment	1.1741	-0.0458	0.0124	-3.7100	0.0000	-0.0700	-0.0216
self_efficacy	7.4437	0.0272	0.0116	2.3600	0.0180	0.0046	0.0499
stress_release	-4.8805	-0.0217	0.0105	-2.0700	0.0390	-0.0423	-0.0011
bmi	23.5590	-0.0156	0.0073	-2.1400	0.0320	-0.0298	-0.0013
image	-4.9010	-0.0183	0.0091	-2.0200	0.0440	-0.0361	-0.0005

For exercise_days = 7	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_rowing	0.5597	0.1032	0.0232	4.4500	0.0000	0.0578	0.1486
start_parents	0.3276	-0.0488	0.0160	-3.0500	0.0020	-0.0802	-0.0174
mech_none	0.2833	-0.0259	0.0161	-1.6100	0.1080	-0.0575	0.0057
contentment	1.1741	-0.0161	0.0046	-3.5200	0.0000	-0.0250	-0.0071
self_efficacy	7.4437	0.0096	0.0041	2.3200	0.0210	0.0015	0.0176
stress_release	-4.8805	-0.0076	0.0037	-2.0400	0.0420	-0.0150	-0.0003
bmi	23.5590	-0.0055	0.0026	-2.0800	0.0370	-0.0106	-0.0003
image	-4.9010	-0.0064	0.0032	-2.0000	0.0460	-0.0127	-0.0001

Prb. exercise_days=	Obs	Mean	Std. Dev.	Min	Max
0	293.0000	0.0199	0.0403	0.0001	0.2880
1	293.0000	0.0345	0.0560	0.0003	0.2833
2	293.0000	0.0621	0.0764	0.0008	0.2613
3	293.0000	0.0757	0.0719	0.0017	0.2096
4	293.0000	0.0971	0.0712	0.0040	0.2081
5	293.0000	0.1081	0.0585	0.0084	0.1974
6	293.0000	0.4657	0.2105	0.0200	0.6721
7	293.0000	0.1369	0.1391	0.0008	0.7106

Table 5.16 *Ologit predicted probabilities for the number of days of weekly exercise*

I will discuss these tables in more detail in section six.

5.5.3 EXERCISE INTENSITY

Using the regression equation:

$$exercise_{intensity_i} = \alpha + \beta_1(prim\_walking) + \beta_2(prim\_swimming) + \beta_3(prim\_rowing) + \beta_4(prim\_biking) + \beta_5(prim\_running) + \beta_6(self\_efficacy) + \beta_7(stress\_release) + \beta_8(contentment) + \varepsilon_i \tag{5.3}$$

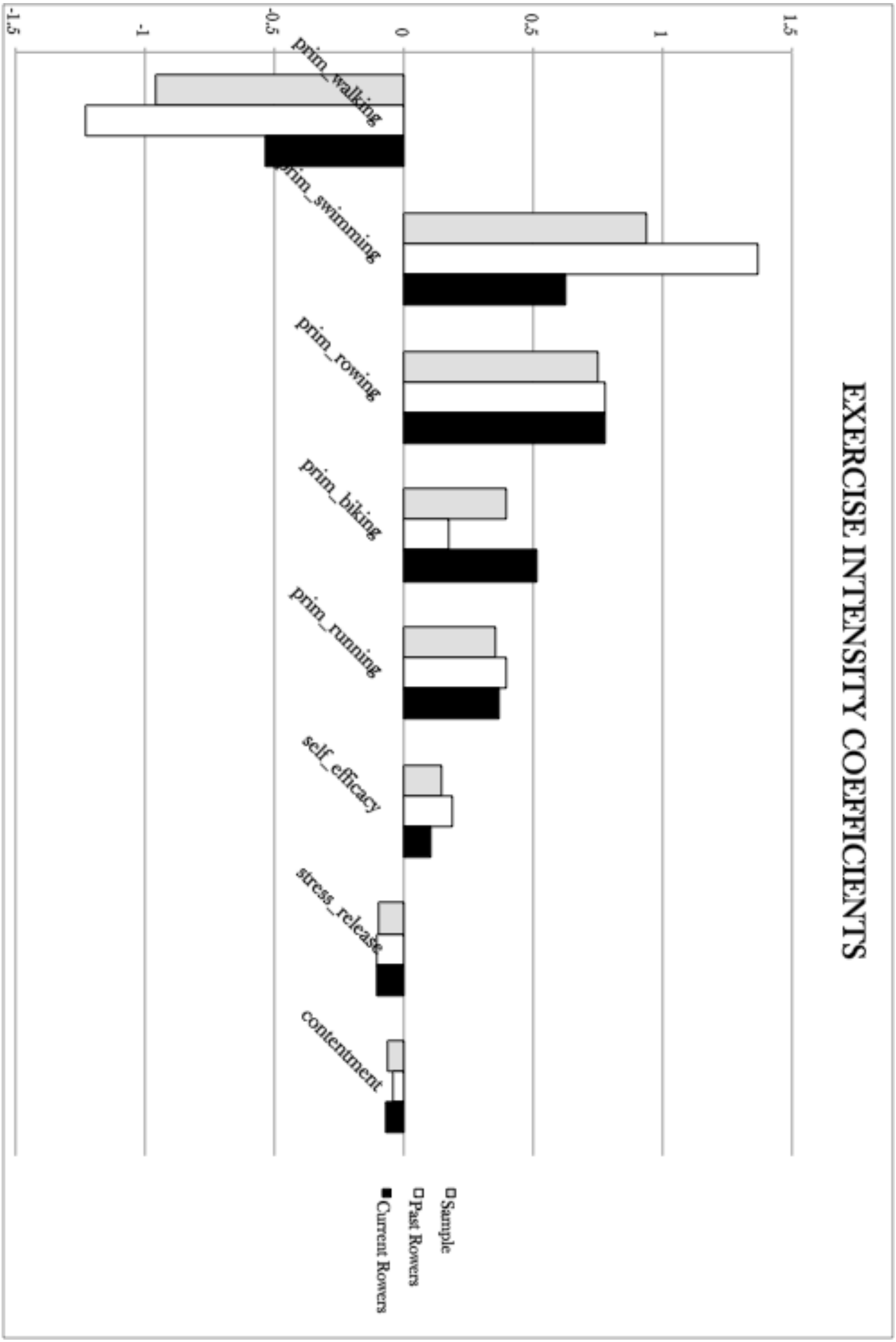
I obtained the following results for the coefficients on the independent variables:

Table 5.17 β *– coefficients from the exercise intensity regressions, given by equation (5.3)*

	Entire Sample	Past Rowers	Current Rowers
	exercise_intensity	exercise_intensity	exercise_intensity
prim_walking	-0.953	-1.226	-0.531
	(2.87)**	(2.54)*	(1.08)
prim_swimming	0.942	1.368	0.627
	(2.46)*	(2.15)*	(1.28)
prim_rowing	0.748	0.778	0.777
	(4.88)**	(2.81)**	(4.16)**
prim_biking	0.400	0.174	0.517
	(1.98)*	(0.49)	(2.08)*
prim_running	0.358	0.398	0.367
	(2.09)*	(1.25)	(1.76)
self_efficacy	0.145	0.187	0.105
	(5.69)**	(4.62)**	(3.04)**
stress_release	-0.098	-0.103	-0.099
	(3.90)**	(2.17)*	(3.28)**
contentment	-0.062	-0.039	-0.071
	(2.32)*	(0.79)	(2.13)*
_cons	2.214	1.845	2.506
	(8.99)**	(4.52)**	(7.75)**
R^2	0.42	0.50	0.37
N	293	102	191

* $p<0.05$; ** $p<0.01$

Figure 5.3 *β – coefficients from the exercise intensity regressions, given by equation (5.2)*



Ordered logit regression results for exercise intensity are:

```
Iteration 0:   log likelihood = -351.69514
Iteration 1:   log likelihood = -291.07453
Iteration 2:   log likelihood = -282.61165
Iteration 3:   log likelihood = -280.87924
Iteration 4:   log likelihood = -280.82609
Iteration 5:   log likelihood = -280.82607
```

Ordered Logistic Regression n 293
LR Chi^2 (8) 173.85
Prob > Chi^2 0
Log likelihood: -280.8267 Pseudo R^2 0.1821

exercise_intensity	Coef.	SE	z	P>|z|	[95% Conf. Interval]	
prim_walking	-1.7897	0.7398	-2.4200	0.0160	-3.2396	-0.3397
prim_swimming	3.0748	1.2866	2.3900	0.0170	0.5531	5.5966
prim_rowing	1.6855	0.3821	4.4100	0.0000	0.9366	2.4344
prim_biking	0.5753	0.4839	1.1900	0.2340	-0.3730	1.5236
prim_running	0.4113	0.4042	1.0200	0.3090	-0.3809	1.2034
self_efficacy	0.3227	0.0662	4.8800	0.0000	0.1931	0.4524
stress_release	-0.2785	0.0652	-4.2700	0.0000	-0.4063	-0.1507
contentment	-0.0929	0.0683	-1.3600	0.1740	-0.2268	0.0410
/cut1	-0.7046	0.7406			-2.1562	0.7470
/cut2	-0.1527	0.6899			-1.5049	1.1995
/cut3	1.0599	0.6363			-0.1871	2.3069
/cut4	2.5467	0.6378			1.2967	3.7967
/cut5	4.9222	0.6933			3.5634	6.2810

Table 5.18 *Ologit output and coefficients for exercise intensity, indicating the directions of variation*

Table 5.19 *Ologit marginal effects for each exercise frequency*

For exercise_intensity = 0	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_walking	0.0239	0.0078	0.0045	1.7200	0.0850	-0.0011	0.0166
prim_swimming	0.0171	-0.0134	0.0085	-1.5700	0.1160	-0.0300	0.0033
prim_rowing	0.5597	-0.0073	0.0040	-1.8400	0.0650	-0.0151	0.0005
prim_biking	0.0887	-0.0025	0.0024	-1.0300	0.3050	-0.0073	0.0023
prim_running	0.1672	-0.0018	0.0020	-0.9100	0.3620	-0.0056	0.0021
self_efficacy	7.4437	-0.0014	0.0007	-1.9400	0.0520	-0.0028	0.0000
stress_release	-4.8805	0.0012	0.0007	1.8600	0.0630	-0.0001	0.0025
contentment	1.1741	0.0004	0.0004	1.1500	0.2500	-0.0003	0.0011

For exercise_intensity = 1	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_walking	0.0239	0.0056	0.0039	1.4500	0.1470	-0.0020	0.0133
prim_swimming	0.0171	-0.0097	0.0070	-1.3800	0.1680	-0.0235	0.0041
prim_rowing	0.5597	-0.0053	0.0034	-1.5500	0.1200	-0.0120	0.0014
prim_biking	0.0887	-0.0018	0.0019	-0.9600	0.3370	-0.0055	0.0019
prim_running	0.1672	-0.0013	0.0015	-0.8600	0.3880	-0.0042	0.0016
self_efficacy	7.4437	-0.0010	0.0006	-1.6100	0.1080	-0.0023	0.0002
stress_release	-4.8805	0.0009	0.0006	1.5600	0.1180	-0.0002	0.0020
contentment	1.1741	0.0003	0.0003	1.0600	0.2890	-0.0002	0.0008

For exercise_intensity = 2	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_walking	0.0239	0.0301	0.0153	1.9700	0.0490	0.0002	0.0601
prim_swimming	0.0171	-0.0518	0.0262	-1.9800	0.0480	-0.1030	-0.0005
prim_rowing	0.5597	-0.0284	0.0106	-2.6800	0.0070	-0.0491	-0.0076
prim_biking	0.0887	-0.0097	0.0087	-1.1100	0.2660	-0.0268	0.0074
prim_running	0.1672	-0.0069	0.0071	-0.9700	0.3320	-0.0209	0.0071
self_efficacy	7.4437	-0.0054	0.0019	-2.8300	0.0050	-0.0092	-0.0017
stress_release	-4.8805	0.0047	0.0017	2.6800	0.0070	0.0013	0.0081
contentment	1.1741	0.0016	0.0012	1.2600	0.2070	-0.0009	0.0040

