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The Influence of Physical Activity on Information Processing in Consumer Decision Making

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Declaration

I certify that the thesis I have presented for examination for the PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

I warrant that this authorisation does not, to the best of my belief, infringe the rights of any third party.

I declare that my thesis consists of 53,165 words (including footnotes and excluding references and appendices).

Abstract

When people engage in physical activity they often report that it alters the way they think and feel. These lay beliefs are generally supported by research on the cognitive benefits of physical activity. But despite the evidence on benefits of physical activity for cognition, little research has investigated whether physical activity has any effect on judgment and decision making, particularly in unrelated domains such as consumer decision making.

This thesis presents seven empirical studies which demonstrate that both regular and single bouts of physical activity influence consumers' product judgments and decision making. Specifically, the key results indicate that physical activity leads decision makers to weigh different product information more appropriately. The results were robust to the inclusion of various control variables.

In the first part of this thesis, five studies investigate the effect of physical activity on decision makers' ability to rely on relevant versus irrelevant information. Past research has shown that when faced with irrelevant product information, consumers often find it difficult to ignore the irrelevant information, and typically dilute their judgments (i.e. their judgments are less extreme). In contrast, the results of this research show that regular physical activity aids people's ability to focus on relevant information and ignore irrelevant information in product judgments.

In the second part of this thesis, three further studies indicate that physical activity influences attribute weighting in consumer decisions that require trade-offs between desirability and feasibility attributes. Decision makers tend to place a lot of emphasis on the desirability attributes, often at the expense of feasibility attributes. The findings of this research indicate that physical activity leads consumers to not overly focus on desirability, and consider feasibility attributes more in choices that require trade-offs between them. The findings have important implications for marketing and public policy since they extend the benefits of physical activity to a novel domain – information processing in consumer decision making.

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Table of Contents

List of Tables

List of Figures

Chapter 1. Introduction

Why do people engage in physical activity? It's annoying, it's boring and it hurts. When asking avid exercisers for their reasons to engage in physical activity, they swear by the positive effects of it. Not only do they report improvements of their physical health, but they also claim that physical activity changes the way they feel emotionally, and the way they think. Physical activity supposedly lifts their mood and clears their mind. People who regularly engage in physical activity often report a plethora of other benefits they experience, in addition to the health benefits. From antique philosophers to modern politicians and business managers, there are numerous quotes about the benefits of physical activity for the body and mind.

Generally, these lay beliefs in the benefits of physical activity are supported by empirical research investigating effects of physical activity on mental wellbeing and cognitive functions. For example, beneficial effects of physical activity have been found for emotional health (Hopkins, Davis, Vantieghem, Whalen, & Bucci, 2012; Lathia, Sandstrom, Mascolo, & Rentfrow, 2017), memory (Floel et al., 2010) and executive functions (Barenberg, Berse, & Dutke, 2011). Overall, studies indicate that physical activity enhances cognitive functions and protects against the development of neurodegenerative diseases (Kramer & Erickson, 2007). These cognitive benefits have been found for experimental manipulations using single bouts of physical activity (Tomporowski, 2003) as well as long-term interventions and cross-sectional studies (Jacobson & Matthaeus, 2014; Smith et al., 2010).

Despite the abundant evidence of physical activity benefits for cognition, little research has investigated the effect of physical activity on judgment and decision making. We know little about whether physical activity has any effect on how people form judgments and make decisions; and we know even less about whether physical activity has any effect on how people form judgments and make decisions in domains that are unrelated to the physical activity itself.

People don't engage in physical activity in a vacuum. They integrate their physical activity routine in their daily lives with activities following right afterwards, many of which require making decisions. Imagine a person shopping in a supermarket right after leaving the gym where they performed an intense workout. Would this person judge products differently and make other choices than a person who hadn't been exercising?

Similarly, would you expect a person who is a regular, persistent exerciser to make different judgments and choices than someone who is mostly sedentary? What about decisions in domains that are unrelated to exercising such as consumer decisions?

People's lay beliefs in the positive effects of physical activity would certainly support the notion of improved decision making capabilities. However, we often don't have great insight into how we make decisions and the factors that influence us (Nisbett & Wilson, 1977). Thus, such lay belief must be tested empirically. Studies on the cognitive benefits of physical activity indeed indicate that there might be differences in exercisers' information processing, which could influence judgments and decision making in unrelated consumer domains.

Contribution of this research

Prior research has not examined the effect of being physically active on unrelated consumer decision making. While research in cognitive neuroscience and exercise psychology suggest beneficial effects of physical activity for cognitive functions, not much is known about its effects on sports-unrelated decision making processes. The current research is about physical activity and its influence on information processing in unrelated consumer decision making. I demonstrate that regularly physically active individuals are less susceptible to dilution effects when being confronted with irrelevant information. Specifically, regularly physically active individuals seem to be better able to focus on relevant information in product judgments, compared to their less active counterparts. Interestingly, this effect occurs irrespective of the individual's ability to inhibit irrelevant product information. Additionally, this research demonstrates that a single bout of physical activity can influence how consumers make trade-offs between desirability and feasibility attributes. I demonstrate that a single bout of physical activity leads consumers to focus more on feasibility attributes and focus less on desirability attributes, compared to a baseline condition. Similarly, regularly physically active individuals show more equal weighting of desirability and feasibility attributes, compared to inactive individuals who place more emphasis on the desirability of a product. Across these two sets of studies, this research advances current understanding of how regularly physically active individuals may differ from inactive individuals when making consumer decisions which require integrating several decision attributes. Further, this thesis extends research on spillover effects by providing new insights into the effect of a single bout of physical activity on unrelated consumer decision making.

It is important to examine the effect of physical activity on judgment and decision making for a number of reasons. First, this research contributes to the literature on benefits of engaging in physical activity. It extends the research to a new domain that has previously not been considered in the physical activity literature – judgment and decision making. The results can help promote physical activity uptake among sedentary people and strengthen perseverance among those who are already physically active, by further establishing the importance of physical activity for general health and wellbeing, including individual decision making capabilities.

Second, this research adds to the literature on spillover effects in consumer decision making (Khan & Dhar, 2006). It is one of the first investigations of spillover effects of physical activity on subsequent, unrelated judgments and decisions in the consumption domain. There are a number of practical applications of the research. For example, marketing managers at gyms or stores in the vicinity of exercise facilities can use the findings to better promote their products. Products targeted at physically active individuals such as exercise gear (or even products and services unrelated to exercising) could be promoted in a way that corresponds to the findings of this research.

Third, the findings shed light on potential remedies against bias in situations when people tend to make suboptimal consumer decisions. The research in this thesis presents physical activity as a simple strategy to de-bias and improve decision making. Hafenbrack, Kinias, and Barsade (2014) showed that it is possible to de-bias people with a 15 minute mindfulness meditation. Their research focuses on a specific aspect of decision making - the sunk-cost bias. Research is needed to investigate the potential of physical activity to de-bias decision making in other applied domains such as information processing in consumer decisions.

Finally, the findings of this research can be extended from the consumer domain to decision making in management more generally. Improving health and wellbeing of employees has become a trend in the corporate world. US businesses spend about £3.5 billion per year on employee wellness programs, many of them on cut-price gym fees or work-based exercise facilities (Spicer & Cederstrom, 2015). Numerous businesses already incorporate physical activity initiatives in the workplace to reduce stress, improve physical and mental health and prevent work absence of their employees. However, it is unclear whether these physical activity initiatives have any effect on employees' decision making behaviour at the workplace. Based on the research in this thesis it is possible to

extrapolate the findings to related domains in management, and hopefully stimulate research on the effects of physical activity for decision making in the workplace.

1.1 Overview of the Research

The results reported in this thesis shed light on whether physical activity affects unrelated judgments and decision making in the consumer domain, and how this occurs. Across seven empirical studies outlined in chapter three and four, physical activity leads to altered judgments and decision making in unrelated decision domains. Specifically, I find that physical activity leads consumers to weigh different pieces of information more appropriately and improves reliance on relevant as opposed to irrelevant product information.

Before detailing the theoretical background in chapter two, I will define the concept of physical activity and briefly give an overview of the health benefits. Before presenting the respective empirical studies, I will review studies investigating the effect of physical activity on cognitive functions as well as the underlying neuro-physiological mechanisms. I will also discuss the relevant literature on decision making processes in sports, and studies investigating the effects of physical activity on sport decision making. This will be complemented by a review of research studies investigating the effect of physical activity on sport-unrelated decision making, including spillover effects on consumers' food choices.

Based on this literature, I propose a novel benefit of physical activity for information processing in consumer decision making. Two experimental paradigms which require attribute weighting – the dilution effect and the desirability-feasibility choice conflict - will be introduced. The effect of physical activity on information processing in these two decision making paradigms will be tested in chapter three and four.

A range of different methods was used to investigate the effect of physical activity on consumer judgments and decision making. Studies one, two and seven investigate in a cross-sectional design whether self-reported regularly physically active individuals make different consumer decisions than inactive individuals. Studies three and six are quasi-experimental field studies in which I test gym goers before and after their gym visit. Study five is a lab experiment which investigates the effect of a single bout of physical activity on consumer judgments, using an experimental manipulation of acute physical

activity. Studies four and eight investigate seasoned runners' consumer decision making and relate their decisions to their past running performances.

The methodologies were varied in order to increase the external validity of the results. This was particularly important since physical activity is a real world activity. Solely conducting highly controlled laboratory experiments did not seem like a comprehensive approach to study the effects of physical activity on unrelated consumer decision making, since it cannot represent adequately how and why people are exercising in the real world.

A number of different sample populations with varying characteristics were used to improve the generalizability of the research beyond a particular sample. Studies one, two and seven investigate Amazon Mechanical Turk workers living in the United States. Study three investigates London gym members from socially diverse backgrounds, while studies four and eight investigate seasoned runners who participate in organized park-runs across the UK. Study five investigates a student sample at the LSE Behavioural Research Lab, while study six tests student and staff gym members at the LSE Students' Union gym.

Figure 1-1 provides a graphical overview of the structure and aims of the research conducted in this thesis. While previous research has investigated the effect of physical activity on other domains, this research is one of the first to investigate unrelated consumer decision making. Specifically, I explore the effect of a single bout of physical activity as well as regular physical activity on two judgment and decision making paradigms which require complex processing of relevant and irrelevant information. As shown in Figure 1-1, the dilution effect paradigm requires people to ignore irrelevant information in order to perform well in the task. The task performance in the dilution effect paradigm was investigated in study one to five. The desirability feasibility trade-off paradigm on the other hand requires people *not* to ignore relevant information. This was investigated in study six to eight.

Study one, two and seven compare the task performance of regularly physically active individuals to the task performance of their less active counterparts. The effect of a single bout of physical activity is investigated in study five and six. In study three, regular physical activity and the effect of a single bout of physical activity is examined concurrently. Study four and eight are correlational studies, which relate regular runners' task performance to continuous physical activity variables.

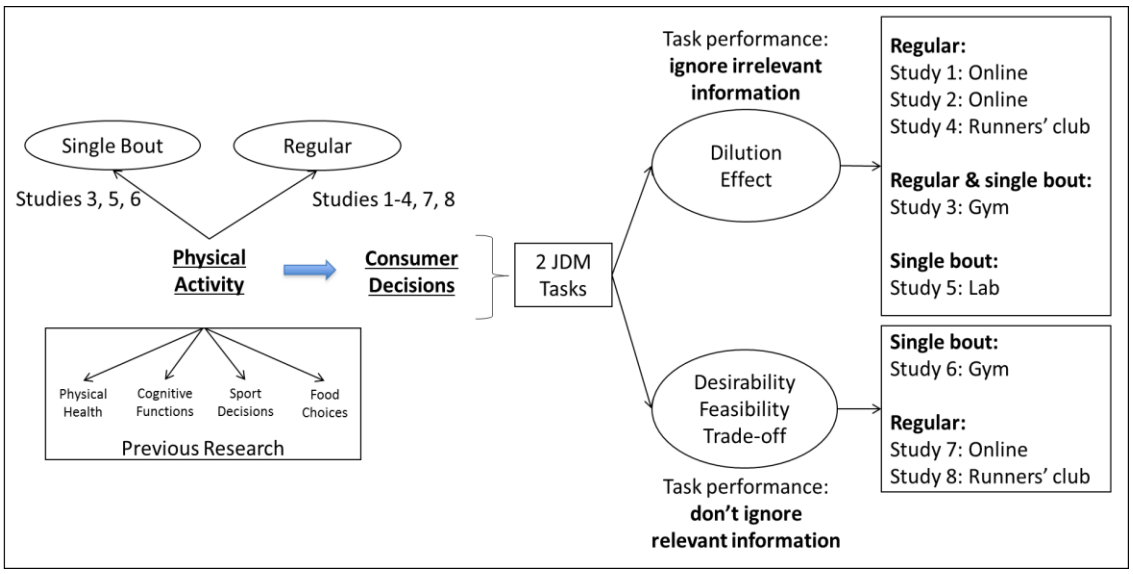


Figure 1-1. Overview of the research conducted in this thesis

In Chapter 5, I will discuss the key results of this thesis and reflect on different process findings and alternative explanations which were ruled out. I will outline the limitations of the studies and propose new directions for future research, before concluding with the practical implications of this research.

1.2 A Definition of Physical Activity

Physical activity is generally defined as "any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level" (Caspersen, Powell, & Christenson, 1985, p. 126). What is common to most conceptualizations of physical activity is that it causes a significant increase in heart rate and respiration compared to a resting state. Heart rate - measured in number of beats per minute – is usually divided into three categories: resting heart rate (typically around 70-80 beats per minute), maximum heart rate during peak physical exertion (typically around 220 beats per minute minus a person's age), and the target heart rate (60% - 85% of the maximum heart rate). This heart rate is most beneficial for heart and lungs.

Respiration is measured in VO_2 max (V = volume of oxygen in millilitres per kilogram of bodyweight per minute, O_2 = oxygen, max = maximum); that is the maximum amount of oxygen that can be used during peak exertion. To assess an individual's VO_2 max accurately, the oxygen and carbon dioxide concentration of the inhaled and exhaled air during maximum exertion must be measured using specialised equipment (Nigg,

Jordan, & Atkins, 2012). Since such sophisticated equipment is often not available, physical activity researchers instead use a simple self-report measure of exertion - the Borg scale of perceived exertion. This commonly used scale is a highly validated self-report measure showing correlations with exerciser's heart rate, lactate levels, percentage of VO_2 max and breathing rate (Borg, 1998).

Aerobic physical activity can be distinguished from anaerobic physical activity based on the physiological processes that are happening in the muscle cells. During aerobic physical activity the muscle movement uses oxygen to burn carbohydrates and fats in order to produce energy. Cardiovascular physical activity is generally considered being aerobic and includes activities such as jogging, cycling or swimming. Anaerobic physical activity on the other hand entails shorter bursts of intense activity such as sprinting or heavy weightlifting. It increases physical strength as opposed to endurance. During this type of physical activity more energy is released than can be supplied by the aerobic metabolism. This leads muscle cells to switch to burning carbohydrates only, but not fats. This metabolism does not require any oxygen (hence it is called 'anaerobic'). The downside of the anaerobic metabolism is that it produces certain waste molecules which ultimately lead to fatigue. Therefore anaerobic physical activity cannot be sustained over a longer period of time (Skinner & Mclellan, 1980). Practically, anaerobic physical activity must entail a certain level of aerobic physical activity. Thus, physical activity is never purely anaerobic, but a mix of both of aerobic and anaerobic.

In everyday language the terms physical activity and physical exercise are often used interchangeably, but they do relate to slightly different concepts. Physical exercise is a subset of physical activity and is determined by the motivation to increase or maintain physical fitness. Caspersen et al. (1985) define physical exercise as "physical activity that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective" (p. 128). In this thesis I am investigating the broader category of physical activity (entailing physical exercise) and its effect on consumer decision making; although I will occasionally refer to people who are physically active as 'exercisers' for the sake of readability.

I am defining physical activity as any bodily movement produced by the contraction of skeletal muscle that increases breathing and heart rate significantly above the baseline resting state level and that is performed for at least 10 minutes continuously. I distinguish between regular physical activity and single bouts of physical activity. Regular physical activity is defined as physical activity on:

- three or more days, of at least 20 minutes per day and of vigorous intensity, or
- five or more days of at least 30 minutes per day and of moderate intensity, or
- five or more days of any combination of moderate or vigorous intensity achieving at least 600 metabolic equivalent (MET)-minutes per week, whereby the MET formula takes into account differences in metabolic expenditure for vigorous and moderate intensity activity.[1]

This categorisation is based on the recommendations by the World Health Organisation (World Health Organization, 2010) and the Chief Medical Officers of the UK (Davies, Burns, Jewell, & McBride, 2011). When engaging in physical activity of vigorous intensity, breathing should be fast and it should be difficult to talk at the same time. When engaging in physical activity of moderate intensity, breathing should be increased compared to rest but it should still be possible to talk at the same time. A single bout of physical activity is defined as physical activity that is performed for at least 10 minutes continuously, of at least moderate intensity.

Further, I distinguish between two underlying motivations. Leisure-time physical activity is performed as a recreational activity (i.e., activities solely for recreation, sport, fitness, exercise or leisure. Examples of leisure-time physical activity include brisk walking, dancing, hiking or swimming). Work-related physical activity is performed as part of someone's paid or unpaid work (i.e., work activities including study/training, household chores, harvesting food, labouring). Table 1-1 provides an overview of moderate and vigorous intensity physical activity during work or leisure time.

[1] Moderate MET-minutes per week = 4 * moderate-intensity activity minutes * moderate days; Vigorous MET-minutes per week = 8 * vigorous-intensity activity minutes * vigorous-intensity days

Table 1-1. *Examples of physical activity in the leisure and work domain*

Physical Activity	
Leisure-time:	**Work-related:**
Activities for recreation, sport, fitness, exercise or leisure	Paid or unpaid work including study, training, or household chores
Vigorous intensity: • Football • Tennis • High-impact aerobics • Aqua aerobics • Ballet dancing • Fast swimming • High intensity interval training	**Vigorous intensity:** • Forestry (chopping, carrying wood) • Sawing hardwood • Labouring (shovelling sand) • Loading furniture (stoves, fridge) • Instructing spinning (fitness) • Instructing sports aerobics • Sorting postal parcels (fast pace)
Moderate intensity: • Brisk walking, hiking • Cycling, jogging • Dancing, low-impact aerobics • Horse-riding • Yoga, Pilates	**Moderate intensity:** • Cleaning (vacuuming, mopping) • Digging dry soil (with spade) • Woodwork (sawing softwood) • Mixing cement (with shovel) • Labouring (pushing loaded wheelbarrow, operating jackhammer)

1.3 Health Benefits of Physical Activity

Physical activity is beneficial for one's health. The positive effects of physical activity on physiology and health have been investigated for decades, and led the World Health Organisation to emphasize the significant role of physical activity as a preventative measure to reduce the health and socioeconomic burden caused by chronic diseases. Insufficient physical activity is the fourth leading 'modifiable behavioural risk factor' behind smoking, high blood pressure, and overweight/obesity, and is responsible for approximately 3,200,000 deaths per year worldwide (World Health Organization, 2010).

Regular physical activity lowers the risk for chronic diseases such as coronary heart disease which causes heart attacks and strokes by as much as 35%. It further decreases the risk of diabetes, obesity and hypertension (Bassuk & Manson, 2005; Warburton, Nicol, & Bredin, 2006). A recent epidemiological study with more than 1.44 million adults showed that regular physical activity is associated with a lower risk of thirteen

different types of cancer, including breast, lung and colon cancer. The more people exercised the more their cancer risk reduced (Moore et al., 2016). Of course, there are also exceptions to this. Moore et al. (2016) also found the opposite trend for melanoma and slow growing prostate tumours. People often exercise outdoors and are more likely to get sunburned, which is a major cause for melanoma. Physically active individuals also tend to be more health conscious and go to check-up appointments more regularly. This might explain the increased incidence of (otherwise dormant) slow growing prostate tumours in physically active men.

In one of the earliest studies linking physical activity and longevity, Morris, Heady, Raffle, Roberts, and Parks (1953) investigated the effect of physical activity at work on the risk to falling ill with coronary artery disease. They compared London bus drivers, who sat for over 90% of their shift, to bus conductors, who climbed up to 750 steps in the double-decker buses per working day. They found that the physically active bus conductors had lower rates of coronary artery disease during middle-age; in cases where they did suffered from it, it was less severe and it was developed later in life than in their sedentary bus driver colleagues. These findings were replicated with sedentary civil servants and physically active postal workers who delivered the post on their bicycles. They concluded that physical activity - as a natural defence mechanism of the body - can protect the aging heart against coronary artery disease, and therefore lead to a longer life. Warburton et al. (2006) provide a more recent, extensive review of the health benefits of physical activity.

The Chief Medical Officers of the UK have set guidelines on physical activity for adults in order to produce these health benefits. The guidelines recommend engaging in physical activity of at least moderate intensity, for at least 150 minutes per week in bouts of ten minutes or more. Alternatively, physical activity of vigorous intensity should be performed for at least 75 minutes per week, or a combination of both vigorous and moderate intensity physical activity. Physical activity should be performed regularly and aerobically using major large muscle groups steadily and rhythmically, to raise heart rate and breathing significantly (Davies et al., 2011).

In 2016, 61% of adults in the UK met the physical activity recommendations of at least 150 minutes of moderate activity (such as brisk walking or cycling) per week according to the British Heart Foundation (2017). This corresponds to around 40 million people in the UK, with men being more likely to be physically active than women. Conversely, around 20 million adults in the UK are considered physically inactive,

leading to annual healthcare costs of £1.2 billion for the National Health System. Economic analysts have forecasted that if 70% of the UK population met the target of exercising 150 minutes per week, employers could save £487 million per year in lost productivity by preventing 2.78 million sick days (Balcombe, Jones, & Deane, 2006). Therefore, promoting physical activity is not only a major goal for public policy, it is also a major goal for businesses, as companies try to engage their employees in physical activity to improve work performance and outcomes.

Chapter 2. Theoretical Background

This chapter provides an overview of the literature on physical activity and its effect on cognitive functions and decision making, and develops the theoretical foundation for the subsequent empirical chapters. First, I will review research on effects of physical activity on cognitive functions. This will include neuro-scientific evidence, which forms the basis for the conjectures tested in this thesis. Secondly, I will assess the current literature which investigates physical activity and decision making behaviour. This includes research from the area of exercise psychology, consumer psychology (in particular food choices) and other judgment and decision making domains (e.g., risk judgments). Thirdly, I will introduce two consumer decision making paradigms which involve attribute weighing – the dilution effect and the desirability-feasibility choice conflict – and how they relate to the outlined physical activity literature.