Table 5.19 *Ologit marginal effects for each exercise frequency*

For exercise_intensity = 3	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_walking	0.0239	0.1199	0.0553	2.1700	0.0300	0.0116	0.2282
prim_swimming	0.0171	-0.2060	0.0907	-2.2700	0.0230	-0.3838	-0.0283
prim_rowing	0.5597	-0.1129	0.0303	-3.7300	0.0000	-0.1723	-0.0536
prim_biking	0.0887	-0.0385	0.0329	-1.1700	0.2420	-0.1031	0.0260
prim_running	0.1672	-0.0276	0.0275	-1.0000	0.3160	-0.0814	0.0263
self_efficacy	7.4437	-0.0216	0.0058	-3.7400	0.0000	-0.0330	-0.0103
stress_release	-4.8805	0.0187	0.0051	3.6300	0.0000	0.0086	0.0287
contentment	1.1741	0.0062	0.0047	1.3100	0.1890	-0.0031	0.0155

For exercise_intensity = 4	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_walking	0.0239	0.2797	0.1201	2.3300	0.0200	0.0444	0.5150
prim_swimming	0.0171	-0.4805	0.2135	-2.2500	0.0240	-0.8990	-0.0621
prim_rowing	0.5597	-0.2634	0.0700	-3.7600	0.0000	-0.4007	-0.1261
prim_biking	0.0887	-0.0899	0.0765	-1.1800	0.2400	-0.2398	0.0600
prim_running	0.1672	-0.0643	0.0636	-1.0100	0.3120	-0.1890	0.0604
self_efficacy	7.4437	-0.0504	0.0122	-4.1200	0.0000	-0.0744	-0.0264
stress_release	-4.8805	0.0435	0.0119	3.6500	0.0000	0.0201	0.0669
contentment	1.1741	0.0145	0.0108	1.3500	0.1780	-0.0066	0.0357

For exercise_intensity = 5	Mean value	dy/dx	SE	z	P >|z|	[95% Conf. Interval]	
prim_walking	0.0239	-0.4431	0.1830	-2.4200	0.0150	-0.8018	-0.0845
prim_swimming	0.0171	0.7613	0.3189	2.3900	0.0170	0.1363	1.3864
prim_rowing	0.5597	0.4173	0.0945	4.4200	0.0000	0.2322	0.6025
prim_biking	0.0887	0.1424	0.1198	1.1900	0.2340	-0.0923	0.3772
prim_running	0.1672	0.1018	0.1000	1.0200	0.3090	-0.0943	0.2979
self_efficacy	7.4437	0.0799	0.0164	4.8900	0.0000	0.0479	0.1120
stress_release	-4.8805	-0.0690	0.0162	-4.2600	0.0000	-0.1007	-0.0373
contentment	1.1741	-0.0230	0.0169	-1.3600	0.1730	-0.0561	0.0101

Prb. exercise_intensity =	Obs	Mean	Std. Dev.	Min	Max
0	293	0.0169	0.0422	0.0002	0.4260
1	293	0.0102	0.0203	0.0001	0.1371
2	293	0.0419	0.0645	0.0007	0.2942
3	293	0.1087	0.1065	0.0035	0.3555
4	293	0.3374	0.1425	0.0425	0.5327
5	293	0.4850	0.2787	0.0048	0.9529

Table 5.20 *Ologit predicted probabilities for exercise intensity*

The next section discusses all the tables in more detail.

6 DISCUSSION, LIMITS & CONCLUSION

6.1 PREDICTIONS DISCUSSION

Returning to the predictions specified in the analysis, prediction 1 and its subsections (1.1, 1.2, 1.3) were found to be true, with the adage that the number of older sibling athletes had a positive effect on the age of cessation. Longer career duration was associated with higher levels of exercise maintenance among past rowers, supporting prediction 2. Regression results supported this prediction, though the initial comparison of means was statistically insignificant. On average, physically active individuals were taller, endorsing prediction 3. Among the incentive rankings, current exercise levels were predicted best by extrinsic rankings, rather than by intrinsic ones. This was true across all activity groups and across rowing statuses. Although prediction 4 was found to be false, this result is of particular interest because it so contradicts the supporting literature: previous theory overwhelmingly supports the idea that maintenance is predicted most accurately by intrinsic motivations. As was discussed in the introduction, rowing serves as an intersection between exercise and sport, and the evidence from my analysis suggests extrinsic incentives crowd-out intrinsic ones, successfully motivating maintenance.

Analysis of prediction 5 shows a similarly confounding result. Contrary to the theory presented on commitment devices, a comparison of means suggests that rowers who report the use of commitment devices are able to do so to a greater degree of efficacy than individuals analyzed in the literature. This is likely due to the difference in incentive structure for rowers compared to many athletes, discussed in the previous point. Commitment devices represent an extrinsic incentive: although the individuals who utilize these devices do not experience sufficient intrinsic motivations, as sophisticated hyperbolic discounters, they are able to regulate their incentives for exercise to maintain higher physical activity levels.

Prediction 6 was found to hold – physically active individuals reported higher self-efficacy levels, and higher levels of intrinsic motivation than their inactive cohorts, though both groups were found to have higher levels of extrinsic motivation compared to intrinsic motivation. Prediction 6.1 was false: although self-efficacy is a statistically significant predictor for *activity_class, exercise_days* and *exercise_intensity,* the leading predictor of current activity levels was *prim_rowing*, the indicator for primary activity type. This result is probably due to the sample of rowers, and is a proxy variable separating all individuals surveyed into "people who currently row" and "people who do not currently row." Our definition of "current rowers" is that they are participating on a competitive team, but it seems that a more accurate separation would be based on the primary activity type.

Analysis of the current incentives for exercise disproves prediction 7. Past and current rowers were seen to rank extrinsic motivators as most important, and do not deviate significantly on their intrinsic incentive rankings. Predictions 7 and 8 were motivated by the papers of Kilpatrick et al., (2005) and Frederick et al. (1993): both of these predictions were found not to hold for the individuals sampled – image motivation was found to be different across active and inactive individuals, as opposed to due to gender differences.

6.2 REGRESSIONS DISCUSSION

Contentment, self-efficacy, *prim_rowing* and the stress release ranking were found to be significant predictors of all three dependent variables. Contentment and stress release had negative effects for the sample population, although stress release had small positive effects on the activity class and exercise frequency of past rowers. Self-efficacy and *prim_rowing* had positive effects across the board; *start_parents* had negative effects on both activity class and exercise frequency, as did the image ranking.

6.2.1 ACTIVITY CLASS & EXERCISE FREQUENCY

Since activity class and exercise frequency describe highly related behavior, many of their predictors in the OLS regression were the same. The results show that *prim_rowing* is the leading predictor of *activity_class*, and *exercise_days*. Looking at the OLS regressions, for a one-point increase in *prim_rowing*, *activity_class* increases by 1.265-points for the entire sample. Among past rowers, this result is even stronger, which makes sense: the marginal effect of each respondent whose primary activity is rowing is more significant among the population with fewer rowers (diminishing marginal effects). This result shows that individuals whose primary physical activity is rowing are a full 1.265 activity classes higher (or 2.53 hours per week more), on average. This is hardly surprising, given the sample population of past and current rowers, but it does point to an important distinction in the incentive comparisons. It seems that differing incentives for maintenance are linked to the completion of the activity, regardless of whether or not respondent's practices are "coached and/or compulsory."

Start_parents is the next largest predictor of exercise maintenance, and it is negative. This result is very interesting: respondents who reported parental influence at initiation also reported activity classes 0.462 lower, or almost an hour per week less, than those who did not. Among past rowers, this effect was less strong and found to be statistically insignificant. However, the effect on current rowers was enormous, shifting the activity class down by 0.632 (1.26 hours per week less). For exercise frequency, current rowers who selected the "My Parents" indicator exercised almost a full day less (0.733) per week. Including the dilution from past rowers, the overall sample effect is a decrease of 0.548 days per week, on average. This finding suggests that parental motivation at initiation negatively affects current exercise levels. No previous report of this result is found in the literature reviewed, suggesting that parental influence on exercise incentives is an area requiring more research. While distinctions are made in the literature between initiation and maintenance, the striking result here is that the effects of initiation incentives persist despite exposure to high levels of physical activity in the interim. Indeed, further statistical testing among those who indicated "My Parents," reveals similar ages of initiation and cessation, similar career durations, and a comparable ratio of past and current rowers.

For activity class, the *mech_social* indicator is the next largest predictor, especially among current rowers. I suspect that this result is due to the fact that current rowers reported "Social support/obligations" in lieu of "I am currently on a rowing team, and that is what motivates my current exercise." Evidence for this can be found in the disparate directions of the effect on current and past rowers. Current rowers who reported this indicator variable were 0.621 activity classes higher than those who did not; past rowers who did so were 0.240 activity classes lower, on average. From here, the overall sample effect is a result of the fact that fewer past rowers responded to the survey than current rowers.

For exercise frequency, the *mech_none* indicator predicted a decrease in the number of weekly exercise days by 0.375, on average. In past rowers, this effect was slightly weaker (-0.326) and among current rowers, slightly stronger (-0.472). In other words, respondents who indicated not using any commitment mechanisms reported fewer days of exercise per week. The number of parent athletes was significant at the 5% level, only for the entire sample. Generally speaking, an increase in the number of parent athletes had a small positive effect on weekly exercise hours. Contentment, self-efficacy, image ranking and relatedness ranking were also found to be statistically significant regressors of both exercise hours and frequency, albeit with much smaller effects.

6.2.2 EXERCISE INTENSITY – RANKING TOUGHNESS

The regression results for exercise intensity show, not altogether unsurprisingly, that primary activity type is the leading predictor of exercise intensity. By comparing the significance of the effects, I can form a proxy ranking for the intensity of the selection of lifestyle endurance sports offered in the survey. The leading predictor for exercise intensity is the *prim_walking* indicator, with a negative effect for the sample population. Then, in order, *prim_swimming, prim_rowing, prim_biking* and *prim_running*, are the variables with the largest β–coefficients for the sample population. Interestingly, for past rowers, the largest positive coefficient for exercise intensity was on *prim_swimming* – the primary activity indicator for swimming. This means that those who reported *prim_swimming* also reported higher intensities than those who indicated *prim_rowing*, among past rowers. Although the true intensity of the sports is not compared, it seems unimportant to do so in the face of the fact that past rowers perceived swimming to be more intense than rowing. Past rowers rated swimming at higher intensities than current rowers did (β of 1.368 compared to 0.627), whereas current rowers rated biking as more intense than past rowers did (β of 0.517 compared 0.174). Self-efficacy had small positive effects on exercise intensity levels, whereas stress release rankings and contentment had negative effects, for the entire sample.

6.3 ORDERED LOGIT DISCUSSION

The marginal coefficient describes how the probability of being in a particular *activity_class* or *exercise_days* category changes with a one-point increase in the independent variable. These results are particularly useful because they allow for a comparison of the marginal effects across activity classes and exercise frequencies. The following graphs show the marginal effects on each activity class (0-6), exercise frequency (0-7) and intensity ranking (0-5) for the two leading variables of interest – *prim_rowing* and *start_parents*. The y-values for each category indicate the change in probability of being in that particular category for a one-point increase in the variable of interest from its mean value. For example, for the sixth exercise intensity group (i.e., *exercise_intensity* = 5) increasing the *prim_rowing* indicator from its mean value by one-point increases the probability of the respondent being in that category by 0.4173 points.

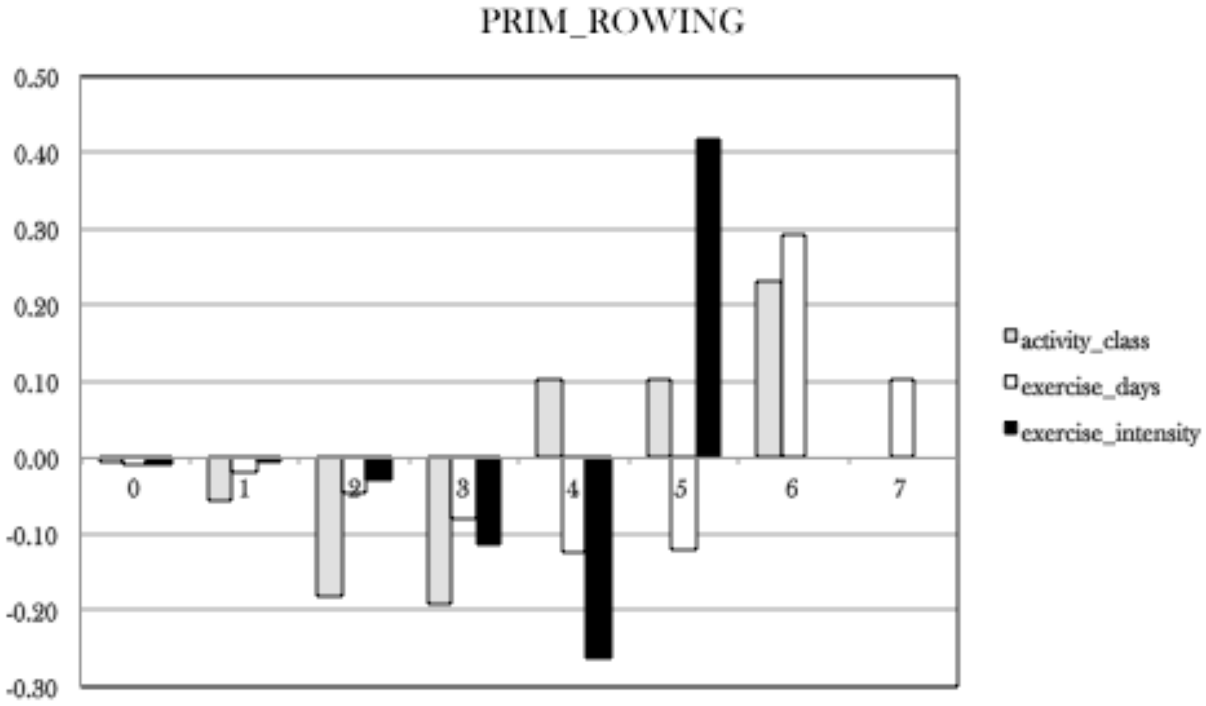


Figure 6.1 *Marginal effects of* prim_rowing *on each* activity_class, exercise_days *and* exercise_intensity *category*

	COEFFICIENTS		
CATEGORY	activity_class	exercise_days	exercise_intensity
0	-0.0057	-0.0082	-0.0073
1	-0.0575	-0.0183	-0.0053
2	-0.1800	-0.0465	-0.0284
3	-0.1929	-0.0794	-0.1129
4	0.1017	-0.1253	-0.2634
5	0.1034	-0.1196	0.4173
6	0.2309	0.2941	-
7	-	0.1032	-

Table 6.1 *Marginal effects of* prim_rowing *on each* activity_class, exercise_days *and* exercise_intensity *category*

The *prim_rowing* indicator shows a negative effect for the first four activity classes in Figure 6.1, indicating that respondents whose current form of exercise is rowing were less likely to be in each of these categories. The effect changes direction for the fifth activity class (*activity_class* = 4), and increases in magnitude, indicating an increased probability of the respondent belonging to the highest three activity classes. Overall then, *prim_rowing* has a positive effect on weekly exercise hours: marginal effects indicate a reduced probability of the respondent belonging to the lower activity classes and increased probability of belonging to the higher activity classes.

Similar effects are observed for exercise frequency and intensity, albeit with the direction of effect shifting around different points. The trend for exercise intensity is particularly interesting: it seems to show that there is a decreased probability of being in the first five intensity categories, but that the marginal effect is increasingly negative. In other words, a one-point increase in *exercise_intensity* from the mean value has a much larger negative effect on the fourth and fifth categories. This is because almost 97% of respondents who indicated *prim_rowing* were in the top two categories for exercise intensity. The graph also shows that the largest positive marginal effect of *prim_rowing* on *exercise_days* is for those who indicated 6 days of exercise per week. Of the

164 respondents who reported rowing as their primary activity, 111 (68%) reported exercising for six days in the previous week. Thus, the marginal effects of the *prim_rowing* indicator on the probability of belonging to a particular frequency category are largest for this class.

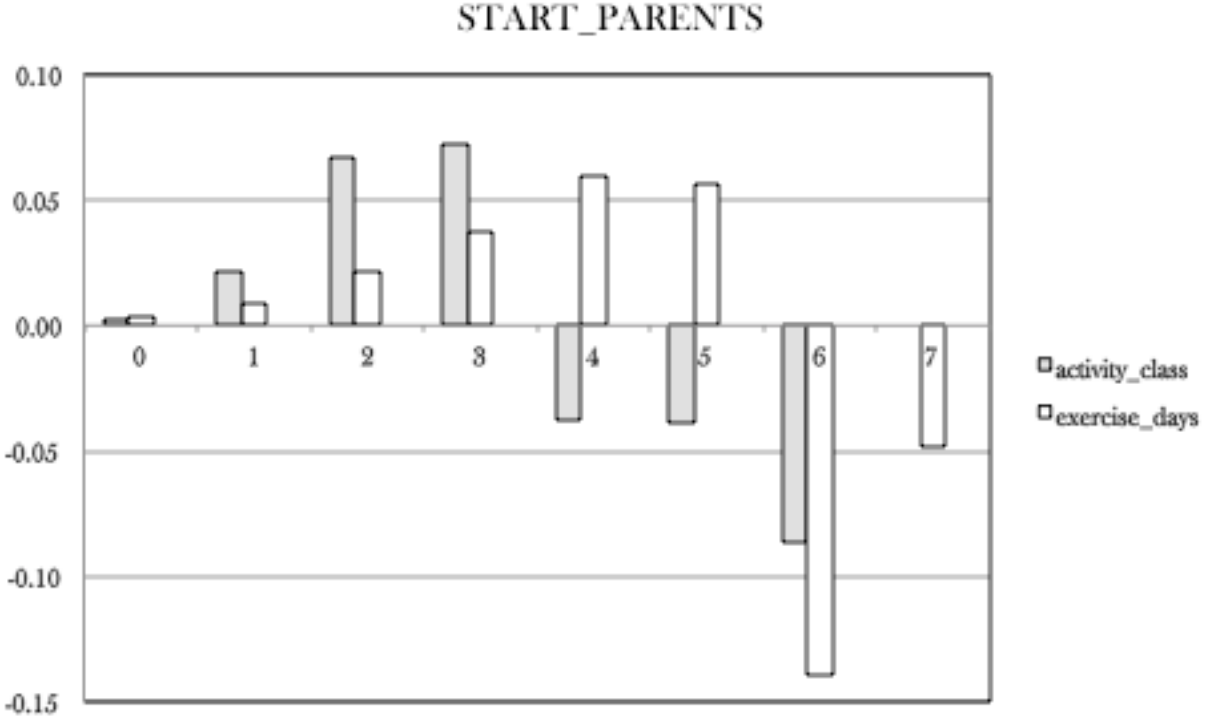


Figure 6.2 *Marginal effects of* start_parents *on each* activity_class *and* exercise_days category

	COEFFICIENTS		
CATEGORY	activity_class	exercise_days	exercise_intensity
0	0.0021	0.0039	-
1	0.0214	0.0087	-
2	0.0671	0.0220	-
3	0.0719	0.0375	-
4	-0.0379	0.0593	-
5	-0.0386	0.0566	-
6	-0.0861	-0.1391	-
7	-	-0.0488	-

Table 6.2 *Marginal effects of* start_parents *on each* activity_class *and* exercise_days category

The opposite is true for the *start_parents* indicator: Figure 6.2 shows increased likelihood of the respondent belonging to the lowest four activity classes and the lowest six frequency categories. This shows a negative effect on physical activity overall, with the largest impact on the highest activity class and second highest frequency class. The coefficients for *start_parents* on exercise intensity were not statistically significant in the regression, and as such were not included.

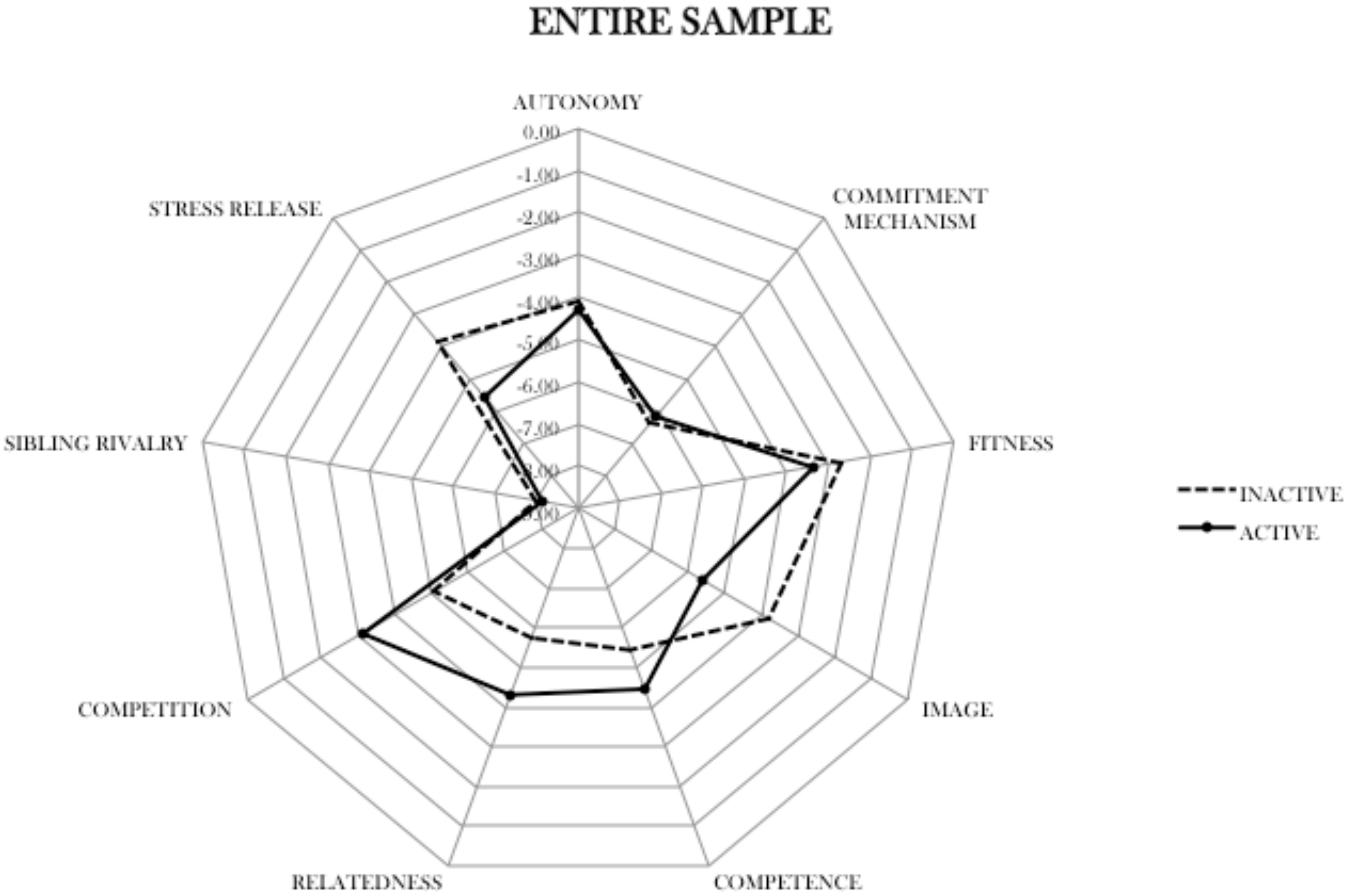
For a one-point increase in *start_parents* from the mean value, the probability of being in the highest activity class decreases by 0.0861, and the probability of being in the six-day-per-week exercise frequency group decreases by 0.1391. Both graphs indicate that the direction of effect changes for the fifth and sixth activity classes, and the seventh and eighth frequency categories. It seems that activity distinctions are made on these boundaries. In the context of the survey, the incentives for those in the highest three activity classes are significantly different than those in the lowest four, and those in the highest two frequency categories face different incentives than those in the lowest six. All graphs from the ordered logit analysis will be presented in the Appendix, section 5.

6.4 INCENTIVE RANKINGS DISCUSSION

An original goal of this paper was to examine how the incentive structure for exercise differs between those who are active and those who are inactive. Comparing average rankings across activity groups has shed some light on this result, but a visual synthesis of the tables presented in the analysis elucidates some results. For the entire sample, extrinsic motivations were ranked highest, among active and inactive individuals. Following the regression and ordered logit analyses, two clarifying distinctions arose. First, activity class incentives and behavior shift for the top three, rather than the top four classes. Second, the *prim_rowing* indicator may have served as a better marker of the differing incentive structure than the measure used in the survey of coached or compulsory practices.

Figure 6.3 shows a graph of the differing incentive structures between active (activity classes 4-6) and less active (0-3) respondents, for the entire population. As a reminder, the survey asked individuals to rank from "1 – Most important" to "9 – Least important," meaning that the important incentives are closer to zero in value. I multiplied these rankings by negative one to correct for this effect in the analysis. The axis on the radar graph expands from -9.00 to 0, with markers closer to the center signifying less importance. The main purpose of these graphs is to visualize the differences in incentives: specific values can be found in the tables presented. Further tables will be presented in the Appendix (section 6).