2.1 The Effect of Physical Activity on Cognitive Functions

The physiological health benefits of physical activity have been known for decades. But physical activity also seems to positively affect brain functions and psychological wellbeing. Regular physical activity, specifically aerobic exercise, lowers the risk of suffering from neurodegenerative diseases such as Parkinson's and Alzheimer disease (Ahlskog, Geda, Graff-Radford, & Petersen, 2011). Randomised controlled trials show that physical activity interventions attenuate the symptoms of cognitive decline in patients suffering from dementia or mild cognitive impairment compared to sedentary controls. Improved memory functions and increased hippocampal brain volume after long-term physical activity interventions have also been found for healthy seniors. These results are supported by cross-sectional brain imaging studies which report larger grey matter and hippocampal volume for physically active seniors compared to sedentary or unfit seniors. In addition, fMRI studies in adults over their 50s show that physical activity interventions between six to twelve months can improve the functional connectivity between different brain areas (Erickson & Kramer, 2009; Northey, Cherbuin, Pumpa, Smee, & Rattray, 2017).

Benefits of physical activity for cognitive functions have not only been shown for older people, but also for children and adolescents. Most physical activity studies

involving children have examined executive functions. Best (2010) provides a recent overview of experimental research investigating the effect of physical activity on children's executive functions. For example, Hillman et al. (2014) investigated the effect of a nine month afterschool physical activity program on children's electrical brain activity and their performance on behavioural measures of executive control in a randomised controlled trial. They found significantly greater improvements in cognitive flexibility (in a colour-shape switch task) and attentional inhibition (in the Flanker task) among the physically active group compared to the waiting list control group. Improvements after long-term physical activity interventions have also been found for children's working memory (Kamijo et al., 2011), planning and mathematic achievement (Davis et al., 2011).

A range of different methods including cross-sectional, correlational studies, randomised controlled trials and neuro-level experiments have been used to investigate the effects of physical activity on cognitive functions in healthy adults. Barenberg et al. (2011) conducted a systematic literature review of physical activity interventions and cognitive functions. The goal was to establish whether executive functions can benefit from long-term and short-term physical activity. They found that eight out of nine long-term physical activity interventions (of duration between ten and 40 weeks) and ten out of 14 short-term single bout interventions provided empirical evidence of improvements of executive functions due to physical activity. While long-term interventions had positive effects on all kinds of executive functioning tasks, short-term interventions had significant positive effects on tasks which predominantly required inhibition, i.e. a deliberate suppression of dominant, automatic, or pre-potent responses (e.g., Stroop test, Flanker task, Go/No-go, Paced Auditory Serial Addition Test). They also found occasional, positive effects of a single bout of physical activity for tasks requiring complex working memory processes (e.g., operation span task, reading span task, Wisconsin card sorting test, Sternberg test, and alternate uses test).

It is noteworthy to mention that there is growing evidence that physical activity influences people's affective system, in addition to the cognitive benefits. People who exercise regularly have higher scores on self-esteem and self-efficacy questionnaires, they report greater well-being, less state and trait anxiety, a lower level of stress, and have a lower risk of suffering from depression (Fox, 1999). Hopkins et al. (2012) tested the effect of a single bout versus a four-week physical activity regime on healthy subjects' state anxiety, depression scores, perceived stress and positive and negative affect. They

found that participants reported a decrease in stress and state anxiety when exercising for four weeks and an increase in positive mood on exercise days compared to non-exercise days. Dietrich and Audiffren (2011) summarize that moderate, aerobic physical activity generally has a positive effect on people's affect, which reaches well into the post-exercise period: physical activity reduces stress, depression and anxiety and induces analgesia and sedation. In their 'reticular-activating hypofrontality' model of acute exercise, they attribute these positive effects to an increase of serotonin (which has an antidepressant effect) as well as an increase of endorphins and endocannabinoids, leading to a general sense of wellbeing. They further argue that exercise induces a state of hypofrontality – a deactivation of the frontal cortex during physical activity. This reduces the processing of information which cause stress, anxiety and negative thinking. Thus, physical activity diminishes negative emotional processes, such as rumination.

Although it is possible that affective changes caused by physical activity lead to differences in people's judgments and decision making, this was not the main focus of the research in this thesis. The majority of the empirical studies I conducted included different measures of affect as control variables.

Neurophysiological Explanations

Several neurophysiological explanations of why and how physical activity influences cognitive functions have been proposed. On a neuronal level, non-human animal research has examined the molecular and cellular processes triggered by physical activity. Physical activity leads to increased cell proliferation and survival of neurons in several brain areas. Most commonly observed is a positive effect of physical activity on the neurons in the dentate gyrus of the hippocampus. In addition, it has been observed that physical activity leads to an increase in brain-derived neurotrophic factor (BDNF), which is a molecule associated with brain plasticity. BDNF leads to increased neuronal outgrowth, improved synaptic functions and survival of neurones. It has been described as one of the most fundamental neuronal factors for learning, memory and general cognition (Hillman, Erickson, & Kramer, 2008).

Positive effects of physical activity on brain health have even been found in newly born rat pups whose mothers had been randomly assigned to a physical activity programme of voluntary wheel-running during pregnancy. Compared to a group of control pups whose mothers had been sedentary during pregnancy, the pups with active mothers had significantly increased levels of BDNF protein in the hippocampus (Kim,

Lee, Kim, Yoo, & Kim, 2007). Furthermore, physical activity leads to the formation of new blood vessels in various brain areas such as the cortex, the cerebellum, the striatum and the hippocampus.

Exercise-induced structural and functional brain changes have not only been observed in animals but also in humans. For example, physical activity has been shown to increase cerebral blood flow in areas associated with cognition, memory and executive functions. Pereira et al. (2007) used MRI technology to map cerebral blood flow in the human hippocampal formation. Healthy participants followed an aerobic exercise regime for three months and showed a significant increase of cerebral blood flow in the hippocampus. This was accompanied by an improved performance on the Rey Auditory Verbal Learning Test (a test of verbal memory).

Ruscheweyh et al. (2011) tested the effect of a six months physical activity regime of medium or low intensity on episodic memory functions in healthy, elderly subjects. They found that physical activity led to an increase in local grey matter volume in the prefrontal and cingulate cortex, and higher levels of BDNF. They also found a significant increase in memory scores on the Rey Auditory Verbal Learning Test in both conditions (medium and low intensity physical activity) compared to a control group without physical activity.

Raichlen et al. (2016) suggest that physical activity such as endurance running, represents a complex activity for the brain even though it might appear repetitive and cognitively undemanding. They argue that physical activity involves sophisticated, simultaneous processing and monitoring of internal and external information. According to them, brain areas related to cognitive functions such as planning, inhibition, monitoring, attentional switching, and multi-tasking are activated and being trained when engaging in physical activity. They conducted a brain imaging study in which distance runners' brain activation was compared to matched control participants who hadn't exercised in the past year. They used functional connectivity magnetic resonance imaging (fcMRI) to compare brain functions assessed at a resting state. In particular, they looked at the functional connectivity of the brain areas which link executive functions with motor control. First, they investigated the connectivity between the motor network (MN) and the default mode network (DMN) – an area which is active while resting and usually associated with mind-wandering and lack of focus. The second network whose connections to the MN were investigated, was the fronto-parietal network (FPN). This area is associated with executive functions and attention.

The authors found a significantly enhanced positive association between the MN and the FPN for the endurance runners. This indicates that endurance runners had improved connectivity between parts of the brain that aid executive functions and attention. At the same time the results also showed an anti-correlation between the MN and the DMN (associated with lack of focus and mind wandering). DMN de-activation has been shown to be associated with improved cognitive performance. Additionally, they found a positive linear association between the brain connectivity values, participants' self-reported time spent being physically active and their fitness levels. The more active the participants were, the stronger the connectivity values.

It is important to note that these results were found in healthy, young adults during a resting state. This shows that physical activity may lead to lasting changes in brain functions, cognition and potentially people's behaviour even at times when they are not active. Therefore, research designs which compare the consumer behaviour of people who are regularly physically active, to those who are sedentary, could be a valuable addition to research designs which focus on the effect of a single bout of physical activity.

Although the above outlined research studies indicate that physical activity leads to improvements of cognitive functions (e.g., attention control, mind wandering), it remains unclear how these improvements relate to specific decision making processes (in the consumer domain or more generally). The types of cognitive tasks usually examined in the previously outlined research studies do not examine processes that typically constitute 'decision making processes'. Specifically, decision processes like the weighing of different pieces of information (e.g., decision attributes) and the integration of this information to form a final judgment or choice, have not been examined in the literature so far. Table 2-1 provides an overview of the literature on regular and single bouts of physical activity and their effect on cognitive functions.

In the next section I will review the literature on physical activity and judgment and decision making in sports and unrelated domains.

Table 2-1. *Summary of the literature on physical activity and the effects on cognitive functions*

Area / discipline	Reference	Type of study	Mode of physical activity	Independent variable	Dependent variable	Finding
Cognitive Neuroscience / Medicine: Older Adults	Ahlskog, Geda, Graff-Radford, & Petersen (2011)	Review	Regular physical activity		Cognitive neuro-protective effects	- Reduced risk of dementia and mild cognitive impairment - Improved cognitive scores - Larger hippocampal volume - Better spatial memory - Attenuated loss of grey matter volume - Improved brain connectivity - Increased brain neurotropic factors (in animals)
	Erickson & Kramer (2009)	Review	Regular physical activity and fitness		Cognitive performance, brain volume, brain function	- Improved cognitive functions (particularly executive control) - Increased prefrontal and temporal grey matter volume
	Northey, Cherbuin, Pumpa, Smee & Rattray (2017)	Meta-analysis	Regular physical activity	Interventions (≥ 4 weeks) of aerobic exercise, resistance training, multi-component training and tai chi Intensity (low; moderate; high)	Global cognition, attention, executive functions, memory and working memory	Improved cognitive functions for physical activity of at least moderate intensity and at least 45 min per session
Developmental Psychology: Children	Best (2010)	Review	Single bout and regular physical activity		Executive functions	- Single bouts of aerobic physical activity enhance executive functions - Regular aerobic physical activity benefits executive functions more sustainably
	Hillman et al. (2014)	RCT	Regular physical activity	9 month physical activity intervention (at least 70 min of moderate-to vigorous physical waiting list control activity) vs.	Electrical brain activity Executive functions: - Attention inhibition - Cognitive flexibility	- Greater improvements in inhibition and cognitive flexibility in physical activity group - Improved brain indices of executive control

	Kamijo et al. (2011)	RCT	Regular physical activity	9 month physical activity intervention (at least 70 min of moderate-to vigorous physical activity) vs. waiting list control	Working memory Electrical brain activity	Improved cognitive control of working memory in the intervention group
	Davis et al. (2011)	RCT	Regular physical activity	13 week aerobic physical activity programme (20 or 40 min/day) vs. control group	Cognitive functions fMRI brain activity Academic achievement	- Improved cognitive performance - Improved math achievements - Increased prefrontal cortex activity - Reduced posterior parietal cortex activity
Animal Research	Hillman, Erickson & Kramer (2008)	Review	Regular physical activity		Various indices of brain health in the mouse brain	- Increased cell proliferation and cell survival in the hippocampus - New blood vessel growth in different brain areas - BDNF up-regulation
	Kim, Lee, Kim, Yoo, & Kim (2007)	Experiment	Regular physical activity	Pregnant control group vs. running group (daily forced treadmill run for 30 min at mild-intensity)	Short term memory, Hippocampal neurogenesis, BDNF in rats	Maternal physical activity increased BDNF expression, enhanced cell survival and improved short term memory
Cognitive Neuroscience: Healthy Adults	Barenberg et al. (2011)	Review	Single bout and regular physical activity	Long term interventions of moderate and vigorous intensity (≥ 10 weeks); Single bout interventions of at least 20 min (treadmill running, ergometer cycling)	Executive functions: shifting, inhibition, dual task coordination, complex requirements	Long term interventions: - Improved executive functions in 8 of 9 studies - Effects on all types of executive functions - Occasional effect on tasks with complex requirements Single bout interventions: - Improve executive functions in 10 of 14 studies - No effect on shifting - Consistent effect on inhibition tasks
	Hopkins et al. (2012)	Experiment	Single bout and regular physical activity	4 week physical activity programme + physical activity on final test day vs. 4 week physical activity program + no physical activity on the final test	Novel object recognition memory, state anxiety, depression, perceived stress, positive and negative mood	- Single bout + regular physical activity improved recognition memory and decreased perceived stress - Single bout of physical activity had no effect on recognition memory and perceived stress

			day vs. single bout of physical activity vs. sedentary		
Pereira et al. (2007)	Experiment	Regular physical activity	3-month aerobic physical activity intervention (4 times per week)	Cerebral blood volume in the hippocampus Rey Auditory Verbal Learning Test	- Physical activity increases cerebral blood volume in the dentate gyrus - Cerebral blood volume correlated with aerobic fitness and cognitive function
Ruscheweyh et al. (2011)	RCT	Regular physical activity	6-month intervention, 3 times per week for 50 min Control vs. low intensity aerobic physical activity vs. medium intensity aerobic physical activity	Episodic memory, neurotrophin and catecholamine levels, grey matter volume	- Increased memory scores, no difference between intensity groups - Increased grey matter volume in prefrontal and cingulate cortex - Increased BDNF levels
Raichlen et al. (2016)	Correlational	Regular physical activity	Endurance runners vs. sedentary controls	Resting state functional connectivity of brain areas which link executive functions with motor control	- Difference in functional brain connectivity - Dose response relationship between connectivity strength and physical activity engagement
Voss, Kramer, Basak, Prakash & Roberts (2010)	Meta-analysis	Regular physical activity	Athletes (professional and university-level) vs. non-athletes	Attentional cueing, processing speed, attention tasks	- Improved processing speed and performance in attention tasks among athletes
Heisz, Clark, Bonin & Paolucci (2017)	RCT	Regular physical activity	6 week intervention, 3 times per week for 20 min Physical activity training (high intensity interval) vs. physical activity + cognitive training vs. no training control	High-interference memory task, general recognition memory, serum neurotrophic factors brain-derived neurotrophic factor, insulin-like growth factor-1.	- Improve performance on high-interference memory task for physical activity groups - No improvement of general recognition - Greater fitness improvement associated with greater increase of BDNF and insulin-like growth factor-1 - Higher responders to physical activity benefitted most from the combined training
Gap	Unclear relationship between cognitive functions and decision making processes; Do cognitive benefits induced by physical activity extend to decision making processes? Do cognitive benefits induced by physical activity extend to different domains, like consumer decision making?				

2.2 Physical Activity and Judgment and Decision Making

Does physical activity influence how people form judgments and make choices? Surprisingly, few studies have investigated this question. As Johnson (2006) notes research which experimentally investigates the influence of physical activity on judgment and decision making has been limited. Even though from a methodological point of view this domain provides great opportunities to investigate decision making in a natural setting (e.g., before, during, after physical activity; regular vs. single bouts of physical activity; aerobic vs. anaerobic physical activity).

2.2.1 Research in Sport and Exercise Psychology

The research in sport and exercise psychology which investigates decision making can generally be categorized into two main fields. The first research field focuses on *decision making within a particular sport*. Research studies within this field investigate which decision making processes are prevalent and optimal while a particular sport is played, and how these decision making processes vary depending on a person's experience. Fast, automatic processing of relevant stimuli is often necessary in sports in order to perform well. Several studies have shown that in sport deliberating over decisions can lead to worse outcomes than intuitive, heuristic decision making. This is particularly valid for experts in a specific sport who develop an implicit knowledge structure through years of practice. Such knowledge structures must first be learned deliberatively before they can transition into automatic decision making processes.

Beilock, Bertenthal, McCoy and Carr (2002) showed that experienced golf players performed worse when they were asked to pay attention to their swing, promoting a deliberative style of thinking. Novices on the other hand performed better using a deliberative style of decision making. These findings have been replicated with experienced handball players who performed better when they had no time to think rather than when viewing a scene from a game for 45 seconds before deciding (Johnson & Raab, 2003). Raab and Johnson (2008) provide an overview over intuitive and deliberative decision making processes in sport.

Mann, Williams, Ward, and Janelle (2007) performed a meta-analysis of 42 studies which compared the perceptual-cognitive performance of sport experts and novices. They found that the sport experts consistently reacted faster and performed better in sport-

specific decision making tasks (e.g., response accuracy, response time, visual search, spatial memory) than non-experts.

Even though this expert performance approach provides valuable insights into decision processes within a specific sport and the role of expertise, it does not shed light on decision making that is unrelated to the sport itself. The applicability to other decision domains is limited, since only sport-specific decisions were investigated.

The second field of research uses experimental lab studies to investigate *effects of physical activity on decision making within sports*. These studies generally investigate specific processing aspects of decision making in a particular type of sport (e.g., the time it takes to react and choose an action like passing the ball to another player). Comparable designs have been used for these lab experiments. During and / or shortly after a physical activity manipulation, subjects view slides or video clips of a scenario depicting a sports match (usually football or handball scenes). Participants then have to indicate how they would react if they were the player in the presented situation. The choice alternatives are provided (e.g., passing the ball, shooting, dribbling, or running). The two dependent variables that are measured are response speed and decision accuracy, which is evaluated using expert ratings.

The research group around Terry McMorris conducted several experiments using variations of such a design (McMorris & Graydon, 1996a, 1996b, 1997; McMorris et al., 1999). Whilst cycling on an ergometer at different intensities, subjects watched football scenes and had to choose between four potential play responses. The decision accuracy of the responses was scored by experts. They found a facilitating effect of physical activity on decision response speed in all of their studies. While physically active participants made faster decisions, they found no effect of physical activity on decision making accuracy, apart from one study - a finding they interpreted as an artefact.

Tenenbaum, Yuval, Elbaz, Bareli, and Weinberg (1993) used a similar design to investigate the effect of physical activity on the decision making of experienced and inexperienced handball players. Their participants viewed slides of handball scenarios during a treadmill run. They found a moderating effect of participants' experience. When tested after 45 minutes of physical activity both experienced and inexperienced participants performed better in terms of decision making accuracy, but after 90 minutes of physical activity only experienced subjects continued to make better choices than at rest. The performance of inexperienced players on the other hand decreased. Similarly, Fontana and Pittsburgh (2007) found a facilitating effect of physical activity on decision

accuracy and response speed, in a sample of experienced football players who viewed football video clips during a treadmill run.

The results of the existing research studies on physical activity and decision making are often not generalizable to other contexts, such as consumer decision making, because only very specific decision situations in sport were investigated. Additionally, some of the research on physical activity lacks external validity since only lab experiments with a high degree of artificiality were used. Real-life physical activity in the field, such as that of gym visitors and their subsequent decision making, has not been investigated. I believe that it is important to investigate physical activity in its natural setting since it is an activity that is strongly influenced by people's motivation and the context.

2.2.2 Research in Sports-Unrelated Decision Domains

Only very few studies have investigated the effect of physical activity on *unrelated judgments and decision making*. Using a correlational design, Jacobson and Matthaeus (2014) investigated whether physical activity status (once or more per week / less than once per week), sport type (self-paced like running / externally paced like football) and sport level (high-skilled / recreational) were associated with the performance in a sport-unrelated decision making task among other cognitive tests. To measure decision making they used the Tower of Hanoi test.[2] Decision making speed (time-per-move ratio) and accuracy (move-accuracy ratio) were used as response variables. The authors found no association between the physical activity variables and decision making performance in the Tower of Hanoi test. This null effect might be due to a lack of sensitivity of this test as a measure of decision making performance in a healthy sample. Although the test has high validity in detecting frontal lobe dysfunctions and decision making impairments (Sullivan, Riccio, & Castillo, 2009), it might not be sensitive enough to distinguish nuanced differences in decision making capability in a healthy population. Jacobson and Matthaeus (2014) did however find that physically active participants performed better on an inhibition task (a modified Stroop test).

Raue, Streicher, Lermer, and Frey (2015) investigated the effect of physical activity on people's judgments of risks. Backcountry skiers and indoor climbers judged the respective sport-related risks before, during and after engaging in the activity. Sport unrelated risk judgments were also investigated during and after a physical activity

[2] Subjects create a tower by moving circular disks of different sizes on and off pegs. Subjects cannot place larger disks on top of smaller ones and can only move one disk at a time.

manipulation in the laboratory using a stationary bicycle. Participants were asked to estimate the probability of being affected by ten general risks, such as getting a severe illness. In three studies the authors found that people's judgments of risks were lower for sport-related as well as unrelated risks during and after engaging in physical activity compared to beforehand. They hypothesized that risk judgments might be lower because of an increased release of adrenaline and dopamine leading to elevated mood states and reduced anxiety. Lower risk judgments might have consequences for decision making under risk. In particular, physical activity might lead to more risk taking behaviour.

In the domain of creative thinking, Oppezzo and Schwartz (2014) found in four experiments that participants performed better on divergent thinking tasks during and shortly after they were physically active. Improved creative thinking may in turn influence decision making, in particular in situations which require people to think of a decision problem in novel ways or to generate alternative options. Using a walking manipulation they found that 81% of participants improved their scores on the Guilford's alternate uses test of divergent thinking compared to a seated control condition. The boost in creative thinking was particularly strong when participants walked outdoors. They hypothesized that a complex causal pathway led to these findings, including elevated mood, an increased activity of people's associative memory and a relaxed inhibition of unusual thoughts.

Based on this literature it is unclear whether physical activity has any effect on unrelated judgments and decisions in the consumer domain. Furthermore, the outlined studies provide limited insight into the underlying mechanisms or pathways through which physical activity influences decision making. Therefore, it is difficult to make predictions about the effect of physical activity on consumer decision making.

2.2.3 Research in Consumer Psychology

The literature on physical activity and consumer decision making is limited to a relatively small set of studies - even though people often engage in consumer behaviour after exercising. A number of studies investigated spillover effects of physical activity on subsequent consumer behaviour in the health domain, particularly on food choices. On the one hand, it is possible that engaging in physical activity can lead to a *permitting spillover* or *licensing effect* (Khan & Dhar, 2006). The reasoning is that 'because I have exercised, I can indulge more / eat more / eat high-calorie food'. Research generally supports the notion of a licensing effect on food choices following physical activity, but

it depends on people's motivation and perception of the physical activity. For example, Fenzl, Bartsch, and Koenigstorfer (2014) found that physical activity led to increased food consumption, but only in people with low behavioural regulation and when the physical activity was labelled as 'fat-burning' as opposed to 'endurance exercise'. Similarly, Werle, Wansink, and Payne (2015) showed that the framing of physical activity can affect subsequent food choices. When they labelled the physical activity as 'fun', participants ate less dessert and fewer hedonic snacks afterwards than when it was labelled as 'exercise'. Similar results were found by Chang and Lin (2015). They only found a licensing effect of physical activity on food consumption for dieters, but not for non-dieters. The licensing effect was present after participants had engaged in physical activity and also when they anticipated to engage in physical activity in the future. Supporting the previous studies a 'fun' framing of physical activity reduced this licensing effect. In an earlier study Werle, Wansink, and Payne (2011) found that one doesn't even have to engage in physical activity for a licensing effect on food choices to occur. They showed that just reading about physical activity also led to compensatory behaviour (i.e., participants served themselves more snacks).

From a theoretical perspective, engaging in physical activity and making food choices can be considered highly related behaviours, since they represent multiple, albeit different paths to achieve the same health-related goal. Kruglanski, Pierro, and Sheveland (2011) define this as 'equifinality'. They showed that if people have a number of different means available to achieve the same goal, it can reduce their commitment to the specific means, but at the same time strengthen their overall goal commitment.

A smaller number of research studies also support the notion of a *promoting spillover effect* of physical activity - physical activity leading to consumer behaviour which works in the same direction (e.g. more health-conscious food choices). For example, correlational studies have found a negative association between regular leisure time physical activity and the consumption of high-fat food, independently of a number of demographic and behavioural confounding variables (e.g., Simoes et al., 1995). In an experimental study, van Kleef, Shimizu, and Wansink (2011) showed their participants commercials about exercising or car insurance, and investigated their food choices during a subsequent lunch. Watching the exercise ads led to a reduction of participants' calorie intake by 21.7% compared to the control group.

While these spillover effects of physical activity on consumers' food choices are interesting and important to investigate, they are not the focus of the research conducted

in this thesis. The aim of this research was to investigate consumer judgments and decisions in domains which are entirely unrelated to physical activity. Hence, health-related decision making, including food choices was excluded. Table 2-2 provides a summary of the literature on physical activity research in the judgment and decision making domain as well as current gaps in the literature which this research aims to explore.

Table 2-2. *Summary of physical activity research in judgment and decision making and related domains*

Decision Domain	Reference	Type of study	Mode of physical activity	Independent variable	Dependent variable	Finding
Sports decision making	Beilock, Bertenthal, McCoy & Carr (2002)	Experimental	Golf	Deliberative vs. intuitive thinking style	Putting performance	Experienced (novice) golfers performed worse (better) with deliberative style of thinking
	Johnson & Raab, (2003)	Experimental		Time pressure vs. no time pressure	Handball decisions: Quality of generated options after viewing play scene	Experienced players performed better under time pressure than under no time pressure
	Mann, Williams, Ward & Janelle (2007)	Meta-analysis	Interceptive vs. strategic vs. other sport	Sport experts vs. novices	Sport-specific decisions: Perceptual-cognitive performance	Faster reaction time and better response accuracy among experts
	McMorris et al. (1996a, b, 1997, 1999)	Experimental	Single bout physical activity: Cycling on ergometer	Moderate vs. maximum intensity vs. rest	Football decisions: Choice quality and response speed after viewing play scenes	Facilitating effect of physical activity on decision response speed
	Tenenbaum, Yuval, Elbaz, Bareli & Weinberg (1993)	Experimental	Single bout physical activity: Treadmill	Walking vs. running	Handball decisions: choice quality after viewing play scenes	Choice quality better during high than low exercise levels
	Fontana & Pittsburgh (2007)	Experimental	Single bout physical activity: Treadmill	Rest vs. moderate vs. high intensity	Football decisions: Choice quality and response speed after viewing play scenes	Facilitating effect of physical activity on decision response speed
Gap:	No investigation of decisions unrelated to sports; artificial lab experiments; no normative evaluation of decision accuracy (coding of sport experts); investigation of decision making during physical activity, but not after physical activity					
Sport-unrelated decision making	Jacobson & Matthaeus (2014)	Correlational	Regular physical activity	Frequency (once or more per week vs. less than once per week); Sport type (self-paced vs. externally paced); Sport level (high-skilled vs. recreational)	Tower of Hanoi: Decision speed (time-per-move ratio) Accuracy (move-accuracy ratio)	No association between physical activity variables and decision making variables

	Raue, Streicher, Lermer & Frey (2015)	Experimental	Single bout of physical activity	Before vs. during vs. after: Backcountry skiing Climbing Rest vs. Cycling on stationary bike with medium intensity	Risk judgments: Sport-related (skiing, climbing) Unrelated (e.g. illness)	Physical activity decreases the perceived likelihood of related and unrelated risks
	Oppezzo & Schwartz (2014)	Experimental	Single bout of physical activity	Sitting vs. walking (treadmill) vs. walking (outdoors) vs. sitting (outdoors)	Guilford's alternate uses test of divergent thinking	Improved creative thinking during and shortly after physical activity
Gap:	No investigation of decision making in the consumer domain					
Spillover effects on food choices	Fenzl, Bartsch & Koenigstorfer (2014)	Experimental	Single bout of physical activity	Cycling labelled as 'fat-burning' or 'endurance' training	Amount of Pretzels eaten post-exercise	Increased food consumption in people with low behavioural regulation and when physical activity labelled as 'fat-burning'
	Werle, Wansink & Payne (2015)	Experimental and correlational	Single bout of physical activity	Walking labelled as 'fun' or 'exercise'	Amount of desert and hedonic snacks eaten post-exercise	Reduced food consumption when physical activity labelled as 'fun'
	Chang & Lin (2015)	Experimental	Single bout of physical activity	Dieter vs. non-dieter; Jogging & jumping rope before vs. after eating; Work-frame vs. fun-frame vs. no-exercise	Amount of potato chips eaten	Increased food consumption for dieters after and before physical activity, when physical activity labelled as 'work'
	Werle, Wansink & Payne (2011)	Experimental	None	Reading about physical activity labelled as 'fun activity' vs. 'tiring exercise'	Amount of snacks served	Increased amount of snacks served after reading about physical activity
	Simoes et al. (1995)	Correlational	Regular leisure time physical activity	Inactive vs. Irregular vs. Regular and not intense vs. Regular and intense	Consumption of 13 high-fat foods	Physical activity associated with lower consumption of high fat food
	van Kleef, Shimizu & Wansink (2011)	Experimental	None	Watching exercise commercial vs. car insurance commercial	Food intake at a subsequent lunch meal	Reduced calorie intake after exposure to exercise commercial
Gap:	No investigation of motivationally unrelated decision making in the consumer domain					

2.3 Proposition Tested in This Thesis: Physical Activity and Information Processing

We often think of physical activity as a highly repetitive, automated motor task which doesn't require much thinking. However, motoric functions have to be combined with cognitive functions in order to engage in physical activity. Before engaging in physical activity you first have to plan the activity (e.g., on Saturday morning I will go for a run). You have to inhibit distractors (e.g., to party on Friday night), and activate a sequence of behaviours (e.g., getting dressed and leaving the house). While exercising you have to integrate complex information from internal sources (unconscious motor information like balancing or gait as well as conscious information like feelings of exertion and pain) and external sources (e.g., a sudden obstacle in the running path). Failing to focus on important information can have costly consequences (e.g., when you fall over the obstacle). On the other hand, some information like the urge to stop running, has to be ignored or suppressed.

When seeing physical activity from this perspective, it can be argued that engaging in physical activity can train our ability to integrate several pieces of information; in particular, physical activity may train the ability to 1) focus on what is important or relevant to achieve a goal and 2) ignore the unimportant or conflicting information. In order to successfully achieve the goal of engaging in regular physical activity, individuals repeatedly have to ignore the unimportant features and not neglect the important, goal-relevant features of their decision environment. This ability might spillover and benefit people in situations that are unrelated to exercising but require integrating several different pieces of information.

According to the 'broad transfer hypothesis' cognitive skills trained by a certain activity (in this case physical activity), can spillover and improve performance in unrelated domains that require similar cognitive skills. Practicing certain skills regularly, for example mental focus and the ability to ignore distractors, should benefit specific aspects of cognitive functions. Irrespective of the context, these skills can also come into force in unrelated situations (Furley & Memmert, 2011). As an example from a different domain, playing action-video games can improve performance on reaction time tests in lab experiments since it improves players' visual short-term memory and their ability to process multiple stimuli simultaneously (Green & Bavelier, 2006).

In the physical activity domain, Voss, Kramer, Basak, Prakash, and Roberts (2010) performed a meta-analysis of 20 laboratory studies investigating differences between athletes (professional and university-level) and non-athletes on measures of cognition in non-sport contexts. Indeed, they found that on measures of processing speed and attention, athletes performed better than non-athletes.

In today's world we are confronted with a huge amount of information all day long. Quite often a big part of that information is irrelevant for the decisions that we have to make. For consumers, filtering out irrelevant product information is becoming an increasingly desirable skill if they want to make good product choices. On the other hand, decision makers should focus on all information that is relevant for their choices. Failing to consider relevant information can be costly. Most consumption choices entail some sort of trade-off between different product attributes (e.g. a highly desirable product has a higher price than a less desirable product). Since such trade-offs can be difficult to make, it can lead to choice deferral or the use of non-compensatory, trade-off avoiding decision making strategies (Weber, Baron, & Loomes, 2001). For example, consumers compare products on one single attribute and ignore all other potentially important attributes. This can lead to sub-optimal choices (apart from specific circumstances).[3] Optimal decision making usually requires consumers 1) to ignore irrelevant information, and 2) to consider all information that is relevant and make compensatory trade-offs when product attributes are negatively correlated.

If physical activity trains and improves the information integration of disparate stimuli as supported by the cognitive and neuroscience literature, then we would expect that physical activity also affects consumers' judgments and decisions in situations that require such complex information integration. Before the empirical chapters, I will introduce two paradigms from the consumer behaviour literature that require people to integrate and weigh several pieces of information

Physical Activity as a Goal-Oriented Activity?

Physical activity is a goal-oriented activity, and it is often correlated with other goal-oriented health behaviours, such as eating healthily (Simoes et al., 1995) or going to medical check-ups (Moore et al., 2016). One might wonder how the cognitive process induced by physical activity is different from any other activity which requires

[3] Gigerenzer (2008) provides an overview of decision environments in which non-compensatory heuristics work well.

persistently pursuing a goal (e.g., learning a new language, quitting smoking, saving money).

Physical activity requires a substantial amount of executive control (including planning, goal-shielding, monitoring, inhibition of distractions). But physical activity also leads to neurophysiological changes in brain areas which support executive control. This bi-directional relationship is unique to physical activity - although it can support executive control for other goal-pursuit behaviours (Mullen & Hall, 2015). Because of the neurophysiological effects which physical activity has on the brain, it functions like a 'booster' in addition to the training of executive control. The cognitive demands of exercising are combined with the beneficial effects of physical activity for brain functions.

Empirical evidence supports this distinction of physical activity from other goal-oriented activity. For example, very recently Heisz et al. (2017) examined the single effect or combination of regular physical activity and cognitive training on participants' neurotropic factors and memory functions. Participants were randomly assigned to a control group (no training), a regular physical activity group (20 min of vigorous physical activity three times per week for six weeks), or a combined group (regular physical activity + a computerized mental training). They found that both intervention groups improved their performance in a high-interference memory task. The cognitive improvement was particularly strong for participants who experienced the greatest fitness benefits and greatest increases in brain-derived neurotrophic factor and insulin-like growth factor-1 through the physical activity intervention. Similarly, physical activity has also been shown to boost the learning of a second language compared to a control group which was sedentary during the learning process (Liu, Sulpizio, Kornpetpanee, & Job, 2017). While physical activity is itself a goal-oriented activity, it is different from other goal-oriented activities in the sense that it causes measurable neurophysiological changes in individuals' brain functions, and associated executive control. Those in turn may enhance goal-pursuit in other domains.

Regular Physical Activity vs. a Single Bout of Physical Activity

The research in this thesis distinguishes between regular physical activity and a single bout of physical activity. It is therefore important to address whether the both 'independent variables' should lead to different or similar outcomes. Dietrich and Audiffren (2011) review that a single bout of physical activity has acute, transient effects

on cognitive functions. Regular physical activity on the other hand has a chronic and durable effect which is caused by morphological changes in the brain structure. When tested *during* physical activity, individuals show increased arousal and improved implicit information processing, but impaired executive functions. *After* a single bout of physical activity however, executive functions are generally improved; this effect is similar to the beneficial effects found after long-term physical activity interventions and among regular exercisers in correlational studies.

Transient improvement in information processing after engaging in a single bout of physical activity may transform into lasting changes when physical activity is performed regularly. For example, Hopkins et al. (2012) found that after a single bout of physical activity, regular exercisers improved their memory performance, while they found no improvement in sedentary individuals after a single bout of physical activity. They explain that *"These data may reflect a gradual development in the beneficial effects of regular exercise, whereby an acute bout of mild exercise can confer cognitive benefits to individuals who regularly engage in exercise. In other words, the degree to which an acute exercise session will influence cognitive performance may depend on the individual's previous physical activity habits."* (Hopkins et al., 2012, p. 8)

Overall, previous literature points towards the direction that a single bout of physical activity can lead to transient improvements of executive functions. Additionally, regular physical activity has chronic effects on executive functions, and may affect people's 'preparedness' to react more strongly to a single bout of physical activity. Therefore, I expected regular physical activity and a single bout of physical activity to lead to similar outcomes with regard to their information processing in consumer decision making.

2.4 Two Attribute Weighing Paradigms

This thesis investigates the effect of physical activity on two well-researched consumer decision paradigms – the dilution effect (Meyvis & Janiszewski, 2002; Nisbett, Zukier, & Lemley, 1981) and the desirability-feasibility choice conflict (Liberman & Trope, 1998; Liu, 2008). Both tasks, outlined in detail in the remaining chapter, require consumers to integrate and weigh several pieces of information to form a judgment and / or make a choice. In the dilution paradigm consumers are presented with irrelevant product information in addition to relevant information. From a normative perspective,

the irrelevant information should be ignored and not taken into account in order to make a valid judgment. The importance of the irrelevant information needs to be down-weighed in the overall judgment. In the desirability-feasibility choice conflict consumers have to trade-off desirability against feasibility attributes. Both attributes are informative and should be taken into account in the decision making process.

2.4.1 The Dilution Effect

Imagine the following situation. Once again, you have forgotten that today is Mother's Day. You want to send flowers to your mother so you go online and look for a flower delivery service that can do the job fast. You find a company that guarantees a same day delivery or you get your money back. It sounds like the company is fast enough to deliver the flowers in time, so you go for it. Now, imagine that the company also provides additional information on their website: they sponsor art events, they have their headquarters in Manchester and were founded in 1972. Would this information influence your judgment of how fast the delivery service is?

From a normative perspective such irrelevant information should not influence your judgment because it is not diagnostic of the desired outcome – a fast delivery. However, research in a variety of domains has shown that people do take irrelevant information into account and typically dilute their judgments (i.e., their judgments become less extreme).

Nisbett et al. (1981) originally labelled this phenomenon *the dilution effect* when they investigated the role of non-diagnostic, irrelevant information in the domain of person perception and stereotypes. Participants in their experiments had to make predictions about a target person (e.g., how much electric shock a person could take, or how many movies a person had watched in the last year). Participants either received only diagnostic, stereotypical information (the person was described as an engineering major student vs. a music major student) or participants received a combination of diagnostic information and non-diagnostic, irrelevant information (e.g., the father is a sales manager for a steel company). All information had been pre-tested for its "usefulness" in predicting the relevant outcome and demonstrated people's stereotypes of engineering vs. music students. In five experiments participants made less extreme predictions if they had received non-diagnostic information in addition to diagnostic information, in comparison to participants who had received only diagnostic information. Participants' social stereotypes had been weakened by providing non-diagnostic information.

Four years earlier, Troutman and Shanteau (1977) published a paper showing the same phenomenon in a more abstract context. They investigated probability judgments in an inference task. Participants were shown two bags each filled with a different proportion of 150 beads. One of the bags was filled with predominately white beads (70), and fewer red beads (30). The other bag was filled in a complementary fashion (70 red beads, 30 white beads). Both bags also contained an equal amount of blue beads (50). Next, one bag was chosen at random and a sample of beads was drawn from it. After seeing the sample of beads participants had to estimate the probability that the bag filled with predominately white beads, had been selected. In this task drawing blue beads represented non-diagnostic information since each bag contained an equal number of blue beads and therefore this information was irrelevant for the estimation task. Similar to Nisbett, Zukier and Lemley's (1981) results in the social domain, Troutman and Shanteau (1977) found that non-diagnostic, irrelevant information reduced participants' probability judgments when it was presented after diagnostic information. Importantly, they also showed that in a control sequence participants interpreted the non-diagnostic information per se correctly (probability judgments of around 0.5); thus, the finding could not be attributed to a misunderstanding of the non-diagnostic blue beads.

Simonson, Nowlis, and Simonson (1993) published the first paper investigating a consumer behaviour adaptation of the dilution effect. Specifically, the effect of irrelevant preference arguments on consumers' choices was investigated. They showed participants arguments which had been used by other consumers to justify their choices. Subjects were told that due to budget constraints each paper & pencil questionnaire had to be used by two participants; hence the answers of the previous participants were already on the paper. The reasons provided by the alleged previous respondent were irrelevant to most subjects (e.g., "I chose Breyer's ice cream because it is kosher"). They found that irrelevant choice explanations given by 'previous respondents' were not disregarded and significantly changed the likelihood of someone choosing a product. In particular, subjects were less (more) likely to choose a product if it had previously been rejected (selected) for irrelevant reasons compared to a control group without 'previous responses'.

During the last 30 years, the dilution effect has been replicated and extended to a variety of applied research domains such as auditor's fraud risk judgments (Glover, 1997; Hackenbrack, 1992; Hoffman & Patton, 1997), cooperation in Prisoner's and Chicken Dilemma games (deDreu, Yzerbyt, & Leyens, 1995), negotiations (Wiltermuth & Neale, 2011), climate change communication (de Vries, Terwel, & Ellemers, 2014), legal

decision making (Smith, Stasson, & Hawkes, 1998), celebrity co-branding (Ilicic & Webster, 2013) and product judgments (Gierl & Huettl, 2012; Malaviya & Sternthal, 2009; Meyvis & Janiszewski, 2002).

Theoretical Explanations of the Dilution Effect

A number of studies have aimed to determine the underlying processes which lead to diluted judgments in light of irrelevant information. Several theoretical mechanisms have been proposed and tested in the literature. Below is an outline of the most frequent explanations of the dilution effect. Please note, however, that this is not a complete summary of all possible mechanisms.

Among the earliest and most popular contestants of the theoretical explanations in the social perception literature is the *representativeness heuristic* (Tversky & Kahneman, 1974). This heuristic describes a judgment strategy that people used to predict the likelihood of an object or person belonging to a certain class or category. People use the similarity between the given information and the typical, representative outcome to infer how likely it is that the outcome will occur based on the information they received. Non-diagnostic, irrelevant information reduces the similarity between the object and the typical outcome that is suggested by the diagnostic information, according to this theoretical account. Diagnostic information is highly representative of the to-be-predicted outcome, whereas non-diagnostic information is *individuating* and makes the object less representative of the target outcome. For example, being a music student is more representative of a stereotypical film-loving student than being a music student whose father is a sales manager for a steel company (Nisbett et al., 1981).

An *averaging* process has also been proposed as a potential explanation of the dilution effect, particularly in the non-social literature (Troutman & Shanteau, 1977). According to this account, irrelevant non-diagnostic information reduces the impact of the diagnostic information on the outcome. This model assumes that people make judgments as if they assign a weight to each piece of information, and that each weight has to be adjusted according to the other weights. If non-diagnostic information receives a weight greater than zero, then the weight assigned to the diagnostic information must be adjusted downwards. Therefore, non-diagnostic information weakens the impact of diagnostic information on the outcome, resulting in a dilution effect.

The *conversational norm* explanation of the dilution effect is based on the communications literature and ascribes the dilution effect to an experimental artefact.

According to the 'maxim of relation' (Grice, 1975) and the 'principle of relevance' (Sperber & Wilson, 1986), people generally expect provided information to be relevant and meaningful when communicating with others. Especially participants in a research study expect provided information to be relevant and informative. Why else would the experimenter give the information? Hence, people attribute meaning to the non-diagnostic information and integrate it in their judgment, resulting in the dilution effect. The debate between Kemmelmeier (2007a, 2007b) and Igou (2007; 2005) gives an overview over recent controversies and findings with regard to the literature on conversational norms as the basis of the dilution effect.

Meyvis and Janiszewski (2002) contrasted and tested each of these theoretical mechanisms rigorously in a series of ten experiments against their proposed theoretical explanation of the dilution effect - *biased hypothesis testing*. They created a product judgment version of the dilution paradigm (the same stimuli was used in this thesis, therefore I will explain it in more detail). Subjects were presented with a series of eight different consumer products or services in random order. First, subjects were told that they should be looking for a particular benefit in a product/service (e.g., "you are looking an airline with superior service"). Subjects then received one piece of supportive information about the product ("#1 in JD Power & Associates Survey on Airline Service"). Subjects in the control condition received no further information. Subjects in the dilution condition sequentially received three pieces of obviously irrelevant product information (e.g., "company founded in 1978"). The product information was pre-tested extensively to guarantee that the information presented was indeed irrelevant vs. diagnostic for people's product judgments.

Finally with all information presented on the screen, subjects in both conditions rated whether they thought the product would deliver the particular benefit ("Has this airline superior service?"). Using this procedure they found a robust dilution effect of irrelevant product information. This dilution effect also persisted in a product choice task, and when the supportive information was presented in the last position instead of first (experiment 1A).

In experiment two, Meyvis and Janiszewski (2002) rule out the averaging account by showing that adding *less* supportive information, instead of irrelevant information, does not lead to diluted judgments (as opposed to the prediction of an averaging model), but actually to more extreme judgments, i.e. a polarization effect.

In experiment three, they investigated the conversational norm account by asking subjects before judging the products whether they thought the given information was relevant or not. They found that even when subjects clearly indicated that the information was not helpful for rating the products, they still showed a robust dilution effect. Moreover, subjects also showed a dilution effect when thinking that the irrelevant information had been randomly picked by a computer (experiment 3A). This casts doubt on the conversational norm account as a theoretical basis of the dilution effect in product judgments.

To rule out the representativeness heuristic account they presented subjects with irrelevant information that increased the perceived similarity between the product description and the typical desired product (experiment four). A representativeness account would predict a polarisation of product judgments instead of a dilution effect. However, this was not the case. Subjects still diluted their judgments when presented with irrelevant but typical product information, unless they were specifically nudged to follow a representativeness heuristic strategy.[4]

Experiments five to seven provide support for the biased hypothesis testing explanation of the dilution effect. The biased hypothesis testing account consists of the following three assumptions: 1) consumers selectively test the focal, positive hypothesis (i.e., that the product will deliver a particular benefit) as opposed to the alternative, negative hypothesis (i.e., the product will not deliver the benefit); 2) consumers selectively search for information that confirms the positive hypothesis, and 3) consumers categorize the provided information according to their search goal as *confirming* or *not confirming* with regard to the focal hypothesis.