Figure 6.3 *Motivational profiles for active (classes 4-6) and less active respondents*



	STATUS	AUTONOMY	COMMITMENT MECHANISM	FITNESS	IMAGE	COMPETENCE	RELATEDNESS	COMPETITION	SIBLING RIVALRY	STRESS RELEASE
ENTIRE SAMPLE	INACTIVE	-4.08	-6.37	-2.68	-3.78	-5.44	-5.73	-5.07	-7.97	-3.88
	ACTIVE	-4.30	-6.16	-3.33	-5.63	-4.45	-4.31	-3.11	-8.16	-5.54

6.5 CONCLUSION

From this work I derive three main conclusions. First, incentives in rowing are extremely extrinsic in nature. Rowers who sustain exercise habits beyond the realms of their coached or compulsory practice activities contradict the incentives reported for individuals in the existing literature. Second, the activity of rowing itself, rather than coached practices, distinguishes between current and past rowers (in terms of incentives and exercise behavior) much more accurately.

Finally, despite rigorous and comparable exercise in the interim, parental influence at initiation reduces the likelihood of sustained exercise. Curiously, age of initiation, age of cessation, and thus career duration, were found to be statistically insignificant, relative to the *start_parents* indicator. Whether the effects of this particular regulatory extrinsic incentive are unique to rowers remains to be seen: further research of this nature among athletes may be useful in investigating this relationship.

This study has two main limitations. First, the effects indicated by the survey are limited in scope due to the lack of a comparable control group. Future work might compare rowers against non-athletes. Second, the methods used to ascertain levels of intrinsic and extrinsic motivation do not match up to the complexity of those used in the existing literature.

With regards to policy, these findings indicate that extrinsic incentives at initiation may be poor motivators of sustained physical activity. However, in contrast to the existing theory, these extrinsic incentives, such as cardiovascular fitness, may be sufficient motivators of exercise maintenance. Increasing the population's exercise levels may simply be a matter of mitigating the effects of time-discounting and information pollution. Technological progress in the widespread use and understanding of quantified exercise data may help to narrow these gaps, though further research is required to investigate the modification of the incentive structures.

REFERENCES LIST

Abrahms, J.L.; Allen, G.J. “Comparative Effectiveness of Situational Programming, Financial Pay-Offs and Group Pressure in Weight Reduction.” *Behavior Therapy*, 1974, vol. 5, iss. 3, pp. 391–400.

Bénabou, Roland; Tirole, Jean. "Intrinsic and Extrinsic Motivation." *The Review of Economic Studies,* 2003, vol. 70, iss. 3, pp. 489-520.

Bhattacharya, Jay; Hyde, Timothy; Tu, Peter. "Section VII: Behavioral Health Economics." *Health Economics*, 2014, New York: Palgrave Macmillan, pp. 496-542.

Bryan, Gharad; Karlan, Dean; Nelson, Scott. "Commitment devices." *Annual Review of Economics,* 2010, vol. 2, iss. 1, pp. 671-698.

Cawley, John. “An Economic Framework for Understanding Physical Activity and Eating Behaviors.” *American Journal of Preventive Medicine*, 2004, vol. 27, iss. 3, Supplement, pp. 117-125.

Charness, Gary; Gneezy, Uri. "Incentives to Exercise." *Econometrica,* 2009, vol. 77, iss. 3, pp. 909-31.

Cohen, Emma E. A. et al. “Rowers’ High: Behavioural Synchrony Is Correlated with Elevated Pain Thresholds.” *Biology Letters* 6.1 (2010): 106–108. *PMC.* Web. 7 May 2015.

DellaVigna, Steffano; Malmendier, Ulrike. “Paying Not to Go to the Gym.” *American Economic Review*, 2006, vol. 96, iss. 3, pp. 694–719.

Deci, E.L.; Ryan, R.M. “Intrinsic Motivation and Self-Determination in Human Behavior.” 1985, Plenum, New York

Frederick, Christina M.; Ryan, Richard M. “Differences in Motivation for Sport and Exercise and their Relations with Participation and Mental Health.” *Journal of Sports Behavior*, 1993, vol. 16, pp. 125-145.

Gneezy, Uri; Meier, Stephan; Rey-Biel, Pedro. "When and Why Incentives (Don't) Work to Modify Behavior." *Journal of Economic Perspectives,* 2011, vol. 25, iss. 4, pp. 191-210.

Jeffery, R.W.; Wing, R.R. “Long-Term Effects of Interventions for Weight Loss Using Food Provision and Monetary Incentives.” *Journal of Consulting and Clinical Psychology*, 1995, vol. 63, iss. 5, pp. 793–796.

Katchova, Ani. "Econometrics - Ordered Probit and Logit Models." *YouTube,* 16 February 2013, http://www.youtube.com/user/econometricsacademy

Kilpatrick, Marcus, Ph.D; Hebert, Edward, Ph.D.; Bartholomew, John, Ph.D. “College Students' Motivation for Physical Activity: Differentiating Men's and Women's Motives for Sport Participation and Exercise.” *Journal of American College Health*, 2005, vol. 54, iss. 2, pp. 87-94.

Kramer, F.M., et al. “Maintenance of Successful Weight Loss Over 1 Year: Effects of Financial Contracts for Weight Maintenance or Participation in Skills Training.” *Behavior Therapy*, 1986, vol. 17, iss. 3, pp. 295–301.

Mahoney, M.J. “Self-Reward and Self-Monitoring Techniques for Weight Control.” *Behavior Therapy*, 1974, vol. 5, iss. 1, pp. 48–57

McAuley, Edward; Lox, Curt; Duncan, Terry E. “Long-term Maintenance of Exercise, Self-Efficacy, and Physiological Change in Older Adults.” *Journal of Gerontology,* 1993, vol. 48, iss. 4, pp. 218-224.

Murcia, Juan A.M., et al. “Peers’ Influence on Exercise Enjoyment: A Self-Determination Theory Approach.” *Journal of Sports Science & Medicine,* 2008, vol. 7, iss. 1, pp. 23–31.

Nilson, Thor S.; Daigneault, Ted and Matt Smith. "Basic Rowing Physiology." *Basic Rowing Physiology, World Rowing*, FISA, Web., 18 April, 2015 http://www.worldrowing.com/mm/Document/General/General/10/87/38/Chapter_2_-_Basic_Rowing_Ph_English.pdf.

Paloyo, Alfredo R., et al. "The Causal Link Between Financial Incentives and Weight Loss: An Evidence-Based Survey of the Literature." *Journal of Economic Surveys*, 2014, vol. 28, iss. 3, pp. 401-420.

Physical Activity Guidelines Advisory Committee. "Physical Activity Guidelines Advisory Committee Report, 2008." *Washington, DC: US Department of Health and Human Services,* 2008, A1-H14.

Pohlman, John T.; Leitner, Dennis W. “A Comparison of Ordinary Least Squares and Logistic Regression.” *The Ohio Journal of Science*, 2003, vol. 103, iss. 5, pp. 118-125, *Ohio State University Knowledge Bank*

Ryan, Richard M., et al. "Intrinsic Motivation and Exercise Adherence." *Int Journal of Sport Psychology*, 1997, vol. 28, iss. 4, pp. 335-354.

Robinson, Timothy T.; Carron, Albert V. "Personal and Situational Factors Associated with Dropping Out versus Maintaining Participation in Competitive Sport." *Journal of Sport Psychology*, 1982, vol. 4, iss. 4, pp. 364-378.

Rogers, Todd Ph.D.; Milkman, Katherine L. Ph.D.; Volpp, Kevin G, PhD. “Commitment Devices: Using Initiatives to Change Behavior.” *Journal of the American Medical Association,* 2014, vol. 311, iss. 20, pp. 2065-6.

Saccone, A.J.; Israel, A.C. “Effects of Experimenter Versus Significant Other-Controlled Reinforcement and Choice of Target Behavior on Weight Loss.” *Behavior Therapy*, 1978, vol. 9, iss. 2, pp. 271–278.

Sallis, James F.; Hovell, Melbourne F.; Hofstetter, Richard C. “Predictors of Adoption and Maintenance of Vigorous Physical Activity in Men and Women.” *Preventive Medicine*, 1992, vol. 21, iss. 2, pp. 237-251.

Seabrook, John. "Feel No Pain." The New Yorker, July 22nd, 1996, p. 32

US Department of Health and Human Services: *2008 Physical Activity Guidelines for Americans*; USDHHS, Washington DC (2008)

Volpp, K., et al. “Financial Incentive-Based Approaches for Weight Loss.” *Journal of the American Medical Association*, 2008, vol. 300, iss. 22, pp. 2631–2637.

Wansink, Brian. “Mindless Eating: Why We Eat More than We Think.” 2006, New York: Bantam.

Weil, Thomas E. "Timeline of Rowing." *RowingHistory-Home*, Starboard Oar, 2000, Web, 18 Apr., 2015. http://www.rowinghistory.net/index.html

APPENDIX

A.1 SLOTH MODEL OF TIME ALLOCATION

(Cawley, 2004)

- Assumes individuals seek to maximize their utility (happiness/welfare) subject to time, budget and biology constraints
- $U(S,L,O,T,H,F,W(S,L,O,T,H,F),H(S,L,O,T,H,F,W),Y)$
  - S: Time spent sleeping
  - L: Time spent at leisure (includes physical activity)
  - O: Time devoted to occupation (paid work)
  - T: Time in transportation (includes walking, biking)
  - H: Time spent in home production (unpaid work)
  - Each letter represents a vector of variables that indicate the number of hours of time spent in different pursuits, which directly affect utility (118)
- Indirectly affect utility through weight, W, and health, H
  - Weight is indirectly affected through caloric intake and physical activity (*F* represents caloric intake)
  - *Y* represents a composite of all goods other than food (119)
- Budget constraint: money spent on all goods ($Y + FP_F$) must add up to wage earnings (*w*, wage rate per hour, multiplied by *O*, hours spent at occupation):
  - $Y + FP_F = w * O$ (119)
- Time constraint: hours spent on all pursuits must add up to exactly 24 hours/day
  - $S + L + O + T + H = 24$ (119)

- Biological constraint: changes in weight are determined by caloric intake and expenditure through various activities (when intake > expenditure, weight will rise)
    - $\Delta W = c(F) - f(S, L, O, T, H, G) - \delta(G)W$
    - $c(F)$ Represents the caloric intake as a function of the foods consumed
    - $f(S, L, O, T, H, G)$ Captures the energy expended (function of all activities)
    - $\delta(G)$ Is the metabolic rate, a function of one's genes, G (119)

A.2 PROSPECT THEORY & TIME INCONSISTENCY

(Bhattacharya, Hyde & Tu, *Health Economics*)

- Certainty Effect: Tendency to value lotteries with certain outcomes ($p = 1$) over uncertain lotteries, even more than would be predicted based on risk aversion in expected utility theory (502)
- Loss Aversion: A tendency for people to be risk-averse with respect to gains and risk-seeking with respect to losses, and to value the same quantity of income more when it is framed as a loss than as a gain (508)
- Endowment Effect: The tendency of people to attach a greater value to a loss of a given amount than to an equivalent gain (509)
- Prospect Theory (Kahneman and Tversky, 1979)
    - The editing stage shows how people perceive and organize uncertain options to simplify the decision process
    - Editing stage is the culprit behind some of the observed inconsistencies with expected utility theory (change the nature of the problem due to framing, reference points, loss aversion or the endowment effect)

  - The evaluation stage is where these edited options are assessed against each other and the highest-value prospect is selected
    - Value function is utility calculated relative to a reference point (loss aversion, endowment effect)
    - Weighting function is probability weighted with internal personal biases (certainty effect)
    - Subcertainty is a property of weighting functions: they often add to less than one (515)
- Discounting Function: A vector of weights that indicates how much an individual values utility in present and future periods
  - Assumed to be monotonically decreasing and reasonably approximated with just two parameters (526)
- Beta-Delta Discounting: A discounting function which can be specified by two parameters, β and δ, where $0 < \beta < 1$ and $0 < \delta < 1$. Overall utility sums instantaneous utility from period 0 onwards, and is given by $U_{overall} = U_0 + \beta[\delta U_1 + \delta^2 U_2 + \ldots]$
  - β is the present bias parameter that discounts utility in all non-current periods
    - The closer β is to 0, the more future utility is discounted and the greater the bias towards the present
  - δ is the discount factor parameter that discounts utility incrementally more in each subsequent period (527)
- Preferences are time-consistent only if $\beta = 1$.
  - The resulting function is said to exhibit exponential discounting because utility from period t is worth δ^t as much as utility in the present

A.3 THE LEARNING THEORY MODEL

(Sallis et al., 1992)