When goal relevant information (the product's benefit) was revealed only *after* the product information was presented - eliminating the possibility of goal-related, top-down processing - subjects showed no dilution effect, as predicted by the biased hypothesis testing account. The dilution effect also disappeared when subjects were forced to consider the alternative, negative hypothesis by rating their belief that the product would *not* deliver the benefit. Finally, Meyvis and Janiszewski (2002) show that irrelevant information can actually strengthen the belief in a product's benefit in case a brand is perceived very negatively in the beginning. They show that in this case, subjects try to confirm the hypothesis that the product will *not* deliver the benefit. If presented with

[4] For this, participants were asked to rate the similarity between the product description and the typical desired product, before judging the products' benefits.

irrelevant information in addition to supportive information, participants became more favourable towards the product.

Although all of the results were more consistent with the biased hypothesis testing account than with any other process, Meyvis and Janiszewski (2002) stress that other mechanisms may contribute to or might be the sole cause of the dilution effect in experiments using different stimuli and settings, such as the prediction tasks in social settings.

Moderators

Several research studies introduced moderating variables of the dilution effect. For example, Tetlock and Boettger (1989) found that holding people accountable for their judgments magnified the dilution effect in the social domain. They found that this was due to an increased complexity of thinking which was investigated using thought protocols. This finding, however, was not replicated in the applied domain of auditors' fraud judgments (Glover, 1997; Hoffman & Patton, 1997). In this domain time pressure seemed to reduce the dilution effect (Glover, 1997). Peters and Rothbart (2000) argue that it is not the irrelevant information per se, but the typicality of this information that creates the dilution effect in social judgments. They argue that irrelevant information influences the way in which the relevant information is interpreted – an interaction effect between both types of information. Depending on the typicality, irrelevant information leads to a dilution effect in social judgments, enhancement or no effect at all.

Malaviya and Sternthal (2009) identified individuals' regulatory goal focus as a moderator of the dilution effect in a parity product adaptation. They presented subjects with two products, of which one always outperformed the other on an important dimension. In the 'dilution' condition they added parity product features – both products performed equally on this set of attributes. Thus, these features didn't help to distinguish between the two products and were 'irrelevant' for the product evaluation. They further manipulated subjects' regulatory goal focus (promotion vs. prevention focus) as well as the means of goal pursuit (locomotion vs. assessment). This was operationalized by presenting the product information simultaneously or sequentially. The authors found that adding parity product features can have different effects on product evaluations: enhancement, a dilution effect or no effect, depending on the fit between regulatory focus and the means of goal pursuit. Parity product features led to enhanced product evaluations when there was a fit between regulatory goal focus and the means of goal pursuit

(promotion focus and sequential presentation or prevention focus and simultaneous presentation). Parity product features only led to a dilution effect when there was no fit between regulatory focus and the means of goal pursuit (prevention focus and sequential presentation).

Malaviya and Sternthal (2009) add a novel perspective to the research on the dilution effect by examining motivational factors which may influence information processing. However, their research also deviates from the classic dilution effect design by introducing parity product features as irrelevant information. In most studies investigating the dilution effect 'irrelevant information' is considered as non-diagnostic for the outcome. In Malaviya and Sternthal's (2009) research however, the 'irrelevant' information still helps to evaluate the quality of the product on its own (e.g. battery life of a camera). However, it does not help to distinguish between the two products since both cameras have the same battery life. Arguably, it is more likely to find an enhancement effect than a dilution effect using this design. Additional positive and relevant (for single item evaluation purposes) product information is provided instead of obviously irrelevant information that is not predictive of the product benefit. Future research could test the regulatory fit hypothesis in line with the dilution effect literature by adding obviously irrelevant parity product features to the design.

Individual Differences

A small number of studies have looked at individual differences that can reduce or exacerbate the dilution effect. One noteworthy finding comes from Kemmelmeier (2007a). Subjects who scored low (the bottom quartile) on the Personal Need for Structure scale (PNS; Neuberg & Newsom, 1993) did not show a dilution effect in social judgments. The PNS scale is measuring individual differences in preference for "structure and clarity in most situations, with ambiguity and grey areas proving troublesome and annoying" (Thompson et al. 1992, p3.). Subjects high in PNS prefer simply structured situations and clear straightforward information. Kemmelmeier (2007a) argues that subjects low in personal need for structure are less likely to rely on simple heuristic processing, such as similarity matching or the representativeness heuristic, "but instead engage in more complex processing of the information that avoids the impact of blatantly irrelevant information" (p.53). However, Kemmelmeier's finding could not be replicated by Igou (2007) and is in contrast with Tetlock and Boettger's (1989) finding which show that high processing motivation can exacerbate the dilution effect.

Research studies investigating the dilution effect vary greatly with regard to the domain (social prediction and judgments, probability judgments, applied research, consumer product judgments etc.) as well as the research design (within-subjects vs. between subjects, valence of the irrelevant information, number of irrelevant information, sequential vs. simultaneous presentation). This variety illustrates the robustness of the effect but it also makes it harder to compare the results from different studies. Furthermore, it complicates theory integration which would be necessary to finally tackle the underlying cognitive, motivational or conversational process or the combination of processes that ultimately lead to the dilution effect. Although we know much more about how people process irrelevant information and integrate them into their judgments, evaluations and predictions, there still exists no parsimonious explanation of the dilution effect 36 years after Nisbett, Zuckier and Lemley's (1981) seminal paper.

If physical activity improves the integration of different pieces of information, we would expect exercisers to apply more appropriate weights to different attributes; or make judgments that appear *as if* they applied more appropriate weights to different attributes. In the dilution paradigm wherein people are unable to ignore irrelevant information and end up diluting their judgments, I hypothesized that physical activity would lead to smaller or no dilution effects in product judgments when consumers are faced with irrelevant information. This proposition was investigated in Chapter 3.

2.4.2 The Desirability-Feasibility Choice Conflict

The second consumer decision making task which was investigated in this thesis is the desirability-feasibility choice conflict. Instead of ignoring irrelevant information like in the dilution paradigm, this decision problem requires people to 1) consider all the available information, and 2) to trade-off two negatively correlated attributes against each other. Key in this task is to consider both of the decision attributes in order to make a good decision.

Let me illustrate this with an example of a desirability-feasibility choice conflict. The weekend is coming up and you are planning to go on a hiking trip. There are two possible nature parks you could drive to. One of the parks has a stunning scenery with waterfalls and creeks but it is also quite far away and has limited parking possibilities. The alternative park is much closer and has easily accessible parking. However, the scenery is not quite as good. It has mostly boulders and bushes. Which one would you go for?

This decision is characterized by a trade-off between two conflicting attributes: the scenery of the parks and their accessibility. When choosing the park with the stunning scenery you have to deal with a long and inconvenient journey. When choosing the easily accessible park, you miss out on the stunning scenery. Such a decision problem can generally be described as a desirability vs. feasibility trade-off.

The desirability of a product or activity describes the value of the desired end state. Feasibility on the other hand, concerns the ease or difficulty of reaching this desired end state (Liu, 2008). The quality of a product or the payoff amount in a lottery are examples of desirability features. Examples of feasibility features include the price of a product, the waiting time and accessibility or the probability of winning in a lottery. Consumers frequently have to trade-off desirability against feasibility attributes in order to make optimal product choices.

Research on construal level theory has highlighted the role of feasibility versus desirability attributes in consumer decision making (Liberman & Trope, 1998). According to construal level theory (Trope & Liberman, 2010), psychological distance which can be spatial, temporal or social, influences mental construals. Greater psychological distance is represented by high-level construals. Those are abstract, coherent, and superordinate in comparison to concrete low-level construals. As this is a bidirectional relationship, mental construals can also influence the perception of psychological distance (Trope & Liberman, 2010). For example, when we think about distant events in the future, or remember distant events in the past we construe them more abstractly. Proximal events on the other hand are construed more concretely.

From a construal level perspective, desirability attributes represent a relatively abstract, high-level construal as opposed to the more concrete, low-level construal of feasibility attributes. Liberman and Trope (1998) show that with increasing psychological distance, people assign greater weight to desirability concerns compared to feasibility concerns.

Liu (2008) investigated the effect of a decision interruption on desirability-feasibility trade-offs. She found that consumers focus less on feasibility attributes when decisions were interrupted. The decision interruption lead to a shift in information processing mode from bottom-up to top-down, goal-directed information processing. Participants were more likely to prefer highly desirable but less feasible consumer products after being interrupted. Several other research studies have investigate desirability-feasibility trade-offs in different contexts such as gift giving (Baskin,

Wakslak, Trope, & Novemsky, 2014), rebate redemption (Cohen, Belyavsky, & Silk, 2008) or assortment size preferences (Goodman & Malkoc, 2012).

Sagristano, Trope, and Liberman (2002) extended the research on desirability-feasibility trade-offs to the domain of probabilities and payoffs in gambling. The payoff of a gamble represents the desirability of the outcome, while the probability of winning in a gamble represents the feasibility of the outcome. The authors found that with increasing temporal distance, payoffs had more influence on gambling preferences than the probabilities. In general feasibility attributes (i.e., probabilities) were subordinate to desirability attributes (i.e., payoffs). The subjective importance of the feasibility attribute depended on the desirability of the outcome, but not vice versa. This suggests that people may only consider the feasibility information when the desirability of an outcome is high enough. The desirability information on the other hand remains important irrespective of the level of feasibility. This indicates that people are generally focusing more on desirability attributes. This finding is in line with research suggesting that people are more sensitive to end benefits than to means (Escalas & Luce, 2004; Vallacher & Wegner, 1987; Wegner, Vallacher, Kiersted, & Dizadji, 1986).

Thompson, Hamilton, and Rust (2005) showed that when buying products, consumers give too much weight to the capability of products and neglect usability information. Therefore, they end up choosing overly complex products which leads to reduced satisfaction and negative user experience. Cohen et al. (2008) summarise that under typical conditions desirability features will dominate the importance of feasibility features in the consumption domain. They used a visualisation technique to reduce people's tendency to focus too narrowly on desirability attributes in the context of rebate redemptions – another area in which consumers place too much emphasis on desirability at the cost of feasibility considerations.

Wan and Agrawal's (2011) investigation of carryover effects of self-control on desirability-feasibility trade-offs is particularly related to the research in this thesis. In six experiments they show that exerting mental self-control lowers people's construal level and leads them to focus more on feasibility attributes. They used classic self-control manipulations from the depletion literature like the cross-off letters task, the Stroop test and the white bear task. After completing one of these self-control task, participants had to make choices between options varying in terms of feasibility and desirability. The authors found that depletion caused by performing self-control tasks, led individuals to focus more on their own resources (or lack thereof) and their feelings of fatigue. This in

turn prompted a lower construal mind-set and influenced subsequent decision making. Specifically, it increased participants' focus on the feasibility attributes.

Exerting self-control in a previous, unrelated situation can therefore help consumers to not neglect feasibility attributes in situation in which they are important to consider. Wan and Agrawal (2011) only tested 'mental' self-control tasks as opposed to 'physical' self-control. Physical activity can be seen as an act of self-control and might therefore lead to similar results. But for people who enjoy engaging in physical activity and perceive it as a positive experience, physical activity doesn't necessarily require self-control. Furthermore, it is not clear which predictions to make for people who engage in physical activity regularly. Are they in a chronically lower construal mind-set because they are exerting self-control repeatedly? This is in contrast to the literature which shows that an abstract construal mind-set benefits self-control (Freitas, Gollwitzer, & Trope, 2004), including engagement in physical activity (Sweeney & Freitas, 2014). It remains unclear whether physical activity would have a similar effect as cognitive self-control tasks on feasibility-desirability trade-offs, and whether physical activity would act through the same or different mechanisms.

If physical activity improves the integration of different pieces of information, we would expect exercisers to apply more appropriate decision weights to the feasibility and desirability attributes. That is more weight on feasibility attributes and less weight on desirability attributes, especially in situations when decision makers tend to overly focus on the desirability features and neglect feasibility features (e.g., for future choices). In Chapter 4, I tested the proposition that physical activity would lead to less or no neglect of feasibility attributes in product choices which require trade-offs between desirability and feasibility attributes.

Chapter 3. Physical Activity and the Dilution Effect

The objective of the set of studies outlined in this chapter was to firstly investigate whether regular physical activity is associated with people's judgments in situations which require them to ignore irrelevant product information. The second goal was to eliminate a range of potential alternative explanations; for example individual differences between regular exercisers and inactive participants with regard to their demographics, personality traits and mood. A third goal was to shed light on the potential underlying mechanisms that could explain the relationship between physical activity and people's judgments in the dilution paradigm. Different samples and designs were used to increase the external validity and generalizability of the findings. Studies one and two investigate the effect of irrelevant information on product judgments in regularly physically active versus inactive Mturk workers. Study three and four were conducted in the UK with gym members and seasoned runners who participate in weekly organized runs. Study five was conducted with students at the LSE behavioural research lab and investigates the effect of a single bout of physical activity on consumer judgments in the dilution paradigm, using an experimental manipulation of physical activity.

3.1 Study 1: Regular Physical Activity and the Dilution Effect

The aim of study one was to investigate whether regular physical activity is associated with consumers' product judgments when being confronted with relevant and irrelevant product information. Specifically, I expected inactive participants to show the classic dilution effect, whereas I expected regularly active participants to show no dilution effect. More formally:

H1: People who are regularly physically active show less or no dilution effect when seeing irrelevant product information than inactive people.

No specific hypothesis were formed with regards to work-related or leisure-time physical activity, since arguments for both sides – work related physical activity having the same or different effect than leisure-time physical activity - could be made.

Meyvis and Janiszewski's (2002) consumer product version of the dilution effect was chosen as an experimental paradigm which manipulates the presence of irrelevant information in a between-subjects design. Participants' self-reported regular physical activity was crossed with this design.

Since people who exercise regularly differ from inactive people on a range of characteristics (Bauman et al., 2012; Lathia et al., 2017; Rhodes & Smith, 2006), I included several control variables to eliminate or reduce the effect of any confounding variables on the product judgments. Specifically, I collected information about participants' demographics, personality traits, mood and lay beliefs about physical activity as well as two measures of reasoning. All measures are described in detail in the following methodology section.

Methodology

An individual differences approach was combined with an experimental manipulation of the product information to investigate the dilution effect in inactive compared to different types of physically active individuals (leisure time vs. work physical activity). Participants were recruited online via Amazon's Mechanical Turk and received a $2 payment for their participation. Participants were informed that the study was about individual differences in decision making and problem solving and would last approximately 15 minutes. The data was collected in March 2015.

Dilution effect. Participants completed an adapted version of Meyvis and Janiszewski's (2002, experiment 1) consumer product test of the dilution effect. A 2 (type of information: control vs. dilution) x 7 (product replicate: toothpaste, computer, delivery service, apartment, airline, car, stereo system) mixed design was used, with type of information as the between-subjects factor and product replicate as the within-subjects factor.[5] Participants were randomly assigned to one of the two between-subjects factors.

After providing informed consent, participants were instructed that they would receive information about seven different products or services, and that their task was to indicate whether the product or service delivered a particular benefit. They would receive information about each of the products and this information may or may not be helpful. The original instructions which were used are shown in appendix A.

[5] In the original paper by Meyvis and Janiszewski (2002) eight product categories were used. I decided to exclude one of the product categories because it was related to health behaviour (*Product*: frozen entrée, *Desired Benefit*: healthy, *Supportive Information*: very low in fat). All other product replicates were the same as in the original paper.

Next, participants were sequentially presented with the description of the seven products, in random order. For each product, participants were first given the desirable benefit (*"You are looking for a safe apartment"*) and then received the product description. In the control condition, participants only received one piece of information, which was always supportive and diagnostic of the desirable benefit ("*24 hour on-site security*"). In the dilution condition, this was followed sequentially by three pieces of irrelevant information (e.g., "*complex name: Haywood park*"). The irrelevance of the stimuli had been pretested extensively in the original paper by Meyvis and Janiszewski (2002) to guarantee that the information was indeed perceived as relevant or irrelevant by consumers in this context.[6]

For each replicate, participants rated whether the product would deliver the specific benefit while the product description and information remained visible on the screen. Ratings were given on a 100 point slider scale with anchors at the two end points (e.g., 0 = definitely not safe, 100 = definitely safe). A screenshot of the instructions, the presentation format in the control and dilution condition for one product replicate and a list of all product information are shown in appendix A.

The product judgment task was followed by two measures which were included to account for individual differences in reasoning: the Remote Associates Test (RAT) and the Nonsense Syllogism Test (NST; see appendix J for both measures). The order of the RAT and NST was counterbalanced.

Remote Associates Test. Fifteen items from the original RAT (Mednick, 1968) were used as a test of convergent thinking (Lee, Huggins, & Therriault, 2014). For each item participants were shown three word on the screen (e.g., elephant – lapse – vivid). Their task was to identify a new word which is associated with all of the three words (solution: memory). After receiving instructions and a sample item including solution, participants completed the items in ascending order of difficulty based on results from Lee et al. (2014). Participants had 15 seconds to complete each item and were informed about the remaining time by a countdown timer on the screen. The time limit was included to reduce the possibility of participants looking for solutions online. If participants did not provide an answer within 15 seconds, they automatically advanced to the next item. The RAT score was calculated as the sum of correct responses.

[6] It should be noted that there is no such thing as irrelevant information per se. Information can only be relevant or irrelevant with regard to a specific context. For the product stimuli the information in the dilution condition is irrelevant in the context of the desirable benefit which was provided to participants.

Nonsense Syllogism Test. Participants completed the NST (Ekstrom, French, Harman, & Dermen, 1976) as a measure of deductive, logical reasoning. Participants were presented with several syllogisms each consisting of two premises and one conclusion (e.g., *All alligators are art collectors. Some art collectors live in caves. Therefore some alligators live in caves*). Participants had to assume that the first two statements in each problem were true. Their task was to indicate whether the conclusion drawn from the first two sentences showed good or poor reasoning, by deductively applying the principles of logic. After receiving instructions and two sample items with solutions, participants had to evaluate the validity of 15 nonsense syllogisms. The NST score was calculated as the sum of correct responses.

Personality traits. Next, participants completed the Big Five Inventory-10 (BFI-10; Rammstedt & John, 2007) – a ten item scale which measures individual differences in personality traits (extraversion, agreeableness, conscientiousness, neuroticism and openness). Responses were given on a Likert scale ranging from 1 = disagree strongly, to 5 = agree strongly (see appendix J for the items and instruction).

Mood. To account for individual differences in mood, the BFI-10 was followed by the shortened version of the Profile of Mood States (POMS-SV; Shacham, 1983). The POMS-SV consists of 37 mood adjectives. Participants are asked to indicate how they had been feeling during the past week. Responses were given on a Likert scale from 0 = not at all to 4 = extremely. The POMS-SV consists of six subscales: tension-anxiety, depression-dejection, anger-hostility, fatigue-inertia, vigour-activity and confusion-bewilderment. A total mood disturbance score was also calculated by subtracting the vigour-activity score from the sum of scores on all other subscales (see appendix J).

Regular Physical Activity. To measure differences in physical activity the Global Physical Activity questionnaire was used (GPAQ; Bull, Maslin, & Armstrong, 2009). The GPAQ was originally developed by the World Health Organization for surveillance of physical activity levels. It collects information about physical activity in three domains: 1) physical activity at work; 2) travel to and from places; and 3) leisure-time / recreational physical activity. Participants were informed that vigorous-intensity activities require hard physical effort and cause large increases in breathing or heart rate, while moderate-intensity activities require moderate physical effort and cause small increases in breathing or heart rate. A detailed explanation of vigorous and moderate physical activity during work, for travel and for leisure was provided to participants. This was combined with a list of examples and visual images to help participants assess their personal amount of

physical activity reliably (see appendix B for an example). First, participants indicated for the work domain the number of days in a typical week they were physically active (or not) as well as the duration of moderate and / or vigorous-intensity physical activity. Next, participants indicated for the leisure-time recreational domain, the number of days in a typical week they were physically active (or not) as well as the duration of moderate and / or vigorous-intensity physical activity.

Demographics. Following this, participants completed a demographics section which included questions about gender, age, annual income, and highest level of education as well as current weight and height. This was used to calculate the BMI.

Lay beliefs. At the very end, participants' lay beliefs about positive or negative effects of physical activity were assessed with the following question: "*Do you think a person, who exercises a lot, is worse, about the same or better than a person who doesn't exercise in terms of the following skills?"* Lay beliefs about physical activity were assessed for the following five items in random order: *making good decisions, making judgments about people, making judgments about products, being analytical, being creative.* Responses were provided on 100-point slider scales with the following anchors: 0 = much worse, 50 = about the same, 100 = much better (see appendix J).

Upon completion, participants were thanked for their participation and re-directed to the MTurk website where they received their payment. The data in all studies was analysed using SPSS 21 or Stata 14.

Results

Participants. Three hundred and one individuals living in the United States were recruited. One individual failed to provide the correct answer to an attention filter question and was removed from the data analysis. Eighteen further individuals were excluded from the data analysis since they provide unreasonably high physical activity responses in the GPAQ (more than three standard deviations above the mean for work, travel or leisure activity). This left 281 participants (124 females) for the data analysis. The average age, as indicated by selecting one out of eight categories, fell in the range of 35 - 44 years. The average annual salary, as indicated by selecting one out of nine categories, fell in the $25,001 - $50,000 range.

Regular physical activity. The physical activity responses were processed and truncated according to the GPAQ guidelines for data processing and analysis as outlined below. Physical activity duration was converted from hours and minutes per day to

minutes per week. Only responses which were greater or equal to ten minutes of activity were included since this is the amount of time required to achieve noticeable health benefits. Physical activity data, which exceeded 4 hours per day per category was truncated to equal 240 minutes. Based on the WHO guidelines, a person was classified to be physically active during leisure time if they met any of the following criteria:

- three or more days of vigorous leisure time physical activity of at least 20 minutes per day;
- five or more days of moderate leisure time physical activity of at least 30 minutes per day;
- five or more days of any combination of moderate or vigorous leisure time physical activity achieving at least 600 metabolic equivalent (MET)-minutes per week.

For a person to be classified as physically active at work, the same criteria were applied in the domain of work-related physical activity. Based on their responses in the GPAQ participants were categorized into the following binary physical activity groups:

- regular leisure time physical activity (yes: $n = 113$; no: $n = 168$)
- regular work time physical activity (yes: $n = 86$; no: $n = 195$)

Overall, 40.9% of participants were classified as being sedentary ($n = 115$); that is, they did not perform regular physical activity during leisure time nor at work.

Product judgments. The dependent measure in the dilution task – the judgment of a product's benefit – was first submitted to a 2 (type of information: control, dilution) x 7 (product replicate: car, toothpaste, package delivery service, stereo system, apartment, airline service, computer) mixed design ANOVA. Since the higher order interaction effect involving the product replicate factor was not significant ($p = .920$), the data were collapsed across this factor. The results revealed a significant difference between the type of information ($M_{\text{Control}} = 74.55$, $M_{\text{Dilution}} = 70.81$, $t(279) = 2.81$, $p = .005$). Participants who received only supportive information reported more extreme (i.e., positive) judgments than those participants who also received irrelevant information. Adding irrelevant information weakened participants' beliefs in the product's ability to deliver the desired benefit, thus demonstrating the classic dilution effect.

Next, I submitted the product rating to a 2 (type of information: control, dilution) x 2 (regular leisure physical activity: yes, no) x 2 (regular work activity: yes, no) between subjects ANOVA. This analysis was done in order to examine the effect of the type of information, regular leisure physical activity and regular work activity on the product rating.

The results showed that the second-order interaction (three-way interaction between the type of information, regular leisure physical activity and regular work activity) was not significant, $F(1, 273) = 0.05$, $p = .817$. Furthermore, the two-way interaction effect between the type of information and regular work activity was not significant, $F(1, 273) = 0.05$, $p = .817$. Neither was there an interaction effect between regular work activity and regular leisure physical activity on the product judgments, $F(1, 273) = 1.27$, $p = .919$. There was also no main effect of regular work activity on the product judgments ($F(1, 273) = 2.51$, $p = .114$).

Hence, no main effect or interactions were obtained as a function of regular work activity. Since none of the effects involving the regular work activity factor yielded any significant results, I am not reporting any follow-up analysis for this factor below. For simplicity, sedentary subjects and subjects with regular work activity but who performed no regular leisure-time physical activity are thereafter labelled as 'inactive' subjects.

I found initial support for the hypothesis that regular physical activity during leisure time is associated with a smaller dilution effect when facing irrelevant information. The results yielded a marginally significant interaction effect between the type of information and regular leisure physical activity, $F(1, 273) = 3.63$, $p = .057$.

Simple main effects showed that inactive subjects significantly diluted their product judgments when faced with irrelevant information ($M_{Control} = 75.60$, $M_{Dilution} = 69.82$, $t(166) = 3.19$, $p = .002$). But there was no significant difference in the product judgments for regularly physically active individuals ($M_{Control} = 73.22$, $M_{Dilution} = 72.53$, $t(111) = 0.36$, $p = .717$).

Further pairwise tests showed that there was no significant difference in the product judgments between the regularly physically active participants and the inactive participants in the control condition ($t(134) = 1.29$, $p = .196$). This was also the case in the dilution condition ($t(143) = -1.35$, $p = .178$). It remains unclear whether regularly physically active participants showed no dilution effect because they lowered their product ratings in the control condition, because they increased their product ratings in the dilution condition, or because of both.

Finally, the ANOVA yielded a significant main effect of the type of information, $F(1, 273) = 4.78$, $p = .029$. The results of the interaction between the type of information and regular leisure physical activity are shown in Figure 3-1.[7]

[7] Error bars represent standard errors in all figures; PA = Physical Activity; for each bar the mean and standard deviation (in brackets) are reported.

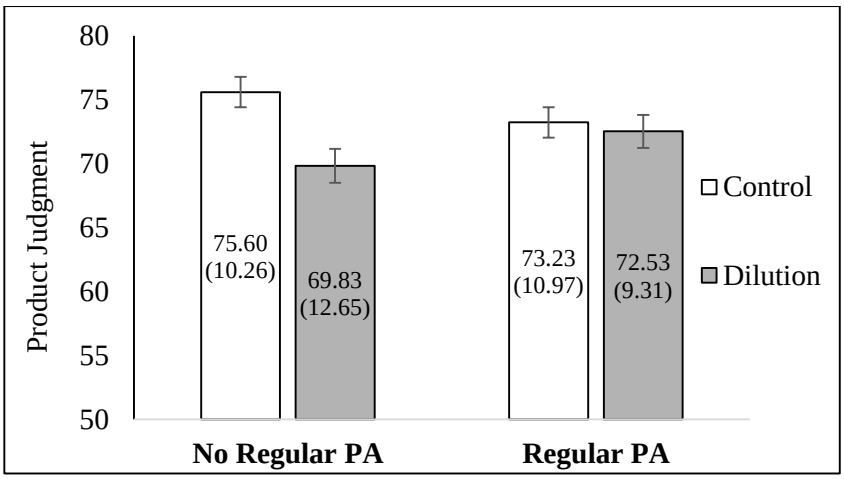


Figure 3-1. Effect of the type of information on the product rating in physically active and inactive individuals

Controls. Several control variables were investigated to take into account potential pre-existing differences between people who are regularly physically active and those who are not. Table 3-1 shows the descriptive statistics of regularly physically active and inactive participants for the control variables.

Demographics: There was no difference between the regularly physically active group and the inactive group with regard to their gender (p = .832) and age (p = .478). However, regularly physically active participants were more likely to report higher income (p < .001) and educational brackets (p = .008). Since income and education were correlated (r = .38, p < .001) they were entered as separate dummy variables in the model. Dummy variables were formed based on median splits. Neither education nor income was associated with the product judgments (p = .773 and p = .834, respectively). Importantly, the interaction effect between the type of information and regular physical activity persisted even after adding income and education to the model (p = .058 and p = .056, respectively).

Personality traits: There were a number of differences with regard to personality traits between people who indicated to engage in regular physical activity and those who didn't. The regularly physically active group reported higher levels of extraversion (M_{No_PA} = 4.06, M_{PA} = 5.84, t(279) = 3.55, p < .001), conscientiousness (M_{No_PA} = 7.55, M_{PA} = 8.07, t(279) = 2.59, p < .010) and lower levels of neuroticism (M_{No_PA} = 5.39, M_{PA} = 4.47, t(279) = 3.65, p < .001). There was also a marginally significant difference for openness, with regularly physically active subjects scoring higher than inactive subjects (p = .076). In terms of agreeableness there was no significant difference (p = .167). Extraversion, conscientiousness and neuroticism scores were added as

covariates to the ANOVA model. Extraversion and neuroticism did not have an effect on the product judgments. Conscientiousness was positively associated with the product judgments (b = 1.06, SE_b = .44, t = .2.43, p = .016). However, the interaction effect between the type of information and regular physical activity remained marginally significant even after controlling for personality traits (p = .063).

Mood: There were no significant differences between participants in the regular physical activity group and the inactive group on the following subscales of the POMS-SV: depression-dejection, confusion-bewilderment, tension-anxiety, anger-hostility and fatigue-inertia (all ps = ns). Regularly physically active participants reported higher scores on the vigour-activity subscale (M_{No_PA} = 1.43, M_{PA} = 1.96, $t(279) = 4.51$, $p < .001$). Further, the total mood disturbance score was marginally lower for regularly physically active individuals (M_{No_PA} = 2.32, M_{PA} = 1.50, $t(279) = 1.88$, p = .092). Vigour-activity and total mood disturbance scores were added to the ANOVA model. Neither variable was associated with the product judgements, nor did they impact the interaction effect between the type of information and regular physical activity, which remained significant (p = .045).

Reasoning: There was no significant difference between participants in the regular physical activity group and the inactive group in terms of their performance in the nonsense syllogism task (p = .311) and the remote associates test (p = .285). Neither reasoning scores were associated with the product judgements, nor did they impact the interaction effect between the type of information and regular physical activity.

Lay beliefs: To control for the potential confounding effect of participants' lay beliefs about the effects of physical activity, the average score for the five belief items was calculated (Cronbach's α = 0.86) and added to the model as a covariate. The results showed that the lay belief score was not related to the product judgments. In addition, the interaction effect between the type of information and regular physical activity remained significant (p = .058). Interestingly, participants generally held strong lay beliefs that physical activity is positively associated with decision making abilities. The average rating was significantly above the scale midpoint 50 with the anchor "about the same" (M = 56.76, $p < .001$). Furthermore, participants who reported to engage in regular physical activity had even more positive lay beliefs about physical activity than inactive individuals (M_{No_PA} = 55.19, M_{PA} = 59.11, $t(279) = 2.73$, p = .007).

Table 3-1. *Descriptive statistics of regularly physically active and inactive participants in study one*

	No Physical Activity (N = 168)	**Regular Physical Activity** (N = 113)	Test statistics
Demographics			
Age	*Mdn* = 4 (35- 44 years)	*Mdn* = 4 (35- 44 years)	$t(279) = 0.71$, $p = .478$
Female	44.6%	43.4%	$\chi^2(1) = 0.05$, $p = .832$
Highest Education	*Mdn* = 4 (2-year College Degree)	*Mdn* = 6 (4-year College Degree)	$t(279) = 2.64$, $p = .009$
Income	*Mdn* = 2 ($25,001-$50,000)	*Mdn* = 2 ($25,001-$50,000)	$t(277) = 3.25$, $p = .001$
Personality traits			
Extraversion	$M = 4.06$	$M = 5.84$	$t(279) = 3.55$, $p < .001$
Agreeableness	$M = 6.84$	$M = 7.17$	$t(279) = 1.36$, $p = .167$
Conscientiousness	$M = 7.55$	$M = 8.07$	$t(279) = 2.59$, $p < .010$
Openness	$M = 7.02$	$M = 7.43$	$t(279) = 1.78$, $p = .076$
Neuroticism	$M = 5.39$	$M = 4.47$	$t(279) = 3.65$, $p < .001$
Mood			
Depression-Dejection	$M = 0.68$	$M = 0.57$	$t(279) = 1.08$, $p = .282$
Confusion-Bewilderment	$M = 0.66$	$M = 0.65$	$t(279) = 0.14$, $p = .888$
Tension-Anxiety	$M = 0.81$	$M = 0.76$	$t(279) = 0.48$, $p = .630$
Anger-Hostility	$M = 0.61$	$M = 0.52$	$t(279) = 1.00$, $p = .318$
Fatigue-Inertia	$M = 1.00$	$M = 0.97$	$t(279) = 0.24$, $p = .405$
Vigour-Activity	$M = 1.43$	$M = 1.96$	$t(279) = 4.51$, $p < .001$
Total Mood Disturbance	$M = 2.32$	$M = 1.50$	$t(279) = 1.88$, $p = .092$
Reasoning			
Nonsense Syllogism Test	$M = 9.49$	$M = 9.80$	$t(279) = 1.01$, $p = .311$
Remote Associates Test	$M = 9.03$	$M = 9.49$	$t(279) = 1.07$, $p = .285$
Lay beliefs	$M = 55.19$	$M = 59.11$	$t(279) = 2.73$, $p = .007$

Discussion

Study one shows initial support for the hypothesis that regular physical activity is associated with no or less dilution effect in product judgments when decision makers are confronted with irrelevant information. Individuals, who are regularly physically active in their leisure time, were less prone than inactive subjects to dilute their judgments when being exposed to irrelevant product information. In short, physical activity during leisure time, was associated with a significantly reduced dilution effect. This finding persisted after controlling for various characteristics that could potentially explain individual differences in the product judgments. The result was robust to the inclusion of demographics (gender, age, education and annual salary), reasoning scores, mood, personality traits as well as lay beliefs about the effects of physical activity.

Interestingly, I did not find the same result for individuals who indicated to be physically active as part of their work. These participants significantly lowered their product judgments after seeing irrelevant information just like completely sedentary individuals. There are two potential explanations for this. First, a number of studies indicate that a motivational component or mindset of physical activity can moderate the benefits of physical activity on psychological as well as health-related outcomes. For example, Crum and Langer (2007) found that room attendants who were told that their work is 'good physical exercise' showed improved health outcomes (in terms of weight, blood pressure, body fat, waist-to-hip ratio and BMI) compared to a control group which did the same amount of work but received no information which framed their work as physical exercise.

Second, the type of physical activity that individuals perform during leisure time is likely to be different from the type of physical activity that people perform as part of their work. During leisure time physical activity, people might engage more in aerobic activities which raise heart rate and breathing significantly over an extended period of time (e.g., endurance training, running on a treadmill). This form of physical activity generally seems to have the most reliable positive effects on cognitive functions (Nokia et al., 2016). People, who engage in physical activity at work are presumably more likely to perform shorter bouts of physical activity, similar to lifting weights. They might not benefit from their physical activity to an extent that is sufficient to result in any measurable cognitive differences.

Study one has several limitations, some of which I tried to address in study two. The significance level of the interaction effect between the type of information and

regular physical activity is above the .05 level. It was therefore crucial to conduct a direct replication of study one to ensure the finding was not simply the results of a type I error. Thus far the results don't provide any insight into whether there was no dilution effect among the regularly physically active participants, because their product ratings in the control condition were lower, because their product ratings in the dilution condition were higher, or because of both.

Another limitation of study one is that it did not investigate potential process mechanisms which could explain the relationship between regular physical activity and the product judgments in the dilution task. Although several measures were included to account for pre-existing individual differences between regularly physically active and inactive people, a number of other third-variable explanations remain. Thus, several other control measures were included in study two.

To summarize, the key finding from study one is that people who regularly engage in leisure-time physical activity do not show a dilution effect when facing irrelevant product information. This finding persisted irrespective of a number of control variables. Study two builds on study one in order to replicate this finding, to eliminate other potential third-variable explanations and to investigate whether improved inhibitory functions among the regularly physically active explain this effect.

3.2 Study 2: A Direct Replication and Test of Alternative Accounts

Study two was designed to 1) directly replicate the findings from study one, 2) shed light on the potential underlying process and 3) eliminate additional confounding variables as alternative explanations. The working hypothesis was updated based on the finding that only leisure-time physical activity but not work-related physical activity, was associated with no dilution effect. For study two, I hypothesized that only leisure time physical activity would lead to a reduced dilution effect, more formally:

H1a: People who are regularly physically active during leisure time show less or no dilution effect when seeing irrelevant product information than inactive people.

Additionally, study two was designed to include a number of measures to test the hypothesis that regular leisure-time physical activity leads to a reduced dilution effect

because of improved inhibitory functions among regular exercisers. As outlined in chapter two, several studies have shown that regular physical activity (and single bouts of physical activity) can lead to improved performance in cognitive tasks which measure inhibitory functions (Barenberg et al., 2011; Erickson & Kramer, 2009; Jacobson & Matthaeus, 2014; Northey et al., 2017). Improved inhibitory functions among regular exercisers could help them to better inhibit the impact of the irrelevant information in the product judgement task.

H2: The relationship between regular physical activity and the dilution effect is mediated by improved inhibitory functions among regularly physically active participants.

The first set of measures and hypotheses investigates individuals' inhibition of the irrelevant product information. First, a recognition memory test for the product information was included to investigate whether regularly physically active individuals process and therefore memorize relevant vs. irrelevant information differently than inactive individuals. Higher error rates and reaction time latencies in the recognition test would be expected for the irrelevant items if regular exercisers were inhibiting the irrelevant information more successfully during information processing.

H2a: People who are regularly physically active during leisure time show higher error rates and reaction time latencies for the irrelevant information in the product information recognition test than inactive people.

Secondly, participants were asked directly to indicate which of the relevant and irrelevant information they had considered when judging the products. Based on hypothesis two, I expected that regular exercisers would indicate to have considered fewer irrelevant information.

H2b: People who are regularly physically active during leisure time indicate to have considered a lower number of irrelevant product information than inactive people.

The second set of hypotheses and measures investigates general inhibition skills unrelated to the product judgment task. First, as a classic measure of inhibitory functions, the Stroop Colour-Word Interference test (Stroop, 1935) was added to investigate potential differences in inhibitory control that are unrelated to the product information. If regular physical activity improves general inhibitory functions, regular exercisers should perform better in the Stroop test.

H2c: People who are regularly physically active during leisure time show lower error rates and reaction time latencies for incongruent trials in the Stroop test than inactive people.

Secondly, two behavioural decision making tasks which require self-control skills were included: delay discounting questions and self-control scenarios. If physical activity improves inhibitory functions, this should also affect regular exercisers' responses in generalized self-control decisions which require an inhibition of immediately gratifying options.

H2d: People who are regularly physically active during leisure time show higher scores in the delay discounting and self-control scenarios (indicating more self-control) than inactive people.

To investigate potential differences in attentional control between inactive and physically active individuals, the Necker Cube Pattern Control test (Bradley & Petry, 1977) was included which measures people's capacity for sustained, directed attention. No specific hypothesis were included for this measure. As control variables, I included a different personality trait measure than in study one, as well as a test of divergent thinking. All measures are described in detail in the following methodology section.

Methodology

A similar procedure to study one was used. Participants were recruited online via Amazon's Mechanical Turk in February 2016 for a $3.50 payment. They were informed that they would take part in a consumer product evaluation study where they had to complete several unrelated questionnaires related to consumer behaviour. After providing informed consent, participants completed the questionnaire.

Order. Half of the participants were randomly assigned to perform all task related to the product judgments in the beginning. The other half of the participants completed all task related to the product judgments after the other measures, but before the demographics and lay belief items. This was done to control for potential effects resulting from hypothesis guessing as well as fatigue.

Dilution effect. This was a direct replication of the product judgement task used in study one. Participants were randomly assigned to one of two between-subjects factors (type of information: control vs. dilution) and were presented in random order with the description of the same seven products or services as in study one (within-subjects: seven replicates). After rating to which extent each product replicate would deliver the particular benefit, participants moved on to the next task.

Personality traits. After evaluating the products' benefits, participants completed a short distractor task which also served as a control variable - the Ten Item Personality Inventory (TIPI, Gosling, Rentfrow, & Swann, 2003). The TIPI is the most commonly used 10-item measure of the Big Five personality trait dimensions (see appendix J for the items and instruction)

Memory task. Next, participants moved on to complete a recognition memory task for the previously seen product information. In particular, I tested participants' recognition memory for the previously seen supportive and irrelevant product information amongst new supportive and irrelevant distractor information. The recognition memory was measured using reaction times as well as correct responses.

A practice reaction time task was completed first. Participants were shown two different statements in the middle of the computer screen. Participants had to react as fast as possible to the specific statement using their left and right index finger. Their task was to press the '1' key at the top of their keyboard if they saw the sentence "*this statement is TRUE".* They had to press the '0' key if the sentence "*this statement is FALSE"* appeared. After they pressed either the '1' or '0' key, the next statement automatically appeared. If they pressed any other key the program would not proceed. Each statement was shown four times (eight items in total) and the order of the statements was randomized. The average reaction time in the practice task was used as a covariate in the analysis.

For the actual product information memory task, participants were told that they would now see some of the product descriptions from the previous product judgment task (i.e., press 1 if seen previously), and some new product descriptions which they had not seen previously (i.e., press 0 if new).

In the control condition, participants saw one previously seen supportive item and one new supportive item for each product replicate in random order (14 items in total). In the dilution condition, participants additionally saw one previously seen irrelevant item (randomly drawn from the three irrelevant descriptions) and one new irrelevant item for each product replicate in random order (28 items in total). A list of all product information used in the recognition memory test is shown in appendix A. As soon as participants had indicated whether an item was old or new by pressing the respective key on their keyboard as quickly as possible, the next item would automatically appear on the screen. This was repeated until participants had completed all items. Reaction times and correct responses were recorded.

Information considered. Participants in the dilution condition were then shown exactly the same product categories and information as they had previously seen in the product judgment task. Each product replicate was shown separately and in random order. Participants were asked to select which information they had considered when judging each product (see appendix A for the exact wording). Participants could select as many or few pieces of information as they wanted (ranging from zero to four pieces information for each product replicate). Since subjects in the control condition had only seen one piece of information, which had always been supportive, they did not perform this task.

Divergent thinking. Following this, participants completed a measure of divergent thinking – the Unusual Uses test (Guilford, 1967). Subjects were asked to generate as many creative uses for a ping pong ball they could think of within two minutes. During the last 15 seconds a count-down timer popped up so that participants could finish their last point before the page automatically advanced to the next task (see appendix J).

Decision making tasks. This was followed by three short decision making self-control scenarios which were adapted from Tuk, Zhang, and Sweldens (2015). Participants had to choose between immediately gratifying options and options with benefits in the long-run (e.g., buying shoes vs. saving money, eating a healthy vs. unhealthy snack). For example, in one of the scenarios participants read the following description:

"You try to save a certain amount every month. However, you've just seen a great pair of shoes on sale. It's really a great deal, but you wouldn't be able to save your target amount if you bought them. What would you do?"

Responses were provided on seven point Likert scales where one end represented the immediately gratifying option and the other end represented the long-term beneficial option (e.g., 1 = Definitely buy the shoes, to 7 = Definitely save the money).

Next, participants completed eight delay discounting items adapted from Tuk et al. (2015). Participants made hypothetical choices between a smaller immediate amount of money and a larger amount of money in the future. An inter-temporal choice score was calculated as the number of times participants selected the delayed reward. The delay discounting score ranged from zero to eight, where eight represented that a person 'always chose the delayed reward' (see appendix I for the items and instruction).

Attention control. Next, participants completed a test of attention control - the Necker Cube Pattern Control test (Bradley & Petry, 1977). Participants saw a three-dimensional wire representation of a cube. This cube repeatedly reverses its perceived orientation when looking at it for more than a few seconds. Participants had to indicate how often the orientation of the cube flipped by pressing a key on the keyboard. Participants were first given a 15 seconds practice task, which was followed by a baseline count of orientation flips. Participants were asked to simply look at the cube for 30 seconds and press the '1' key every time the orientation of the cube changed. This was followed by a second count. Participants were instructed to keep the cube from changing patterns by focusing on one orientation. They were asked to try to hold each orientation for as long as possible, but to keep track of how many times the orientation of the cube changed for a duration of 30 seconds. A screenshot of the Necker cube and the instruction is shown in appendix C.

Stroop test. Participants also completed an online version of the Stroop Colour-Word Interference test (Stroop, 1935) which is a commonly used measure of inhibitory functions. Participants saw a series of colour words on the screen (green, blue, orange, red). These words appeared in different font colours, sometimes matching the meaning of the word (24 congruent trials: e.g., the word BLUE written in blue font colour), and sometimes not matching the word (24 incongruent trials: e.g., the word BLUE written in red font colour). Participants' task was to indicate, as quickly and accurately as possible, the font colour in which the words were written.