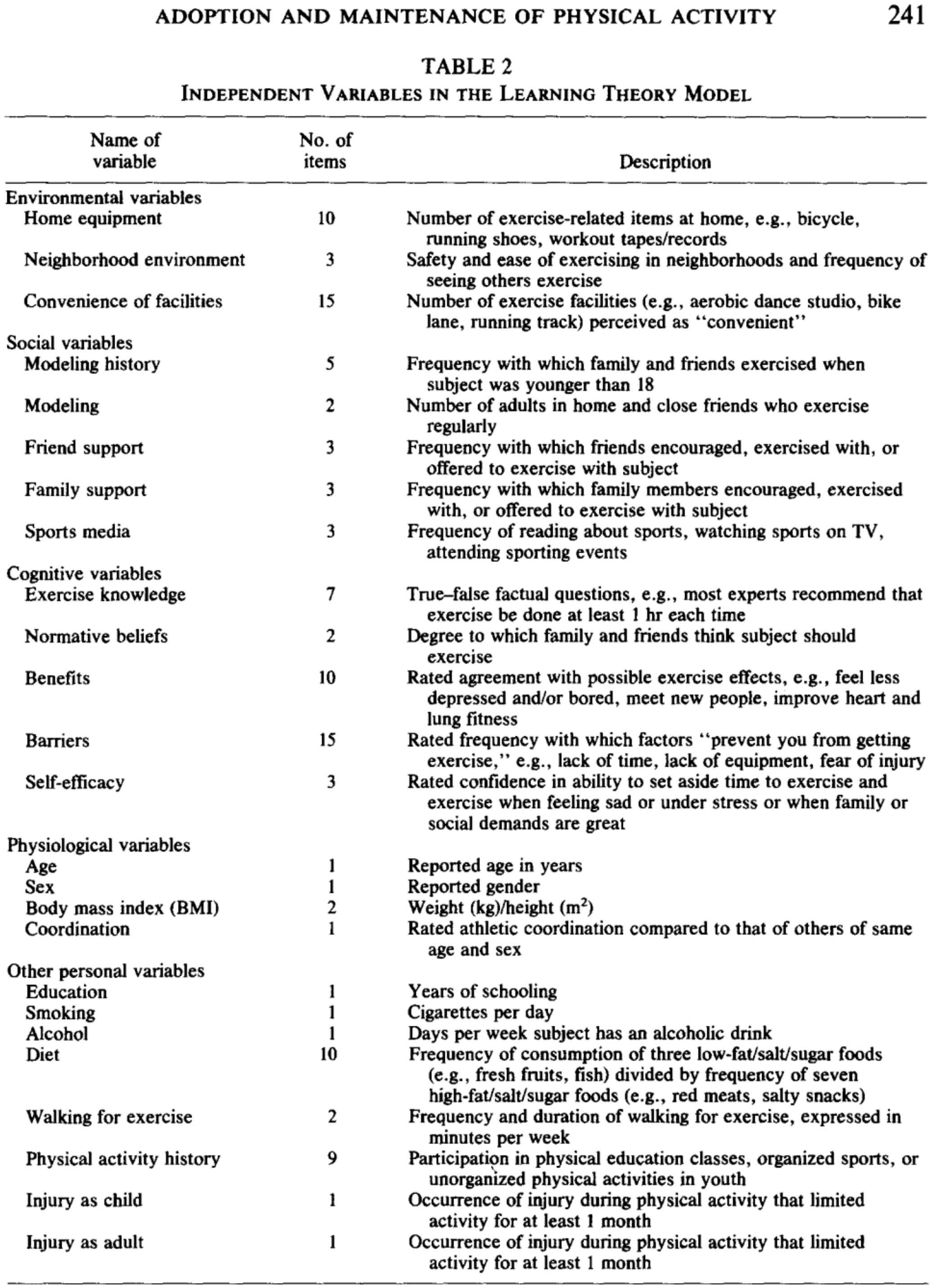
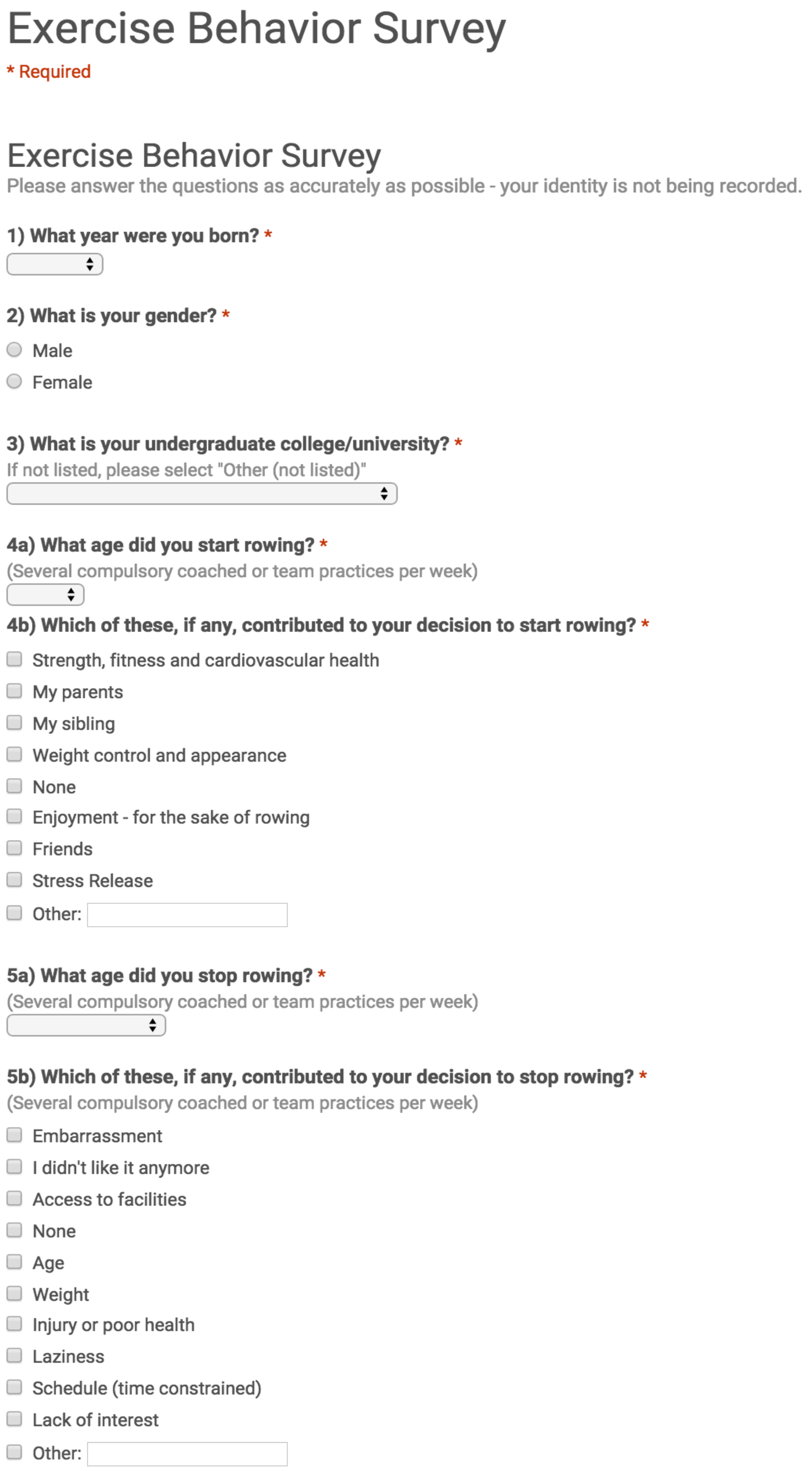


TABLE 2

INDEPENDENT VARIABLES IN THE LEARNING THEORY MODEL

Name of variable	No. of items	Description
Environmental variables		
Home equipment	10	Number of exercise-related items at home, e.g., bicycle, running shoes, workout tapes/records
Neighborhood environment	3	Safety and ease of exercising in neighborhoods and frequency of seeing others exercise
Convenience of facilities	15	Number of exercise facilities (e.g., aerobic dance studio, bike lane, running track) perceived as "convenient"
Social variables		
Modeling history	5	Frequency with which family and friends exercised when subject was younger than 18
Modeling	2	Number of adults in home and close friends who exercise regularly
Friend support	3	Frequency with which friends encouraged, exercised with, or offered to exercise with subject
Family support	3	Frequency with which family members encouraged, exercised with, or offered to exercise with subject
Sports media	3	Frequency of reading about sports, watching sports on TV, attending sporting events
Cognitive variables		
Exercise knowledge	7	True–false factual questions, e.g., most experts recommend that exercise be done at least 1 hr each time
Normative beliefs	2	Degree to which family and friends think subject should exercise
Benefits	10	Rated agreement with possible exercise effects, e.g., feel less depressed and/or bored, meet new people, improve heart and lung fitness
Barriers	15	Rated frequency with which factors "prevent you from getting exercise," e.g., lack of time, lack of equipment, fear of injury
Self-efficacy	3	Rated confidence in ability to set aside time to exercise and exercise when feeling sad or under stress or when family or social demands are great
Physiological variables		
Age	1	Reported age in years
Sex	1	Reported gender
Body mass index (BMI)	2	Weight (kg)/height (m^2)
Coordination	1	Rated athletic coordination compared to that of others of same age and sex
Other personal variables		
Education	1	Years of schooling
Smoking	1	Cigarettes per day
Alcohol	1	Days per week subject has an alcoholic drink
Diet	10	Frequency of consumption of three low-fat/salt/sugar foods (e.g., fresh fruits, fish) divided by frequency of seven high-fat/salt/sugar foods (e.g., red meats, salty snacks)
Walking for exercise	2	Frequency and duration of walking for exercise, expressed in minutes per week
Physical activity history	9	Participation in physical education classes, organized sports, or unorganized physical activities in youth
Injury as child	1	Occurrence of injury during physical activity that limited activity for at least 1 month
Injury as adult	1	Occurrence of injury during physical activity that limited activity for at least 1 month

A.4 SURVEY SENT TO PAST AND CURRENT ROWERS



Exercise Behavior Survey

* Required

Exercise Behavior Survey

Please answer the questions as accurately as possible - your identity is not being recorded.

1) What year were you born? *

2) What is your gender? *

○ Male
○ Female

3) What is your undergraduate college/university? *

If not listed, please select "Other (not listed)"

4a) What age did you start rowing? *

(Several compulsory coached or team practices per week)

4b) Which of these, if any, contributed to your decision to start rowing? *

☐ Strength, fitness and cardiovascular health
☐ My parents
☐ My sibling
☐ Weight control and appearance
☐ None
☐ Enjoyment - for the sake of rowing
☐ Friends
☐ Stress Release
☐ Other:

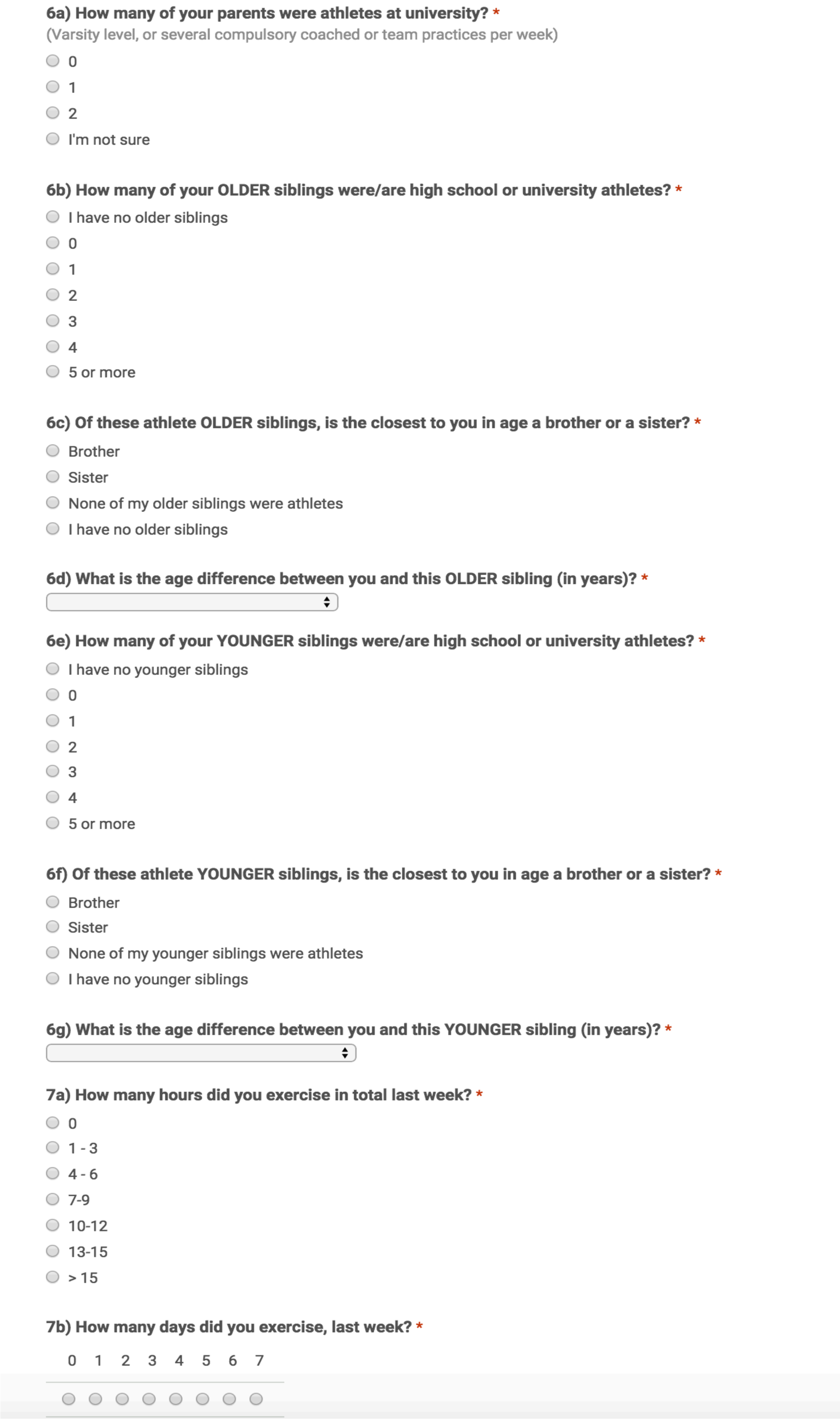
5a) What age did you stop rowing? *

(Several compulsory coached or team practices per week)

5b) Which of these, if any, contributed to your decision to stop rowing? *

(Several compulsory coached or team practices per week)

☐ Embarrassment
☐ I didn't like it anymore
☐ Access to facilities
☐ None
☐ Age
☐ Weight
☐ Injury or poor health
☐ Laziness
☐ Schedule (time constrained)
☐ Lack of interest
☐ Other:



6a) How many of your parents were athletes at university? *
(Varsity level, or several compulsory coached or team practices per week)

○ 0
○ 1
○ 2
○ I'm not sure

6b) How many of your OLDER siblings were/are high school or university athletes? *

○ I have no older siblings
○ 0
○ 1
○ 2
○ 3
○ 4
○ 5 or more

6c) Of these athlete OLDER siblings, is the closest to you in age a brother or a sister? *

○ Brother
○ Sister
○ None of my older siblings were athletes
○ I have no older siblings

6d) What is the age difference between you and this OLDER sibling (in years)? *

6e) How many of your YOUNGER siblings were/are high school or university athletes? *

○ I have no younger siblings
○ 0
○ 1
○ 2
○ 3
○ 4
○ 5 or more

6f) Of these athlete YOUNGER siblings, is the closest to you in age a brother or a sister? *

○ Brother
○ Sister
○ None of my younger siblings were athletes
○ I have no younger siblings

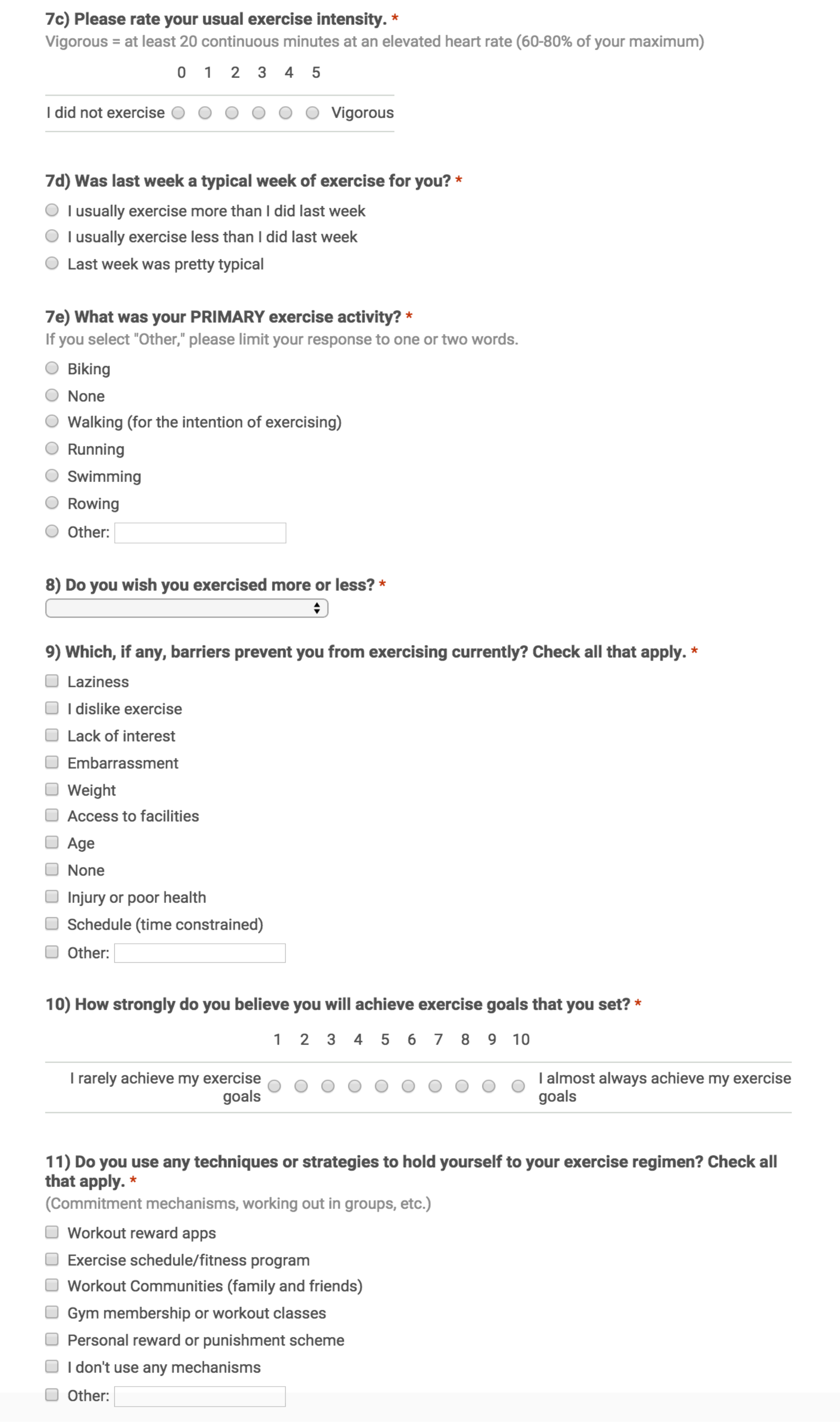
6g) What is the age difference between you and this YOUNGER sibling (in years)? *

7a) How many hours did you exercise in total last week? *

○ 0
○ 1 - 3
○ 4 - 6
○ 7-9
○ 10-12
○ 13-15
○ > 15

7b) How many days did you exercise, last week? *

0	1	2	3	4	5	6	7
○	○	○	○	○	○	○	○



7c) Please rate your usual exercise intensity. *

Vigorous = at least 20 continuous minutes at an elevated heart rate (60-80% of your maximum)

	0	1	2	3	4	5	
I did not exercise	○	○	○	○	○	○	Vigorous

7d) Was last week a typical week of exercise for you? *

○ I usually exercise more than I did last week
○ I usually exercise less than I did last week
○ Last week was pretty typical

7e) What was your PRIMARY exercise activity? *

If you select "Other," please limit your response to one or two words.

○ Biking
○ None
○ Walking (for the intention of exercising)
○ Running
○ Swimming
○ Rowing
○ Other:

8) Do you wish you exercised more or less? *

9) Which, if any, barriers prevent you from exercising currently? Check all that apply. *

☐ Laziness
☐ I dislike exercise
☐ Lack of interest
☐ Embarrassment
☐ Weight
☐ Access to facilities
☐ Age
☐ None
☐ Injury or poor health
☐ Schedule (time constrained)
☐ Other:

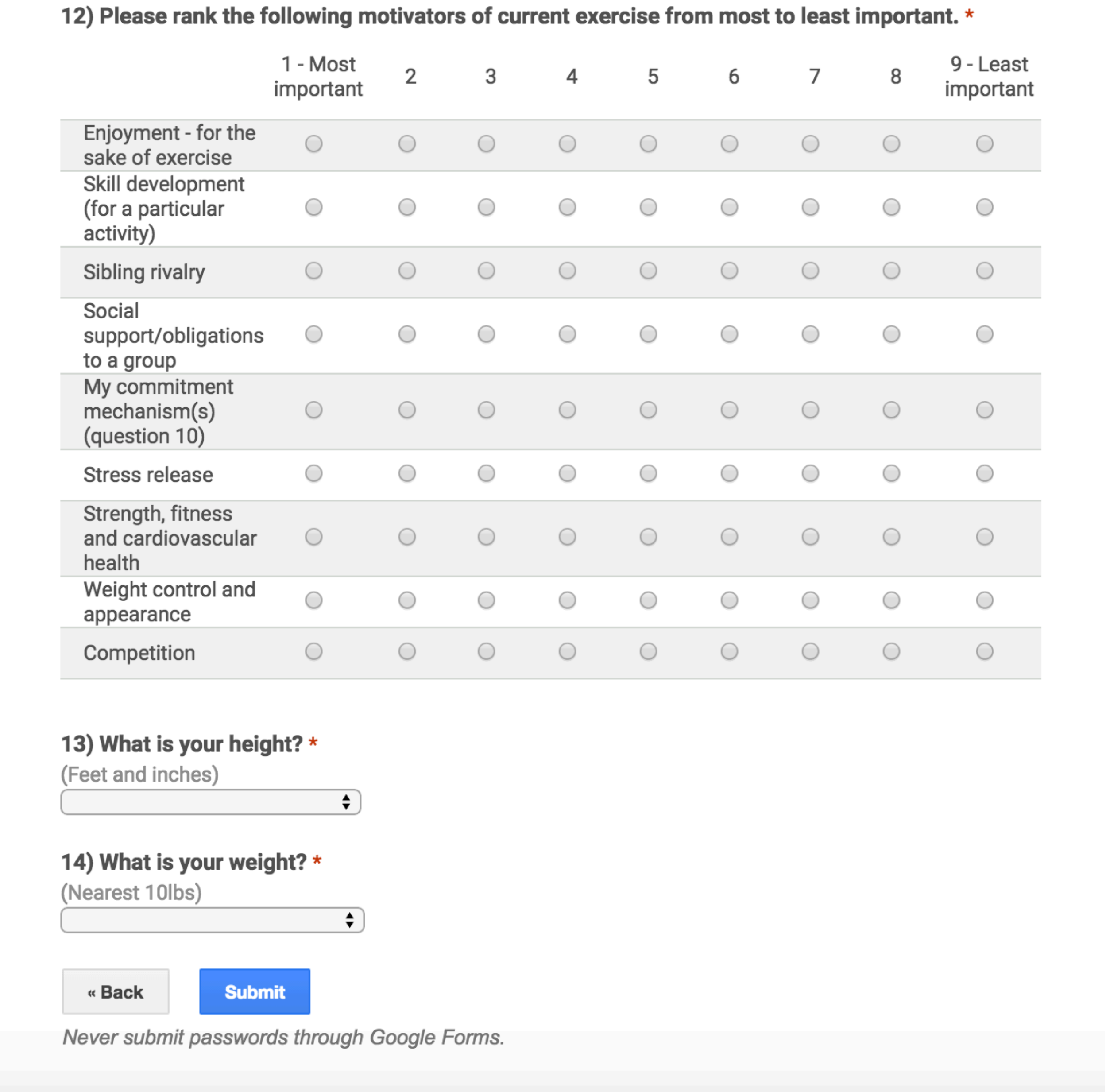
10) How strongly do you believe you will achieve exercise goals that you set? *

	1	2	3	4	5	6	7	8	9	10	
I rarely achieve my exercise goals	○	○	○	○	○	○	○	○	○	○	I almost always achieve my exercise goals

11) Do you use any techniques or strategies to hold yourself to your exercise regimen? Check all that apply. *

(Commitment mechanisms, working out in groups, etc.)