It is much harder for participants to complete this task during the incongruent trials since they have to inhibit the pre-potent response of reading the word. Reading is a very fast and highly automated process and it interferes with the colour naming task during

incongruent trials. The 'Stroop effect' is demonstrated by slower response times and higher error rates during incongruent trials.

Participants had to indicate the font colour of the target word by clicking on one of four colour words printed in black just underneath the target word in a square (two words were presented next to each other, the other two appeared just below them). Once participants had made their selection, the next item would automatically appear on their screen until they had finished all 48 trials. Congruent and incongruent trials were presented in random order. A screenshot of the Stroop test and the instruction is shown in appendix D. Reaction times and the rate of correct responses were recorded.

Regular Physical Activity. Upon finishing the Stroop task, participants moved on to complete the International Physical Activity Questionnaire (IPAQ, Hagstromer, Oja, & Sjostrom, 2006). The IPAQ is almost identical to the GPAQ with regard to the structure, questions and outcome variables. The GPAQ was originally developed for global physical activity surveillance. Therefore, the questions and images provided are also suitable to be used in developing countries. The IPAQ questions and images seemed a better fit for this research, hence I decided to employ the IPAQ for all further studies.

Demographics and lay belief. This was followed by several demographic questions (gender, nationality, age, highest level of education, annual salary, height and weight, dominant hand), and the same lay belief items as in study one.

Results

Participants. Three hundred and two participants completed study two. Out of those, thirteen failed to provide the correct answer in an attention check and were therefore excluded. This left two hundred and eighty-nine participants (52% female, 47% male and 0.7% other) for the data analysis. The majority of participants were from the US (96%). Participants had an average age of 36 years (*SD* = 1.26, range 19 - 78 years). The average annual salary, as indicated by selecting one out of nine categories, fell in the $25,001-$50,000 range. Physical activity responses were processed and truncated according to the IPAQ guidelines for data processing and analysis.

A person was classified to be physically active during leisure time or work if they met the same criteria as outlined in study one. Participants were categorized as being regularly physically active during leisure time (yes: n = 97, no: n = 192) and being regularly physically active at work (yes: n = 76, no: n = 213). Overall, 50% of participants

indicated to be sedentary (n = 145), i.e., they did not perform any regular physical activity during leisure time nor at work.

Product judgments. The dependent measure in the dilution task – judgment of a product's benefit – was first submitted to a 2 (type of information: control, dilution) x 7 (product replicate: car, toothpaste, package delivery service, stereo system, apartment, airline service, computer) mixed ANOVA. Since the higher order interaction effect involving product replicate was not significant (p = .752), the data were collapsed across this factor.

I also tested whether the order in which subjects completed the dilution task (dilution task first, dilution task last) influenced the product judgements or interacted with the type of information and regular physical activity. Since this was not the case I also collapsed the data across the order factor. The results revealed a significant difference between the type of information (M_{Control} = 78.50, M_{Dilution} = 73.02, $t(287)$ = 4.47, p < .001), replicating the classic dilution effect. When seeing irrelevant product information participants significantly lowered their judgments.

A three-way ANOVA was run to examine the effect of the type of information, regular leisure physical activity and regular work activity on the product rating. I submitted the product rating to a 2 (type of information: control, dilution) x 2 (regular leisure physical activity: yes, no) x 2 (regular work activity: yes, no) between subjects ANOVA.

As expected, the three-way interaction between the type of information, regular leisure physical activity and regular work activity was not significant ($F(1, 281) = 0.27$, p = .605). Further, there was no interaction effect between regular work activity and the type of information ($F(1, 281) = 0.27$, p = .605), no interaction effect between regular work activity and regular leisure physical activity ($F(1, 281) = 0.27$, p = .588), and no main effect of regular work activity on the product judgement ($F(1, 281) = 0.29$, p = .605).

Hence, work-related physical activity did not have any significant impact on the product judgments, irrespective of the type of information and the level of leisure-time physical activity. Since none of the effects involving the regular work activity factor yielded any significant results, I am not reporting the descriptive statistics for this factor in the following section. For simplicity, sedentary subjects and subjects with regular work activity but who performed no regular leisure-time physical activity are thereafter labelled as 'inactive' subjects.

There was a significant interaction effect between the type of information and regular leisure physical activity on the product judgements, $F(1, 281) = 4.45$, $p = .036$). This interaction effect indicates that regularly physically active individuals and inactive individuals were differently affected by the type of product information.

Simple main effects showed that regularly physically active participants did not dilute their judgments after seeing irrelevant product information ($M_{Control} = 77.92$, $M_{Dilution} = 76.12$, $t(95) = .84$, $p = .402$). Inactive individuals however showed a significant dilution effect ($M_{Control} = 78.81$, $M_{Dilution} = 71.57$, $t(190) = 4.89$, $p < .001$).

Pairwise tests also revealed that in the control condition there was no significant difference in the product judgment between regularly physically active participants and inactive participants, ($t(289) = 0.49$, $p = .622$). In the dilution condition however, the product rating of regularly physically active individuals was significantly higher than the product rating of inactive individuals ($t(289) = 2.47$, $p = .014$). These results further support the hypothesis 1a and replicate the initial results from study one.

There was no main effect of regular leisure physical activity on the product judgments ($F(1, 281) = 0.80$, $p = .037$). Further, there was a significant main effect of the type of information on the product judgments, $F(1, 281) = 14.76$, $p < .001$.

To summarize, the same association between regular physical activity and the product judgements in the dilution task which was found in study one, was replicated in study two. The results are shown in Figure 3-2.

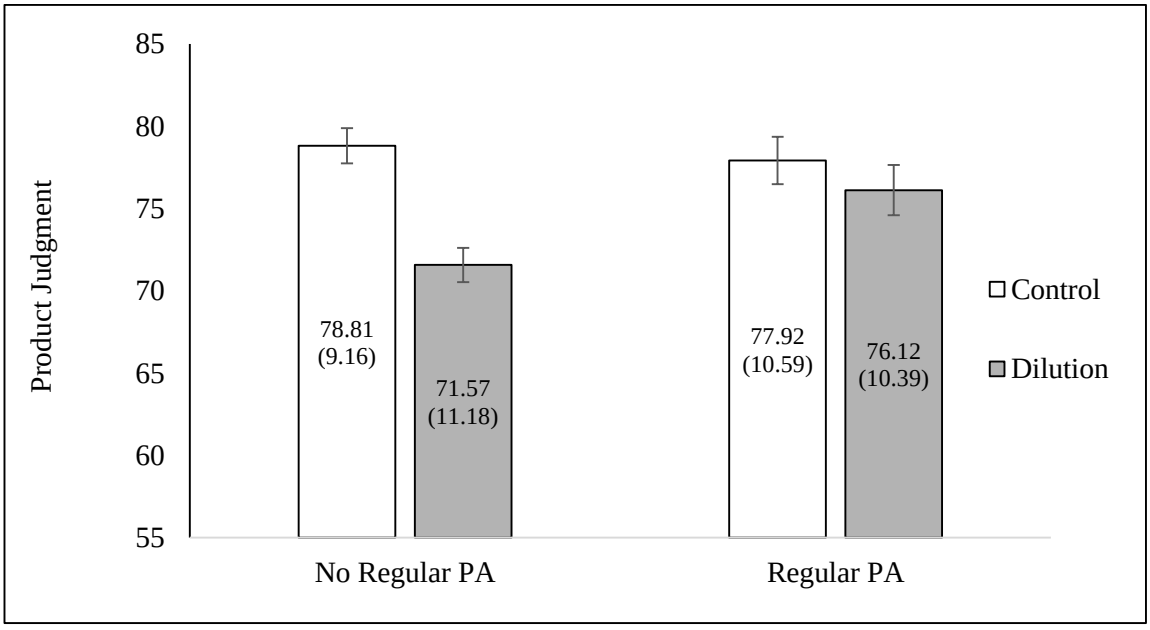


Figure 3-2. Replication of the interaction effect between the type of information and regular physical activity

Table 3-2 shows the test statistics and the average product rating in the control and dilution condition for inactive and regularly physically active participants in studies one and two.

Table 3-2. *Average product rating and test statistics across conditions in studies one and two*

		Physical Activity		
	Type of information	No physical activity	Regular physical activity	
Study 1 Mturk N = 281	Relevant	M = 75.60	M = 73.22	Interaction: $F(1, 273) = 3.63$, $p = .057$
	Relevant + Irrelevant	M = 69.82	M = 72.53	
		$p = .002$	$p = .717$	
Study 2 Mturk N = 289	Relevant	M = 78.81	M = 77.92	Interaction: $F(1, 281) = 4.45$, $p = .036$
	Relevant + Irrelevant	M = 71.57	M = 76.12	
		$p < .001$	$p = .402$	

Controls: There was no difference between participants in the regularly physically active group and the inactive group in terms of their gender ($p = .168$) and age ($p = .146$). Adding both demographics as control variables did not impact the significant interaction between the type of information and regular physical activity ($p = .036$). Regularly physically active participants were more likely to be in higher income ($p < .001$) and education level brackets ($p < .001$). Since income and education were correlated ($r = .40$, $p < .001$) they were entered as separate dummy variables to the model. Neither education nor income had an effect on the product judgments ($p = .123$ and $p = .690$). Importantly, the significant interaction effect between the type of information and regular physical activity persisted after controlling for income and education ($p = .025$ and $p = .044$).

I added the five personality trait variables as covariates to the model, but the significant interaction between the type of information and regular physical activity remained significant ($p = .018$). Further, there was no difference between regularly physically active and inactive participants with regard to the number of unusual uses they had generated in the test of divergent thinking ($p = .787$).

As in study one, the average value of the lay belief items (Cronbach's α = .86) was significantly above the scale midpoint ($t(288) = 15.79$, $p < .001$), indicating that participants believed regular physical activity is associated with improved decision making skills. Adding the lay belief variable to the ANOVA model did not impact the product judgments or the interaction between the type of information and regular physical activity ($p = .031$). Table 3-3 shows the descriptive statistics of regularly physically active and inactive participants for the control variables.

Product Information Recognition Memory – Correct Responses. Participants who had equal to or less than 50% correct responses in the practice reaction time task, were excluded from the analysis ($n = 6$). To investigate whether regularly physically active subjects performed differently in the recognition memory task, I first submitted the average percentage of correct responses for the supportive information to a 2 (product information: supportive old, supportive new) x 2 (regular physical activity: yes, no) mixed design ANOVA with product information as the within-subjects factor. There was a significant main effect of the product information, $F(1, 281) = 8.31$, $p = .004$. Subjects were significantly better at correctly identifying supportive *old* information (M = 95.6% correct) than supportive *new* information (M = 92.5% correct). There was no main effect of regular physical activity and no interaction between regular physical activity and the product information. Hence, regularly physically active individuals were not better or worse at identifying the supportive information than people who don't engage in regular physical activity.

Only half of the sample - those in the dilution condition - had completed the recognition test for the irrelevant product information. Hence, I ran a separate 2 (product information: irrelevant old, irrelevant new) x 2 (regular physical activity: yes, no) mixed design ANOVA for the average percentage of correct responses for the irrelevant items. Subjects were significantly better at identifying irrelevant new information correctly (M = 94.3% correct) than irrelevant old information (M = 87.2% correct, $F(1, 139) = 22.74$, $p < .001$). Again, there was no main effect of regular physical activity and no interaction between regular physical activity and the product information. This indicates that there was no difference in memory between the physical activity groups for any type of product information. Figure 3-3 shows the average percentage of correct responses for the relevant and irrelevant product information in regularly physically active and inactive subjects.

Table 3-3. *Descriptive statistics of regularly physically active and inactive participants in study two*

	No Physical Activity (N = 192)	**Regular Physical Activity** (N = 97)	Test statistics
Demographics			
Age	M = 37	M = 35	$t(287) = 1.46$, $p = .146$
Female	55.5%	46.9%	$\chi^2(1) = 1.90$, $p = .168$
Highest Education	Mdn = 4 (2-year College Degree)	Mdn = 6 (4-year College Degree)	$t(287) = 4.47$, $p < .001$
Income	Mdn = 2 ($25,001-$50,000)	Mdn = 3 ($50,001-$75,000)	$t(287) = 5.85$, $p < .001$
Personality traits			
Extraversion	M = 3.46	M = 3.76	$t(287) = 1.51$, $p = .132$
Agreeableness	M = 5.28	M = 5.51	$t(287) = 1.43$, $p = .153$
Conscientiousness	M = 5.47	M = 5.80	$t(287) = 2.15$, $p = .033$
Openness	M = 5.03	M = 5.18	$t(287) = 0.95$, $p = .341$
Emotional Stability	M = 4.94	M = 5.34	$t(287) = 2.12$, $p = .035$
Unusual Uses Test	M = 4.17	M = 4.10	$t(287) = 0.27$, $p = .787$
Lay Belief	M = 59.93	M = 62.25	$t(287) = 1.62$, $p = .107$

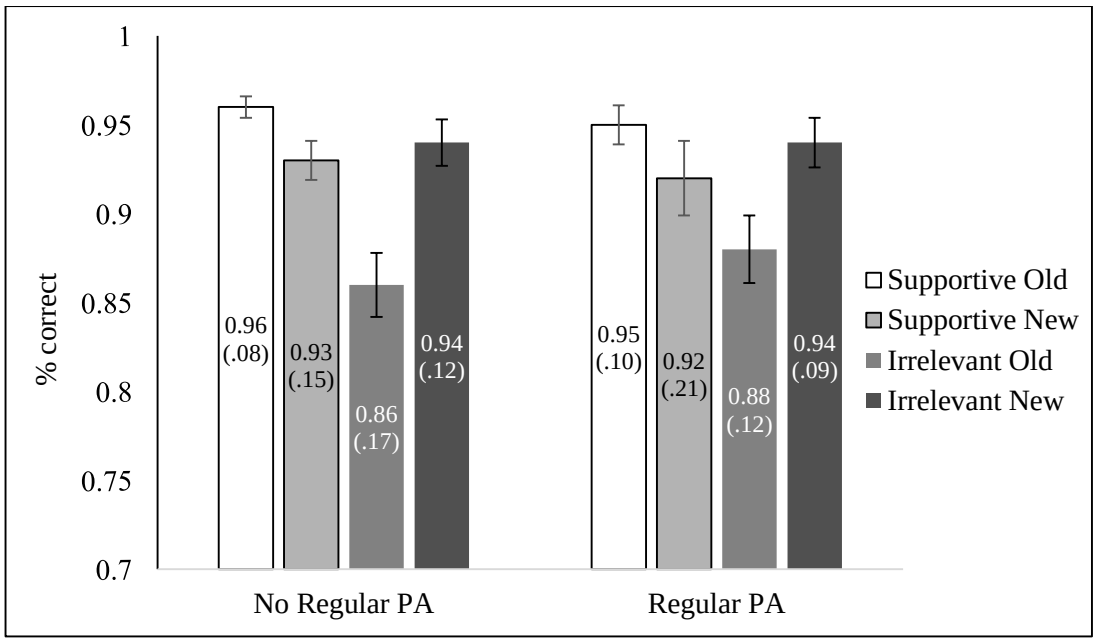


Figure 3-3. Recognition test: Average percentage of correct responses across the type of information and physical activity

Product Information Recognition Memory – Reaction Times. Participants who had equal to or less than 50% correct responses in the practice reaction time task were also excluded from this analysis (n = 6). I removed the reaction times for incorrect responses, excluded reaction time latencies with less than 250ms and more than three standard deviations above the mean, and collapsed the reaction times across the product replicates. The average reaction time in the practice task was included in the analysis as a covariate.

Supportive Product Information: There was a significant main effect of the product information, $F(1, 277) = 36.34$, $p < .001$). Subjects were faster at identifying the supportive *old* product information (M = 1.58 seconds) than the supportive *new* product information (M = 1.73 seconds). There was no main effect of regular physical activity and no interaction between regular physical activity and the supportive product information.

Irrelevant Product Information: There was a significant difference in reaction time between irrelevant *old* and irrelevant *new* product information, $F(1, 137) = 33.04$, $p < .001$). Participants identified the irrelevant *old* product information (M = 1.29 seconds) faster than the irrelevant *new* product information (M = 1.42 seconds). There was no main effect of regular physical activity and no interaction between regular physical activity and the irrelevant product information. Overall, these results indicate that regularly physically active subjects did not differ from inactive subjects with regard to their memory of the irrelevant and relevant product information, measured both in

reaction times and correct responses. These findings indicate that hypothesis 2a was not supported. Figure 3-4 shows the average reaction times for the relevant and irrelevant product information for regular exercisers and inactive subjects.

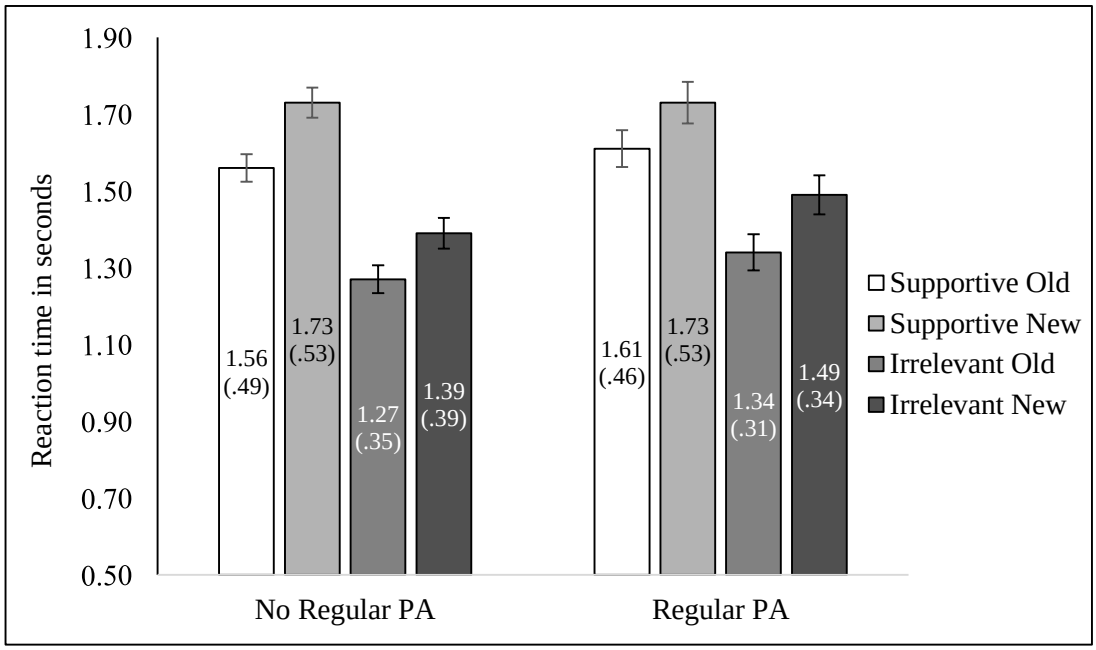


Figure 3-4. Recognition test: Average reaction time across the type of information and physical activity

Number of product information considered. I analysed whether there were any differences regarding the number of relevant or irrelevant information that participants reported to have considered during the product judgments. Only participants in the dilution condition completed this part of the study. Participants could have considered a maximum number of seven relevant product attributes and 21 irrelevant product attributes. The results showed that participants considered a significantly larger number of relevant information (M = 6.65, out of seven) than irrelevant items (M = 3.40, out of 21, $t(143) = 10.09$, $p < .001$). This shows that the irrelevant product information was indeed considered irrelevant in most of the cases. There was no difference between the regularly physically active group and the inactive group with regard to the number of irrelevant attributes they considered ($p = .429$). This is in contrast to hypothesis 2b. People who are regularly physically active during leisure time did not consider a lower number of irrelevant product information than inactive people. Therefore, hypothesis 2b was rejected.

However, there was a significant difference for the number of relevant attributes they considered. The number of relevant attributes individuals reported to have considered, was significantly larger for regularly physically active (M = 6.83) compared to inactive individuals (M = 6.57, t(141.12) = 1.85, p = .018).

I submitted the product judgments to a between-subjects ANOVA (regular physical activity: yes, no) and subsequently added the number of relevant and irrelevant attributes considered as covariates to the model. Only subjects in the dilution condition completed this part of the study, thus there is no factor for the type of information. Without the number of relevant and irrelevant attributes considered as covariates, the product judgments were significantly higher for the regularly physically active group (M_{PA} = 76.13) than for the inactive group (M_{No_PA} = 71.57, F(1, 142) = 5.44, p = .021). After adding the number of irrelevant and relevant attributes considered to the model as covariates, this difference became insignificant (p = .089). The results showed a significant main effect of the number of relevant attributes considered on the product judgments (F(1, 140) = 17.59, p < .001). A higher number of relevant attributes considered was associated with higher product judgments (i.e., less dilution effect) for participants in the dilution condition (b = 4.73, SE_b = 1.13, t = 4.19, p < .001). The number of irrelevant attributes considered however, did not have an effect on the product judgments.

These results indicate that regularly physically active individuals were better at identifying and focusing on the relevant product information, and were therefore less likely to dilute their product judgments, and not because they were better at ignoring the irrelevant information.

Stroop test - correct responses. I excluded subjects from the analysis that had less than 25% correct responses (chance level) on either congruent or incongruent trials since they most likely misunderstood the instructions (n = 5). There was a significant difference in the average percentage of correct responses between congruent trials (M = 98.9% correct responses) and incongruent trials (M = 95.6% correct responses, F(1, 282) = 69.07, p < .001). This result replicates the classic Stroop effect. Participants were responding more correctly in congruent trials than in incongruent trials. There was no difference between regularly physically active individuals and inactive individuals in terms of the average correct responses, and no interaction with the trials (congruent vs. incongruent). Figure 3-5 shows the percentage of correct responses for the congruent and incongruent trials for regular exercisers and inactive individuals.