☐ Workout reward apps
☐ Exercise schedule/fitness program
☐ Workout Communities (family and friends)
☐ Gym membership or workout classes
☐ Personal reward or punishment scheme
☐ I don't use any mechanisms
☐ Other:



12) Please rank the following motivators of current exercise from most to least important. *

	1 - Most important	2	3	4	5	6	7	8	9 - Least important
Enjoyment - for the sake of exercise	○	○	○	○	○	○	○	○	○
Skill development (for a particular activity)	○	○	○	○	○	○	○	○	○
Sibling rivalry	○	○	○	○	○	○	○	○	○
Social support/obligations to a group	○	○	○	○	○	○	○	○	○
My commitment mechanism(s) (question 10)	○	○	○	○	○	○	○	○	○
Stress release	○	○	○	○	○	○	○	○	○
Strength, fitness and cardiovascular health	○	○	○	○	○	○	○	○	○
Weight control and appearance	○	○	○	○	○	○	○	○	○
Competition	○	○	○	○	○	○	○	○	○

13) What is your height? *

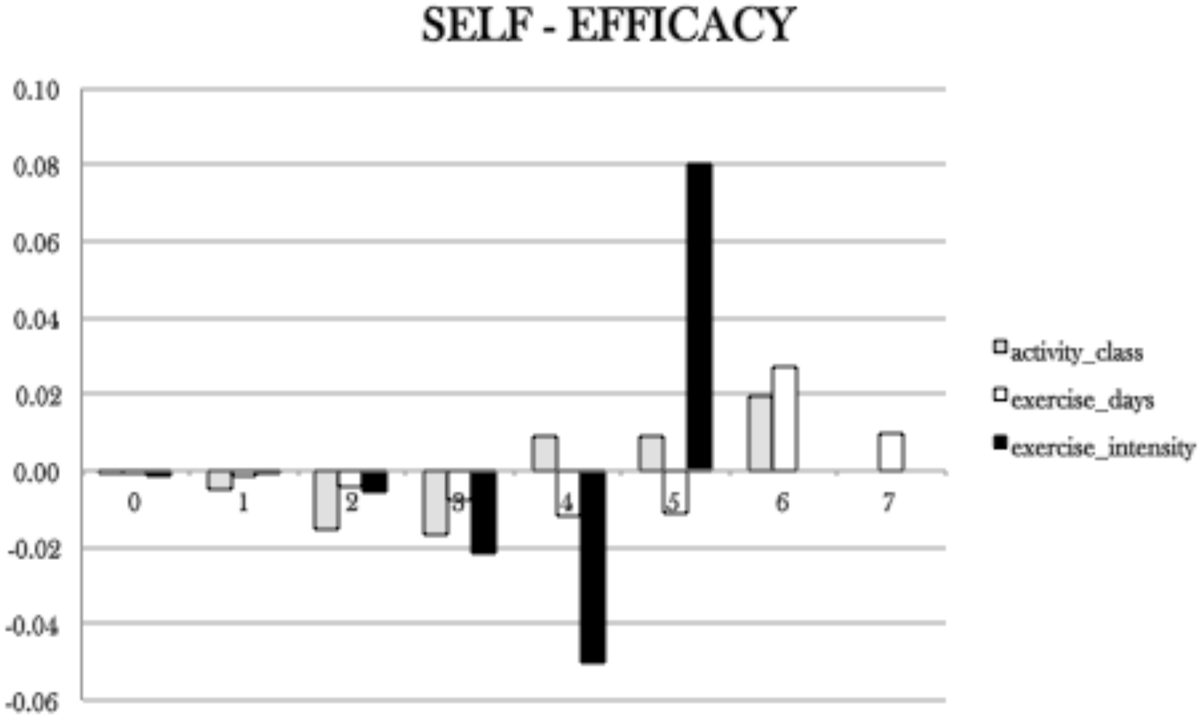
(Feet and inches)

14) What is your weight? *

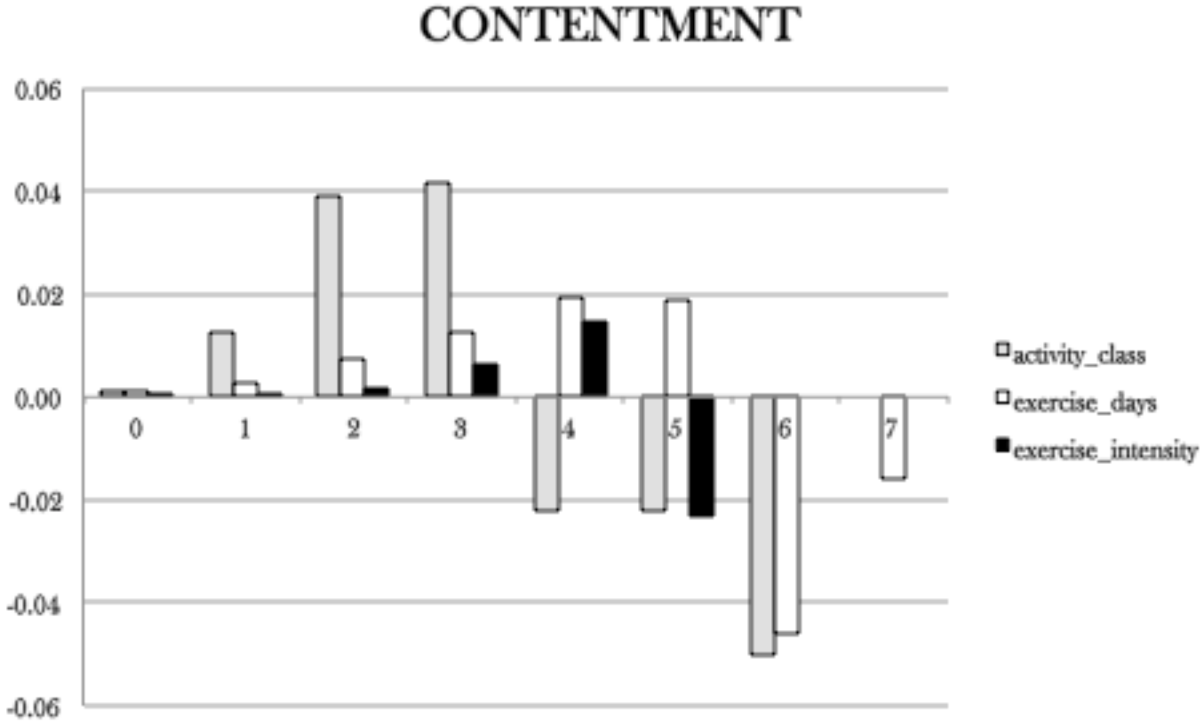
(Nearest 10lbs)

Never submit passwords through Google Forms.

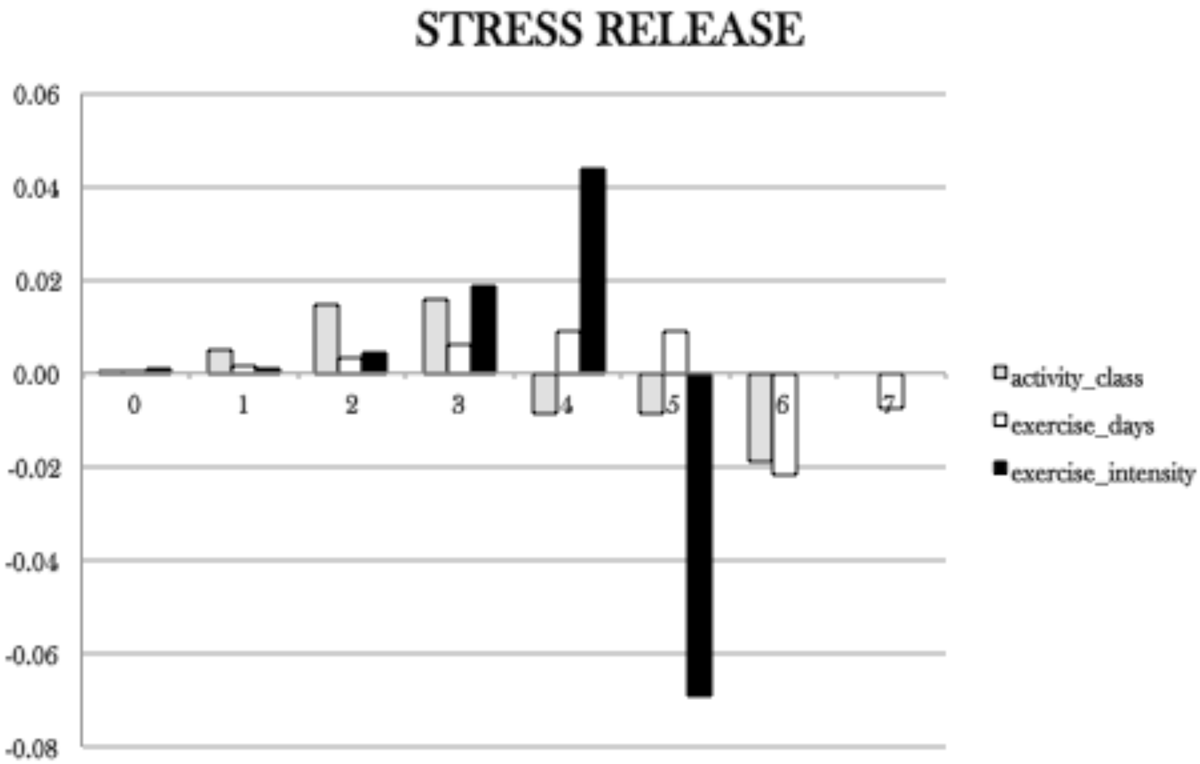
A.5 ORDERED LOGIT GRAPHS & TABLES



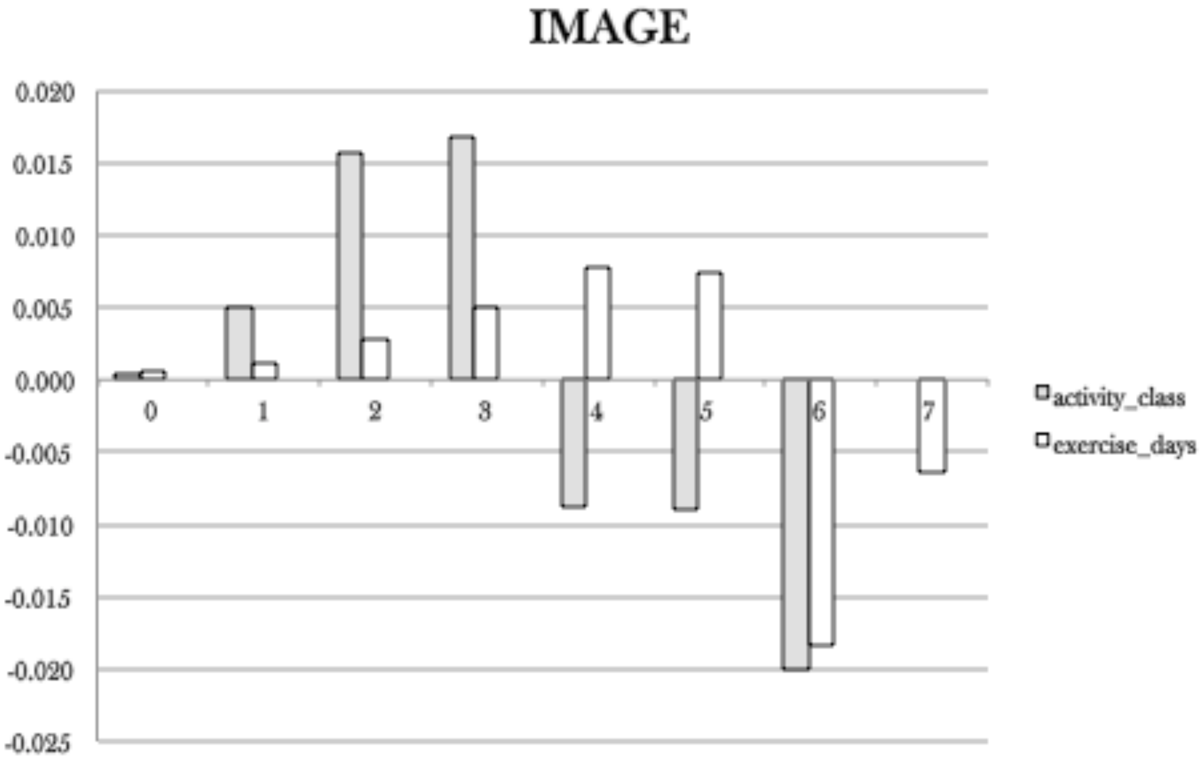
	COEFFICIENTS		
CATEGORY	activity_class	exercise_days	exercise_intensity
0	-0.0005	-0.0008	-0.0014
1	-0.0049	-0.0017	-0.0010
2	-0.0154	-0.0043	-0.0054
3	-0.0165	-0.0073	-0.0216
4	0.0087	-0.0116	-0.0504
5	0.0089	-0.0111	0.0799
6	0.0198	0.0272	-
7	-	0.0096	-