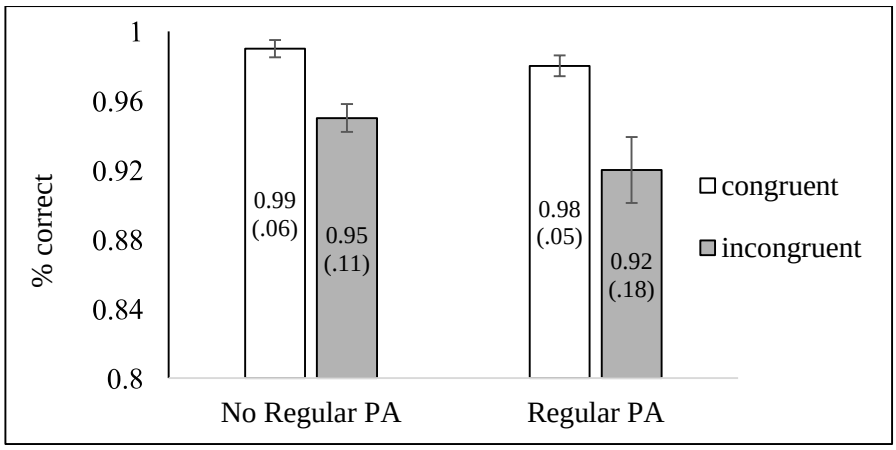


Figure 3-5. Stroop test: Average percentage of correct responses in congruent and incongruent trials for physically active and inactive individuals

Stroop test – reaction times. I removed reaction times for incorrect responses, excluded reaction time latencies with less than 250ms and more than three standard deviations above the mean and collapsed the data across the 24 congruent and 24 incongruent trials. The results indicated that subjects took significantly longer to respond during incongruent trials than during congruent trials ($M_{congruent}$ = 1.23, $M_{incongruent}$ = 1.52, $t(283) = -14.08$, $p < .001$), showing the classic Stroop effect. Again, I found that there was no difference between the regularly physically active group and the inactive group in terms of their reaction time, and there was no interaction with the trials (congruent vs. incongruent). These results indicate that regularly physically active subjects did not differ from inactive subjects with regard to their performance in the Stroop test. This is in contrast to hypothesis 2c which was therefore rejected. Figure 3-6 show the reaction time for the congruent and incongruent trials for regular exercisers and inactive individuals.

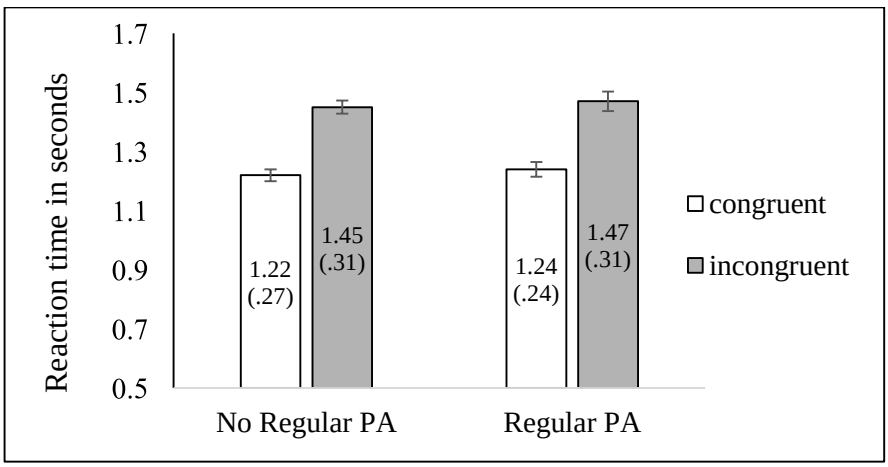


Figure 3-6. Stroop test: Average reaction time in congruent and incongruent trials for physically active and inactive individuals

Self-control decision making. Finally, there was no difference between regularly physically active and inactive participants with regards to their delayed discounting score (M_{PA} = 3.81, M_{No_PA} = 4.21, $t(287) = 1.46$, $p = .145$) and their responses to the self-control decision making scenarios (M_{PA} = 13.47, M_{No_PA} = 13.15, $t(287) = 0.72$, $p = .470$). Therefore hypothesis 2d was also rejected.

Necker Cube Pattern Control test. Participants who had more than 30 orientation flips in either the baseline phase or the pattern control phase were excluded from this analysis. A paired-samples t-test showed that participants reported significantly fewer flips when trying to control the orientation of the cube ($M_{\text{baseline}} = 6.06$, $M_{\text{control}} = 5.01$, $t(275) = 3.28$, $p = .001$). I submitted the number of orientation flips to a 2 (cube: baseline, control) x 2 (regular physical activity: yes, no) mixed-design ANOVA, with cube as the within-subjects factor. The results revealed a significant interaction effect between regular physical activity and the cube condition ($F(1, 274) = 5.43$, $p = .021$). Simple main effects revealed that inactive individuals significantly reduced the number of orientation flips when asked to control the orientation of the cube ($M_{\text{baseline}} = 6.52$, $M_{\text{control}} = 4.93$, $t(181) = 4.03$, $p = .001$). However, there was no difference between the baseline condition and the orientation control condition for the regularly physically active individuals ($M_{\text{baseline}} = 5.17$, $M_{\text{control}} = 5.15$, $t(93) = .039$, $p = .969$).

Interestingly, regularly physically active individuals had an initially lower baseline count (the count was similar to the orientation flip count in the control condition of the inactive individuals). A pairwise test indicated that this difference between the regularly physically active individuals and inactive individuals in the baseline condition was only marginally significant, $t(284) = 1.68$, $p = .093$.

In the pattern control condition, there was no significant difference in the number of orientation flips between the regularly physically active individuals and inactive individuals, $t(277) = -0.37$, $p = .706$. The results from the Necker Cube Pattern Control test are show in Figure 3-7. This result could be interpreted as follows. Regularly physically active individuals might have exerted more directed attention in the baseline count condition and applied more effort to focus on the cube, even when they were not asked to do so.

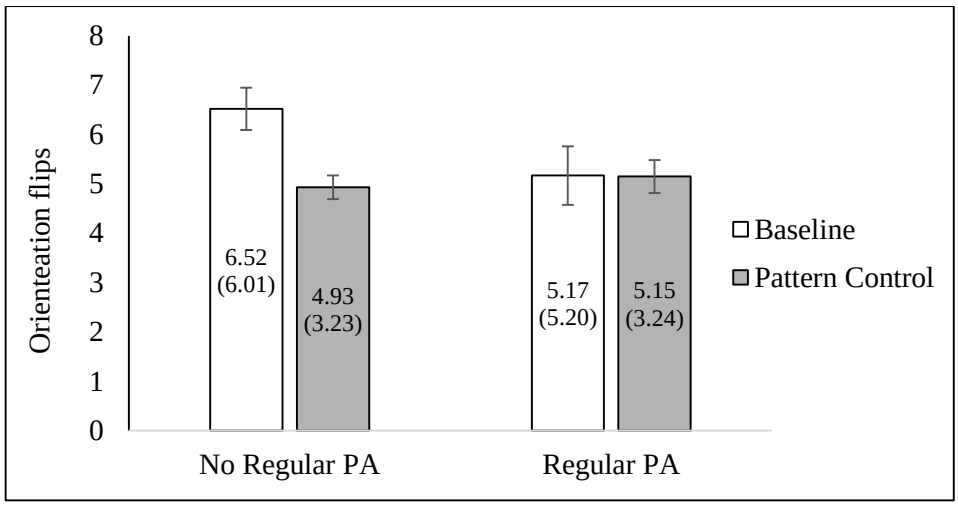


Figure 3-7. Necker Cube: Average number of orientation flips for physically active and inactive individuals

Discussion

Study two replicates the association between regular physical activity and consumer decision making in the dilution paradigm. People who indicated to be regularly physically active during their leisure time did not significantly dilute their product judgments when seeing irrelevant information. Regularly physically active participants had similar product judgement to inactive participants in the control condition. In the dilution condition however, their product judgments were significantly higher than those of inactive participants. These findings support hypothesis 1a. The results were robust to the inclusion of various control variables including demographics (age, gender, income and education), personality traits (TIPI), lay beliefs about physical activity and divergent thinking skills. As in study one, work-related physical activity did not lead to a reduction of the dilution effect. Therefore, I decided to not investigate work-related physical activity any further.

With regard to the underlying process which might drive these results I could refute several potential explanations. I rejected hypothesis 2 that the relationship between regular physical activity and the dilution effect is mediated by improved inhibitory functions of regularly physically active participants. Specifically, the recognition memory and reaction time for the product information did not differ for regularly physically active and inactive individuals (H2a was rejected).

Physically active individuals also did not perform differently in the Stroop test as a measure of inhibitory control (H2c was rejected). This is in contrast to some of the literature on physical activity and executive functions outlined in Chapter two. One reason

for this could be that the Stroop test was performed online using the Qualtrics research platform.[8] Reaction time measures which are collected online without requiring participants to download specific software to their computers are less precise and can be affected by participants' web browsers and internet connection (Woods, Velasco, Levitan, Wan, & Spence, 2015). Therefore, it might not be possible to detect small differences in reaction times between regularly physically active and inactive participants using such a relatively imprecise measurement tool. This also applies to the reaction times for the product information recognition task. The percentage of correct responses on the other hand should not have been affected by this.

Furthermore, I found that regularly physically active individuals did not perform differently to inactive individuals with regard to generalized decision making which requires self-control. Indeed, physically active individuals showed similar responses to inactive individuals in the delay discounting task and in generic self-control decision scenarios (H2d was rejected). Hence, improved inhibition of irrelevant information does not seem to drive the result.

Contrary to the inhibition hypothesis, it seems that regularly physically active individuals were better at identifying and considering the relevant information for their product judgments, irrespective of the irrelevant information (H2b was also rejected). Although based on a self-report, regularly physically active individuals considered a significantly higher number of relevant information than inactive individuals.

Another finding of study two is that physically active individuals reported a lower number of orientation flips in the baseline condition of the Necker Cube Pattern Control test. This indicates that regularly physically active individuals might have been generally more focused and less distractible when completing the test. The lack of a reduction in orientation flips when asked to focus on one orientation, might have been due to a floor effect. However, this remains speculative.

Study two has a number of limitations. So far, I used an observational design combined with an experimental manipulation of the type of information to establish whether regular physical activity is associated with product judgments in the dilution paradigm. This design does not allow causal inferences about the direction of the effect. Considering the growing literature on the effects of physical activity on cognitive functions, it seems likely that physical activity leads to enhanced performance in the dilution task, and not vice versa. However, I cannot rule out the possibility that a third

[8] www.qualtrics.com

variable is influencing both product judgments and physical activity behaviour, even after controlling for the most obvious confounding variables (demographics, conscientiousness etc.).

Another limitation of the research is that it uses self-reported data of physical activity. Self-report measures of physical activity – although the most commonly used method - have been criticized for their lower reliability and validity. People tend to over-report the amount of physical activity they engage in. Thus, I cannot rule out the possibility that people who don't exercise regularly were incorrectly classified as regular exercisers.

The key takeaways from study two are as follows. First, the finding that people who regularly engage in leisure-time physical activity don't show a dilution effect when facing irrelevant product information, was replicated. Secondly, this effect cannot be explained by an improved inhibition of irrelevant information among regularly physically active participants. Thirdly, the findings indicate that an improved focus on relevant product information might drive the results.

Study three connects with study two in the following way. In addition to regular physical activity, I investigated whether a single bout of physical activity has a similar effect on people's product judgements. Secondly, I further investigated the initial finding of an improved focus on relevant information among regular exercisers. Thirdly, I tested for additional potential confounding variables. Finally, I tested a UK sample of physically active individuals to improve the generalizability of the finding.

3.3 Study 3: A Quasi Experimental Field Study at the Gym

For study three I collaborated with a local London gym and tested exercisers on-site to address the problem of potential over-reporting of physical activity as well as to investigate the effect of a single bout of physical activity. I chose a gym outside the university to guarantee a more diverse population pool with varying socioeconomic backgrounds. [9] The exercise facilities included a large gym, a swimming pool, as well as a studio with a full range of group exercise classes. The gym offered a variety of fitness equipment from cardiovascular machines (treadmills, rowers etc.) to resistance equipment as well as a stretching area. The data was collected in June 2016.

[9] http://www.better.org.uk/leisure-centre/london/hackney/kings-hall-leisure-centre

A number of studies has shown that a single bout of physical activity can have similar effects on cognitive functions as regular physical activity (Barenberg et al., 2011; Best, 2010; Hopkins et al., 2012). It was important to investigate whether a single bout of physical activity can also lead to a reduction of the dilution effect similarly to the results found for regular physical activity. Therefore, a quasi-experimental manipulation of a single bout of physical activity was added to the design of the previous two studies. Participants were tested before or after they had been exercising at the gym. The following hypothesis was tested:

H3: After a single bout of physical activity people show less or no dilution effect when seeing irrelevant product information, irrespective of whether they are regular exercisers or not.

In addition, I investigated further whether physical activity (single bout and regular) leads to a reduction of the dilution effect because of an increased focus on relevant product information. Based on the finding from the previous study I hypothesized the following:

H4: Physical activity leads to a reduced dilution effect because of an increased focus on relevant product information.

For this, two measures were included. First, and similarly to the direct question in study two, I asked participants which information they had considered to judge the products. Secondly, participants completed a visual search task which requires them to not focus on pseudo-relevant information (i.e., information that appears relevant, but is actually distracting from the goal).

Finally, I wanted to refute two other potential confounding variables. A regulatory focus measure was included to investigate whether physical activity was associated with participants' regulatory focus, since this construct has been shown to moderate the dilution effect (Malaviya & Sternthal, 2009). In addition, a memory recall test for the goal-specific product information was included to investigate whether physically active individuals process and therefore memorise goal-specific information differently than inactive individuals. If physically active individuals engage in less top-down, goal-directed information processing, this could lead to less biased hypothesis testing (the

mechanism proposed by Meyvis and Janiszewski (2002)), and therefore lead to a reduced dilution effect.

Methodology

I set up a 'testing station' in the hallway connecting the exercise facilities with the gym reception so that people entering or leaving the gym would walk past. People passing by were approached and asked to participate in a five to ten minute research study on physical activity and decision making. They were offered a snack or energy drink as an incentive to participate. If they agreed they were given a tablet (an iPad mini) to complete the study whilst sitting at the testing station. After they completed the study they were thanked for their participation and they could choose their snack or drink.

I used the same procedure as in the previous two studies but added a quasi-experimental manipulation of physical activity by varying the timing of the testing (before vs. after the workout). This was done to investigate additionally whether a single bout of physical activity would influence the product judgments, irrespective of whether someone was regularly physically active or not. Roughly half of the participants were approached when they entered the gym. The other half were approached on their way out of the gym after they had exercised.

The testing station was not located immediately at the exit of the gym but after the changing rooms in order to let people 'cool down' after their exercise. I wanted to avoid testing people immediately after their workout in order to reduce the potentially confounding effect of heightened arousal. Hence, people in the 'after exercise' condition were tested after they had left the changing rooms, and not immediately after they had stopped exercising.

Dilution Effect. After reading a short introduction and providing informed consent, participants completed the same seven product judgments in random order as in the previous two studies. Participants were randomly assigned to be in the control condition (relevant product information only) or the dilution condition (relevant product information + irrelevant product information). A few of the product descriptions were adapted slightly to fit the UK context but the meaning remained the same (e.g., toothpaste recommended by the *British* dental association instead of the *American* dental association, see appendix A for the changes). In addition, the time participants took to judge each of the seven product replicates was recorded.

Regulatory focus. Next, participants completed a short measure of regulatory focus - the commonly employed 'friendship strategies' (Bhargave, Chakravarti, & Guha, 2015; Higgins, Roney, Crowe, & Hymes, 1994; Zhou & Pham, 2004). Participants were asked to choose three out of six strategies for maintaining friendships (see appendix J). Three of them were promotion-oriented strategies (e.g., *"be generous and willing to give of myself"*) and three of them were prevention-oriented strategies (e.g., *"stay in touch and avoid losing contact with my friends"*). Regulatory focus orientation was operationalized as the number of promotion-oriented strategies that were chosen, resulting in a score that ranged from zero to three.

Visual search task. Subsequently, people completed a visual search task that required locating a target figure among visual distractors. I used an image from the "Where's Wally?" books as a stimulus.[10] The scene I used ("On The Beach") shows the target figure Wally – dressed in red and white stripes - walking on a crowded beach. The beach is cluttered with a large number of similarly looking people and objects (e.g., red and white striped towels, see appendix E for the image). Participants were instructed to find Wally and to tap on his location. They were given one minute to find Wally before the page automatically advanced to the next page. Participants' clicks and the time it took them to find Wally were recorded. The reasoning to include this task was as follows: If physical activity leads to an increased focus on relevant information as suggested by the previous study, then physical activity should lead to worse performance in this task. This is because the image is designed in such a way that focusing overly on the red-and-white pattern (pseudo-relevant information) distracts from finding the target figure itself.

Information considered. Like in study two, participants in the dilution condition then indicated which product information they had considered in the previously completed product judgment task. This self-report measure was included to consolidate the finding from the previous study that regular physical activity is associated with considering a higher number of relevant information, as opposed to a lower number of irrelevant information. Unlike study two, participants were presented with only one of the product descriptions. This was done to keep the overall time frame of the study as short as possible. The product category 'car' was used for this question. Participants were asked to select which of the four attributes they had considered when judging the product. I collected whether or not participants selected the relevant piece of information (binary:

[10] http://whereswaldo.com/index.html#findwaldo/map1

yes, no) and how many irrelevant pieces of information they had selected (ranging from zero to three).

Goal recall task. All participants then completed a goal recall task for the product information for one randomly selected product category. The car category was excluded from this. Participants were asked to remember what kind of products they had been looking for in the previous product judgment task (e.g. "*You were looking for a stereo system that is ____. Please remember what kind of stereo system you were looking for*", see appendix A). Participants could give their answer in a text box. If they didn't know the answer, they could leave the text box empty. Due to the shorter time frame of this study, I decided to ask the goal recall question for only one of the product replicates instead of all seven replicates.

Physical Activity. This was followed by the IPAQ and specific questions about the exercise session that participants had just completed in the post-exercise condition, or in the pre-exercise condition, were planning to do. In particular, I asked how long they had been exercising / were planning to exercise and what kind of exercise they had been doing / were planning to do. Participants also completed the Borg Rate of Perceived Exertion scale (Borg, 1998) to indicate how hard or easy the physical activity felt to them / was going to feel. The RPE is a 15 point scale ranging from 6 = no exertion at all, to 20 = maximal exertion.

Exercise motivation. As an additional control measure of regulatory focus, participants completed six questions that were specific to their exercise motivation. These questions were included to investigate whether physical activity was associated with differences in exercise motivation specific to regulatory focus. Participants indicated their agreement to three promotion-oriented exercise motivation items ("*I exercise to get or keep my body in shape", "to stay healthy or improve my health", "to be the person I would ideally like to be*") and three prevention-oriented exercise motivation items ("*I exercise to prevent getting out of shape", "to prevent poor health and illness", "because I feel I should"*). The questions were completed on separate screens and in counter-balanced order. Answers were given on a Likert scale from 1 = disagree to 9 = agree.

Finally, participants completed demographic questions regarding their age, gender and highest educational level. Upon completion, participants were debriefed, thanked for their participation and received their snack or drink.

Results

Participants. Two hundred twenty-seven gym-goers participated in the study. Twenty-four participants gave conflicting responses to the physical activity questions and were therefore removed. This left two hundred and three participants for the analysis (117 females). 36% of participants indicated to have an undergraduate degree as their highest educational level, followed by 25% with a graduate degree, and 24% with a college degree / A-level. Participants had an average age of 37 years (SD = 14.3).

As in the previous studies, physical activity responses were processed and truncated according to the guidelines for data processing and analysis for the IPAQ. A person was classified to be regularly physically active during leisure time if they met the same criteria as in the previous two studies. Based on those criteria 47% of all participants were classified as regularly physically active (n = 95), which was slightly higher than in the previous studies. There was no significant difference in age (p = .926) and education level (p = .151) between regular exercisers and people who didn't exercise regularly. However, the proportion of females was slightly higher among the people who didn't exercise regularly (65% female, $\chi^2(1) = 6.14$, p = .046). Eighty-three participants (41%) completed the study before their workout compared to one hundred twenty (59%) after their workout.

Product Judgments. The product judgments were first submitted to a 2 (type of information: control, dilution) x 7 (product replicate: car, toothpaste, package delivery service, stereo system, apartment, airline service, computer) mixed ANOVA. Since the higher order interaction effect involving the product replicate factor was not significant, the data were collapsed across this factor. As in previous studies, I found a highly significant dilution effect (M_{Control} = 71.19, M_{Dilution} = 58.70, $t(201) = 7.03$, $p < .001$).

Based on the hypothesis (H1a and H3), I expected to find an interaction effect between the type of information and regular physical activity, as well as an interaction effect between the type of information and the time of testing. However, a 2 (type of information: control, dilution) x 2 (time: before exercise, after exercise) x 2 (regular leisure physical activity: yes, no) between-subjects ANOVA yielded a significant three-way interaction between the type of information, the time of testing and regular physical activity, $F(1, 195) = 4.94$, p = .027. In addition, there was a significant main effect of the type of information, $F(1, 195) = 49.5$, $p < .001$. There were no other main or interaction effects.

To disentangle the three-way interaction, I performed separate analysis for the sample that completed the study before vs. after the gym. When tested *before* going to the gym, there was a significant main effect of the type of information, $F(1, 79) = 28.04$, $p < .001$, and no interaction between the type of information and regular physical activity ($p = .591$). This indicates that all participants who were tested before their workout showed the classic dilution effect ($M_{Control} = 71.38$, $M_{Dilution} = 57.23$), irrespective of whether they were regularly physically active or not.

However, this was not the case for participants that were tested *after* their workout. In this group there was a significant interaction between the type of information and regular physical activity, $F(1, 116) = 7.82$, $p = .006$. Simple main effects showed that participants who did not exercise regularly, diluted their judgments significantly when seeing irrelevant information ($M_{Control} = 71.53$, $M_{Dilution} = 54.07$, $t(59) = 5.02$, $p < .001$). However, this was not the case for regular exercisers. Regular exercisers did not dilute their judgments significantly ($M_{Control} = 70.79$, $M_{Dilution} = 66.31$, $t(57) = 1.47$, $p = .147$). Although this group also lowered their product judgments slightly, they did not lower them to the extent that was observed in the other groups.

In the control condition, participants' product ratings did not significantly differ from each other across the remaining conditions ($F(1, 103) = 0.26$, $p = .611$). In the dilution condition however, there was a significant difference between the product ratings across the four groups ($F(1, 92) = 6.03$, $p = .016$). Planned contrasts revealed that the product rating of regular exercisers in the dilution condition after the gym was significantly higher than the product rating in the dilution condition for the other groups (vs. no regular PA, before gym: $p = .018$; vs. no regular PA, after gym: $p < .001$; vs. regular PA, before gym: $p = .011$). These results indicate that hypothesis 3 was not supported. Among inactive participants, a single bout of physical activity did not lead to a reduction of the dilution effect. Surprisingly, regular physically active participants also showed a significant dilution effect when being tested before going to the gym.

The effect of the type of information on the product ratings across the two physical activity groups before and after the gym is shown in Figure 3-8. Table 3-4 shows the test statistics and the average product rating in the control and dilution condition for the different physical activity groups in study three.