	COEFFICIENTS		
CATEGORY	activity_class	exercise_days	exercise_intensity
0	0.0012	0.0013	0.0004
1	0.0124	0.0029	0.0003
2	0.0389	0.0072	0.0016
3	0.0417	0.0124	0.0062
4	-0.0220	0.0195	0.0145
5	-0.0224	0.0186	-0.0230
6	-0.0499	-0.0458	-
7	-	-0.0161	-

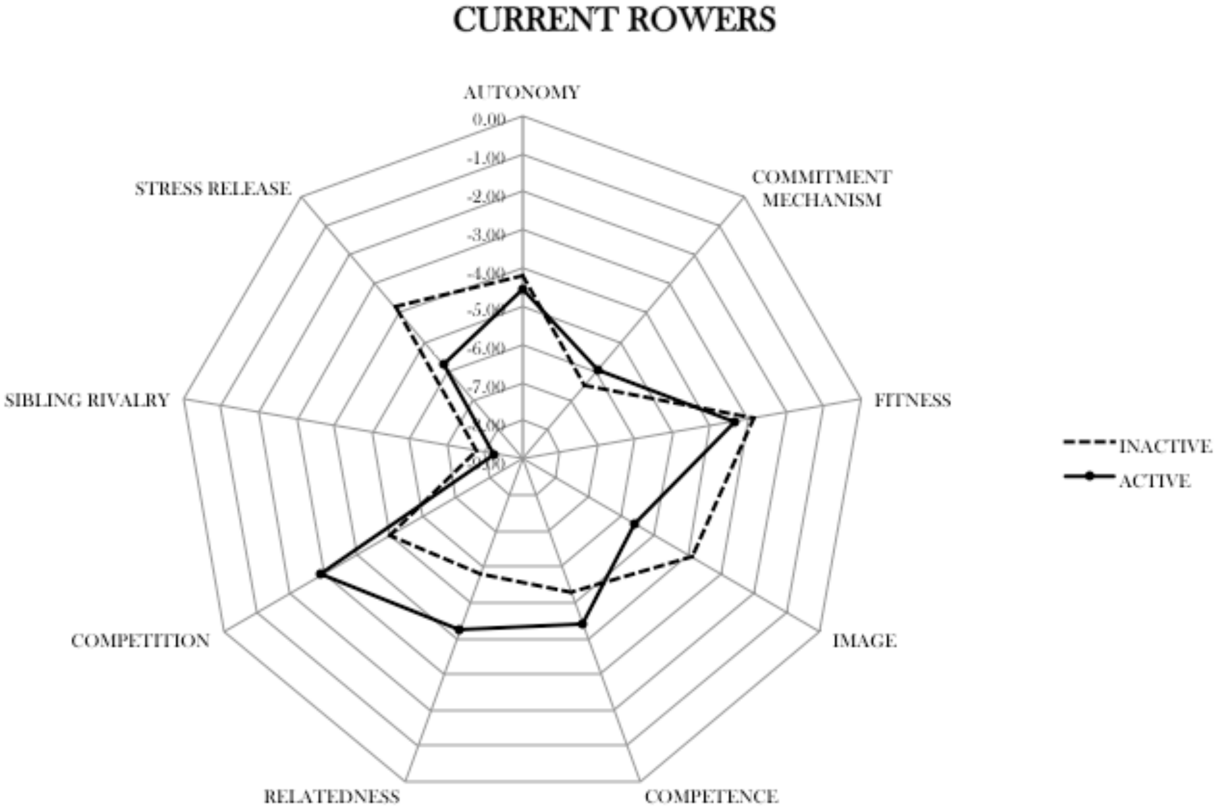


	COEFFICIENTS		
CATEGORY	activity_class	exercise_days	exercise_intensity
0	0.0005	0.0006	0.0012
1	0.0048	0.0014	0.0009
2	0.0150	0.0034	0.0047
3	0.0160	0.0059	0.0187
4	-0.0084	0.0093	0.0435
5	-0.0086	0.0088	-0.0690
6	-0.0192	-0.0217	-
7	-	-0.0076	-

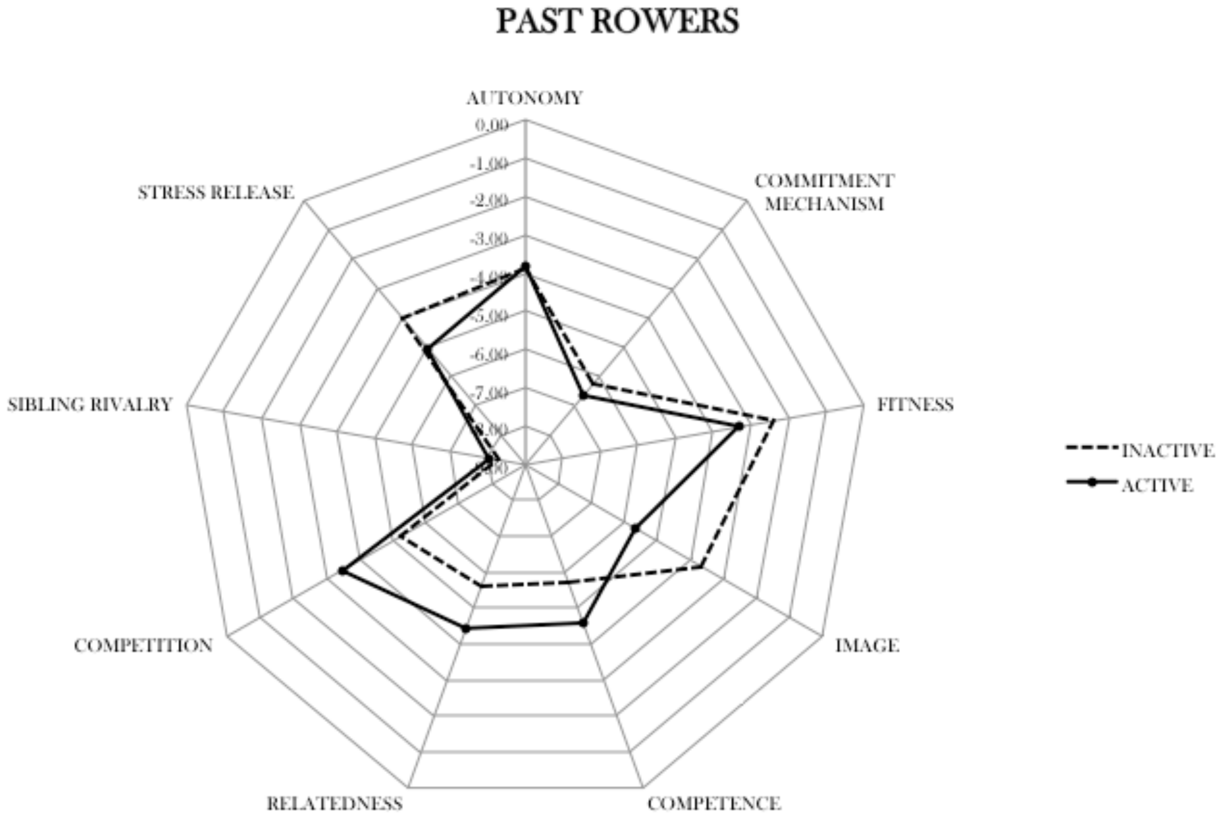


	COEFFICIENTS		
CATEGORY	activity_class	exercise_days	exercise_intensity
0	0.0005	0.0005	-
1	0.0050	0.0011	-
2	0.0156	0.0029	-
3	0.0167	0.0049	-
4	-0.0088	0.0078	-
5	-0.0090	0.0074	-
6	-0.0200	-0.0183	-
7	-	-0.0064	-

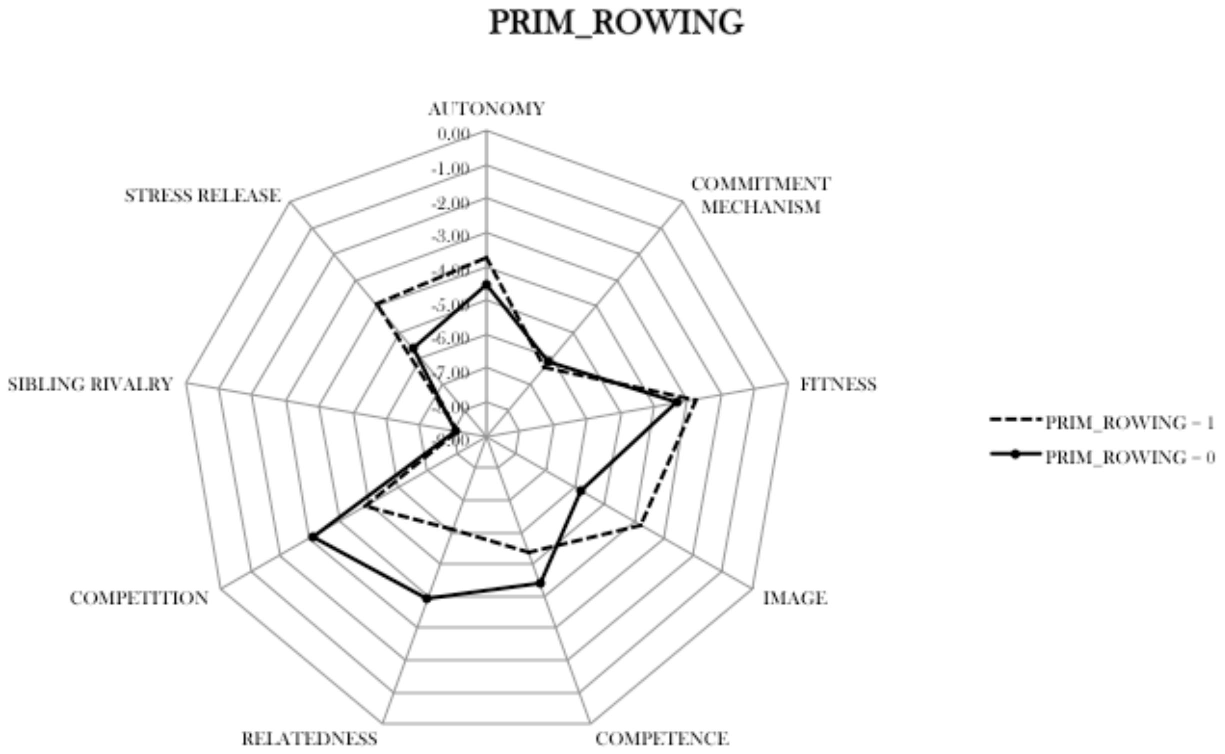
A.6 MOTIVATIONAL PROFILE GRAPHS



	CURRENT ROWERS	
INCENTIVE	**INACTIVE**	**ACTIVE**
AUTONOMY	-4.19	-4.53
COMMITMENT MECHANISM	-6.45	-5.93
FITNESS	-2.85	-3.34
IMAGE	-3.85	-5.63
COMPETENCE	-5.29	-4.38
RELATEDNESS	-5.81	-4.25
COMPETITION	-4.97	-2.93
SIBLING RIVALRY	-7.78	-8.22
STRESS RELEASE	-3.81	-5.79



	PAST ROWERS	
INCENTIVE	INACTIVE	ACTIVE
AUTONOMY	-3.88	-3.83
COMMITMENT MECHANISM	-6.23	-6.63
FITNESS	-2.40	-3.32
IMAGE	-3.67	-5.64
COMPETENCE	-5.70	-4.58
RELATEDNESS	-5.60	-4.44
COMPETITION	-5.23	-3.47
SIBLING RIVALRY	-8.28	-8.05
STRESS RELEASE	-4.00	-5.03



	PRIM_ROWING	
INCENTIVE	**= 1**	**= 0**
AUTONOMY	-3.77	-4.56
COMMITMENT MECHANISM	-6.36	-6.15
FITNESS	-2.75	-3.33
IMAGE	-3.78	-5.78
COMPETENCE	-5.36	-4.43
RELATEDNESS	-6.09	-3.92
COMPETITION	-4.84	-3.13
SIBLING RIVALRY	-8.12	-8.06
STRESS RELEASE	-3.93	-5.63