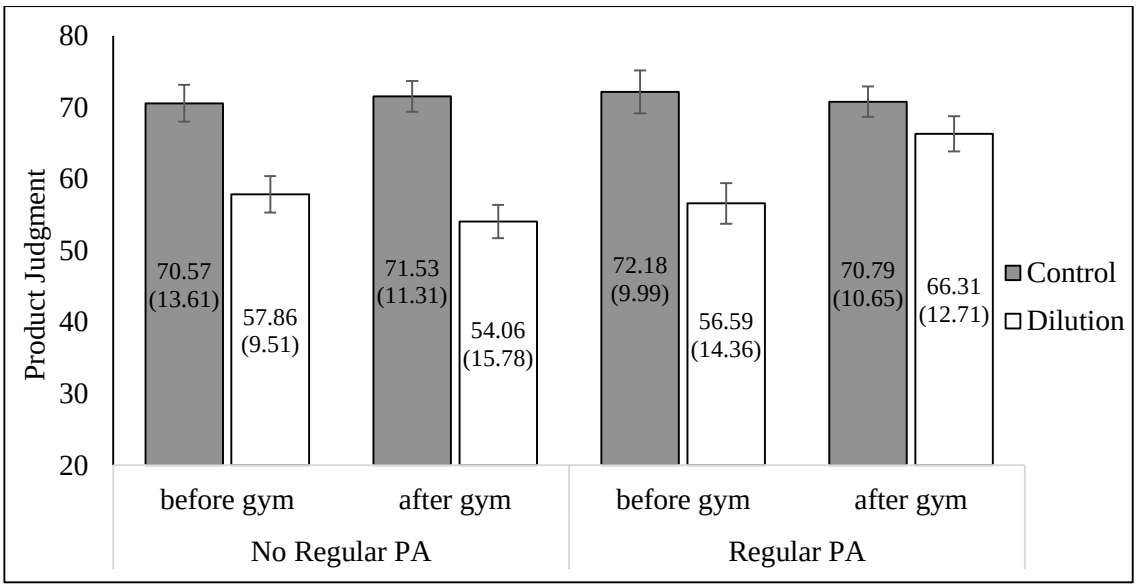


Figure 3-8. Effect of the type of information on the product rating in physically active and inactive individuals before and after exercising

Table 3-4. *Average product rating and test statistics across conditions in study three*

Study 3 Gym N = 203	Type of information	**Physical Activity**		
		No physical activity	Regular physical activity	
Before the gym	Relevant	M = 70.57	M = 72.18	Main Effect: $F(1, 79) = 28.04$, $p < .001$
	Relevant + Irrelevant	M = 57.86	M = 56.59	
After the gym	Relevant	M = 71.53	M = 70.79	Interaction: $F(1, 116) = 7.82$, $p = .006$
	Relevant + Irrelevant	M = 54.07	M = 66.31	
		p <.001	p = .147	

Time spent on product judgments. I analysed the time participants took to complete the product rating for each product replicate as a process variable that could shed light on this three-way interaction effect. I excluded time variables that were more than three standard deviations above the mean or less than 250ms, and averaged the time over the seven product replicates. I submitted the resulting time variable to a 2 (type of information: control, dilution) x 2 (time: before exercise, after exercise) x 2 (regular physical activity: yes, no) between-subjects ANOVA. The result showed a significant

main effect of the type of information, $F(1, 195) = 10.68$, $p = .001$. Participants in the dilution condition took significantly longer to judge the products than in the control condition ($M_{Control} = 8.36$, $M_{Dilution} = 10.83$). Further there was a significant main effect of time, $F(1, 195) = 4.71$, $p = .031$). When tested before going to the gym, participants spent significantly less time to judge the products than when tested after going to the gym ($M_{before} = 8.77$, $M_{after} = 10.42$). There were no other main effects or interactions. Figure 3-9 shows the average time participants spent judging the products in the control and dilution condition when tested before and after going to the gym.

This could indicate that participants were rushing when completing the questionnaire before their exercise because they were interrupted on the way to the gym. Participants who completed the questionnaire after they had exercised took more time to answer the questions, potentially looking at the provided information more carefully.

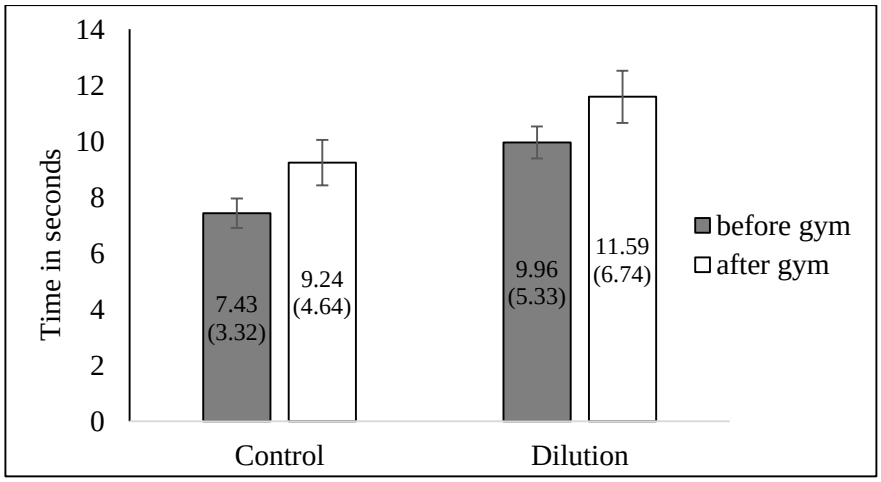


Figure 3-9. Time spent per product replicate before and after the gym in the control and dilution condition

Information considered. Participants in the dilution condition ($n = 96$) indicated for one of the product replicates which pieces of information they considered when judging the product. 80% of participants indicated to have considered the relevant piece of information. This shows that the relevant information was indeed considered relevant for judging the product's benefit. The majority of participants (65%) did not select any of the three pieces of irrelevant information. 22% indicated to have considered one piece of irrelevant information and 9% indicated to have considered two pieces of irrelevant information. To investigate why regular exercisers showed a reduced dilution effect after

their workout, I looked at whether they considered different information before and after exercise.

Relevant information. This variable was binary (relevant information considered? yes or no). For participants who did not exercise regularly there was no difference in the relevant information considered before vs. after exercising (before: 79% vs. after: 79%, $\chi^2(1) = .003$, $p = .958$). However, regular exercisers considered the relevant information more often after they had exercised than beforehand (before: 68% vs. after: 92%, $\chi^2(1) = 4.03$, $p = .045$). This finding supports hypothesis 4.

Irrelevant information. This variable had a score from zero to three. I found no significant differences for the number of irrelevant information considered with regard to the time of testing (before vs. after gym) or regular physical activity.

These findings are parsimonious with the results from study two and point to the direction that a reduced dilution effect is not driven by an improved ability to inhibit or ignore irrelevant information but rather by an improved ability to identify and focus on what is important – the relevant piece of information.

Goal recall task. Slightly more than half of the participants (55%) remembered what kind of benefit they had been looking for in a particular product replicate and wrote down the correct answer. Regular exercisers were slightly better at remembering the goal relevant information (61%) than people who didn't exercise regularly (49%). However, this difference was only approaching significance ($p = .087$). Using log-linear analysis, there was no difference between the before and after exercise conditions, and no interaction between regular physical activity and the time of testing.

Visual search task. Slightly less than half (48%) of the participants found the visual target 'Wally' within the given time limit. Before exercising, participants found the target slightly more often than after exercising (before: 55% vs. after: 43%). However, this difference was not statistically significant, $\chi^2(1) = 2.87$, $p = .090$.

Regular exercisers were significantly more likely to find the target than people who didn't exercise regularly (regular physical activity: 60% vs. no regular physical activity: 40%, $\chi^2(1) = 8.14$, $p = .004$). Interestingly, for people who didn't exercise regularly, there was almost no difference before and after exercising (43% vs. 36%, $\chi^2(1) = 0.47$, $p = .493$). For regular exercisers however, performance dropped after they had exercised (72% vs. 51%, $\chi^2(1) = 4.22$, $p = .040$). The results are shown in Figure 3-10. This finding supports hypothesis 4 and indicates that after exercising, regularly physically active participants might have focused more strongly on the relevant stimuli (the red and white

striped patterns which are designed to distract from finding Wally himself). In the 'Where is Wally' search task focusing more strongly on the relevant stimuli leads to poorer performance, as opposed the dilution task.

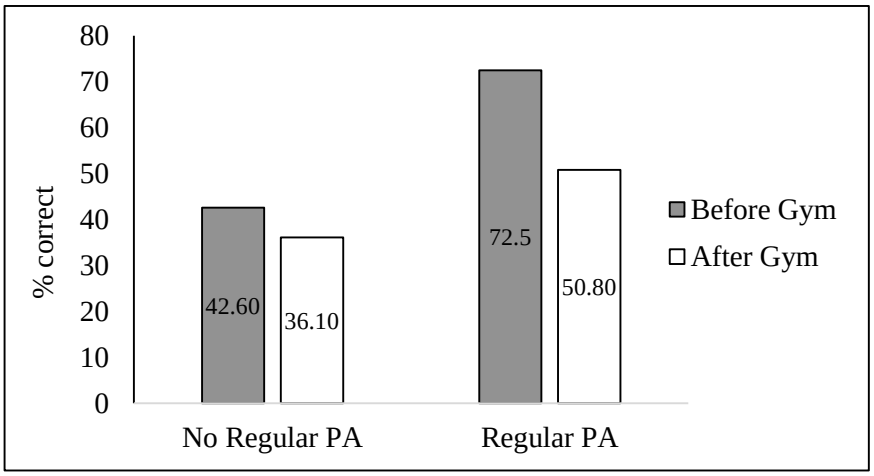


Figure 3-10. Visual Search: Percentage of physically active and inactive individuals who correctly identified the target before and after exercising

Regulatory focus: Friendship strategies. This variable was operationalized as the number of promotion-focused friendship strategies a person had selected, ranging from zero to three. Zero represents stronger prevention focus and three represents stronger promotion focus. On average, participants selected 1.42 (*SD* = .66) promotion-oriented friendship strategies. There was no significant difference in regulatory focus between regular exercisers vs. other participants, the time condition and their interaction.

Regulatory focus: Exercise motivation. I computed the average over the three promotion focus (Cronbach's α = .57) and prevention focus (Cronbach's α = .45) exercise motivation question. Overall, participants indicated a stronger agreement to the promotion focus variable (*M* = 6.97) than the prevention focus variable (*M* = 6.44, $F(1, 201) = 29.41$, $p < .001$). Further, regular exercisers indicated a stronger agreement to both variables than people who didn't exercise regularly, which shows that they generally had a stronger motivation to exercise ($F(1, 201) = 10.63$, $p = .001$). There was no main effect or interaction with the time condition. Additionally I added both variables as covariates to the ANOVA model but this did not have any impact on the product judgments. Table 3-5 shows the descriptive statistics of regularly physically active and inactive participants for the demographic variables and the regulatory focus measures.

Table 3-5. *Descriptive statistics of regularly physically active and inactive participants in study three*

	No Physical Activity (N = 108)	**Regular Physical Activity** (N = 95)	Test statistics
Demographics			
Age	M = 37	M = 37	$t(193) = 0.09$, $p = .926$
Female	65%	49%	$\chi^2(2) = 6.14$, $p = .046$
Highest Education	Mdn = 4 (Undergrad Degree)	Mdn = 4 (Undergrad Degree)	$t(198) = 0.28$, $p = .779$
Regulatory focus			
Friendship strategies (promotion)	M = 1.45	M = 1.39	$t(201) = 0.69$, $p = .489$
Exercise motivation (promotion)	M = 6.71	M = 7.27	$t(201) = 2.66$, $p = .008$
Exercise motivation (prevention)	M = 6.12	M = 6.79	$t(201) = 3.13$, $p = .002$

Discussion

The findings from study three partially replicate the findings of the previous two studies. I find that regular physical activity is associated with a significantly reduced dilution effect in product judgments among a sample of socially diverse UK gym goers. However, this reduced dilution effect was only found in regularly physically active participants after they had been exercising, and not beforehand. All participants showed a significant dilution effect before exercising, no matter whether they were regularly physically active or not. A single bout of physical activity did not result in a reduction of the dilution effect in participants who are not regularly physically active. Therefore hypothesis 3 was rejected.

The data on how much time participants spent to complete the product judgments indicated that when completing the study before going to the gym, participants completed the product judgment task significantly faster than. Participants were possibly hurrying and paying less attention to the product information. When completing the study after having been to the gym, participants spent more time on the product judgments, potentially allowing the benefit of physical activity to eventuate only in this condition.

The results from study three also indicate that focusing more on the relevant information, as opposed to ignoring the irrelevant information, seems to be driving the

reduced dilution effect in this condition. Hypothesis 4 was supported both by the results of the self-report ('which information did you consider?') and the visual search task ('where is Wally'). After regular exercisers had been to the gym, they indicated more often to have considered the relevant information compared to beforehand. This was not the case for people who didn't exercise regularly.

Further, I could refute regulatory focus as a potential motivational confounding variable. There were no differences in regulatory focus between the different groups. In addition, the results don't seem to be driven by participants' focus on the goal-relevant information. There were no differences in goal recall rates between the groups.

To summarize, the key results from study three indicate that a single bout of physical activity is not sufficient to result in a reduced dilution effect. Further, the time regularly physically active people spend on the product judgments was identified as a potential boundary condition. A reduced dilution effect was only found when regular exercisers were tested after the gym, when they took more time to scrutinize the information. Finally, I found additional support for the hypothesis that regular physical activity leads to a reduced dilution effect because of an increased focus on relevant information.

The following study returns to investigating regular physical activity. It was designed to add to the previous studies in the following way. In the three preceding studies, the type of information (relevant versus relevant + irrelevant) was always manipulated between-subjects. However, previous research has also investigated the dilution effect using within-subjects designs (Glover, 1997; Hackenbrack, 1992; Hoffman & Patton, 1997; Peters & Rothbart, 2000). This has the benefit of reducing individual-level variance in product judgments, and would allow the calculation of a 'dilution score'. Such a dilution score would measure the extent to which an individual dilutes their judgments when facing irrelevant information, and could also be used to investigate whether there are any linear relationships with regular physical activity indicators (e.g., how regularly exercisers engage in physical activity).

3.4 Study 4: Seasoned Runners' Performance in the Dilution Task

Study four was conducted in collaboration with an organisation called *parkrun UK*.[11] Parkrun UK is Britain's largest provider of free physical activity with over 1 million runners signed up to their website. Every Saturday morning at 9am parkrun UK organises five kilometre runs in different locations all across the country. Interested people of every ability can sign up on the parkrun UK website and participate for free in a location nearby. Parkrun volunteers help to time each participant's run. After each run participants post their results online, where they are compiled into a table for each location with every runner's results. Runners also have their individual results webpage, where their total number of runs, their personal best, average and slowest running time and further running statistics are publicly available.

I tested the idea of a dilution score in a UK sample of seasoned runners in study four. The aim of study four was twofold. First, I wanted to create and test the feasibility of a within-subjects version of the dilution product judgment task. Secondly, I wanted to investigate whether there is a linear relationship between a persons' within-subjects dilution score and indicators of how regular they engage in physical activity. I expected to find that more regular runners show a smaller difference between their control and dilution product rating. Specifically, I hypothesized the following:

H5: The more regularly a person participated in parkrun, the less they dilute their product judgment when seeing irrelevant information (i.e., a smaller within-subject dilution score).

An outline of the study was submitted to the parkrun research board and received approval to be conducted. The data collection was combined with a different study which investigated the effects of various goals and ways of thinking on performance in parkrun. The study was conducted in July and August 2016.

Methodology

The study was advertised through parkrun's weekly newsletter. Runners were offered a £5 Amazon gift certificate for completing a five minute survey on their phone

[11] www.parkrun.co.uk

or computer in the morning of a parkrun event. Interested runners could sign up through an online link. People who signed up received an email with the link to the actual questionnaire the following Saturday morning at 6am.

Dilution Effect. As opposed to the three previous studies, participants in this study completed a within-subjects version of the dilution paradigm. The experimental design is illustrated in Figure 3-11. The experiment followed a 2 (order: control products first, dilution products first) x 2 (type of information: control, dilution) mixed design, with order as the between-subjects factor and type of information as the within-subjects factor. After a reading a brief introduction and providing informed consent, participants completed six out of the seven product replicates that were used in the previous three studies.[12]

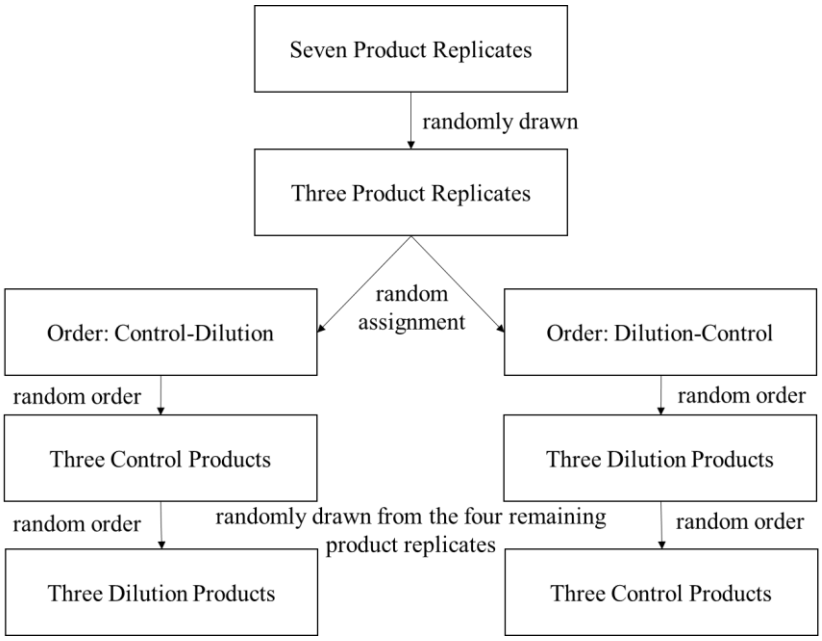


Figure 3-11. Experimental flow of the within-subjects design of the dilution effect stimuli used in study four

First, three out of the seven potential product replicates were randomly selected for each individual. Participants in the control-first condition, saw the control version of those three products (one piece of relevant information only) and rated the products according to their ability to deliver the particular benefit. This was followed by three different products which were presented in the dilution version (one piece of relevant information

[12] Participants completed six instead of seven product replicates in order to have an equal number of product replicates in the dilution and control version.

plus three pieces of irrelevant information). Those three products were randomly selected out of the four remaining products.

Participants in the dilution-first condition completed the dilution version of three randomly selected products first. This was followed by three different, randomly selected products which were shown in the control version. The time participants took to judge each of the six product replicates was also recorded.

After participants had rated all six products, they completed questions regarding their parkrun motivation, and their current mood. Participants answered one item regarding their general mood (*How are you feeling right now?).* Answers were given on a seven point Likert scale ranging from 'very bad' to 'very good'. Next, participants completed thirteen items from the Profile of Mood States (three to four items each from the depression, vigour, anger and fatigue subscale (Cranford et al., 2006)). The score for each subscale was computed as the average of the respective items.

This was followed by two question about participants' motivation to take part in parkrun. The questions were framed to tap into participants' ideal-self and ought-self predilection of physical activity (Higgins et al., 1994). Participants indicated their agreement to the following statements. Ideal self: *I do parkrun to be the person I would ideally like to be.* Ought self: *I do parkrun because I feel I should.* The questions were presented on separate screens and in random order. Answers were given on slider scales ranging from 1 = disagree to 9 = agree.

Physical Activity. Each participant's data was matched with their respective parkrun online profile. I collected data on whether they took part in a run on the day of the survey, and if so what was their running time.[13] I further collected participants' total number of runs they had completed with parkrun, their average time, their personal best, and their slowest time. Participant's running frequency was computed by dividing the total number of runs they had done in the past by the number of possible runs since the date of their first run. Additionally, I noted how many times participants had run in the last two month prior to taking part in the study (ranging from zero to a maximum of eight). I also collected participants' gender and age group from their parkrun profile.

[13] This data was not analysed since it might have been affected by the manipulation of the other study which was conducted at the same time.

Results

Participants. Two hundred seventy-nine participants completed the online survey. Out of those, I was unable to locate the individual parkrun webpages for five participants. Thus, the final sample consisted of two hundred seventy-four runners (132 females). The average age, indicated by one of thirteen age categories, fell in the 44-49 years range. The average time for the five kilometre run was 29 minutes (SD = 5.01). On average, runners had completed 73 runs (SD = 69.5) with parkrun, and 4.8 runs (SD = 2.15) in the last two month prior to the survey, out of a maximum of eight possible runs.

Product Judgments. 61% of participants (n = 167) first saw the three products in the control version followed by three different products in the dilution version, and 39% of participants (n = 107) vice versa (dilution products first, followed by control products).[14]

Not all participants saw the same six products and the average ratings differed for each of the product replicates. This poses a problem in a within-subjects design because it hinders comparison. To standardize the judgments across the product replicates, I calculated the z-scores for each product category. Next, for each individual, I calculated the average over the three z-scores of the products they saw in the control version. The same average was calculated for the three z-scores of the products in the dilution version. This resulted in two variables representing the averaged standardized product judgments for the dilution and the control products.

I submitted the transformed product ratings to a 2 (order: control first, dilution first) x 2 (type of information: control, dilution) mixed design ANOVA with the type of information as the within-subjects factor. The results showed a significant interaction effect between the order condition and the type of information, $F(1, 272) = 25.34$, $p < .001$. The average product rating in each condition is shown in Figure 3-12.[15] When looking at the average transformed product ratings in each condition separately the following pattern emerges.

Between-subjects design. Let me first compare the product rating of participants who first saw the control replicates, to the product rating of participants who first saw the dilution replicates. This part of the design is the same as the between-subjects design used in studies one to three; apart from the fact that participants only saw three and not seven

[14] The unequal proportion was due to a programming error.

[15] Figure 3-12 shows the unstandardized average product ratings for ease of interpretability and comparability with the results from the previous studies. The statistical analysis however was performed on the standardized variables.

product replicates in each condition. To make it easier to interpret and compare the product ratings, the unstandardized mean ratings are reported below. The test statistics however, relate to the standardized product ratings. The results show that in the between-subjects comparison, the runners did not significantly dilute their judgments when seeing irrelevant information compared to only relevant information, $M_{Control}$ = 71.41, $M_{Dilution}$ = 70.32, $t(272) = .583$, $p = .562$. In Figure 3-12 this is visualized by the dark bar on the left side and the light bar on the right side. This finding replicates the result of the previous studies and indicates that regular runners did not show a (between-subjects) dilution effect when facing irrelevant product information.

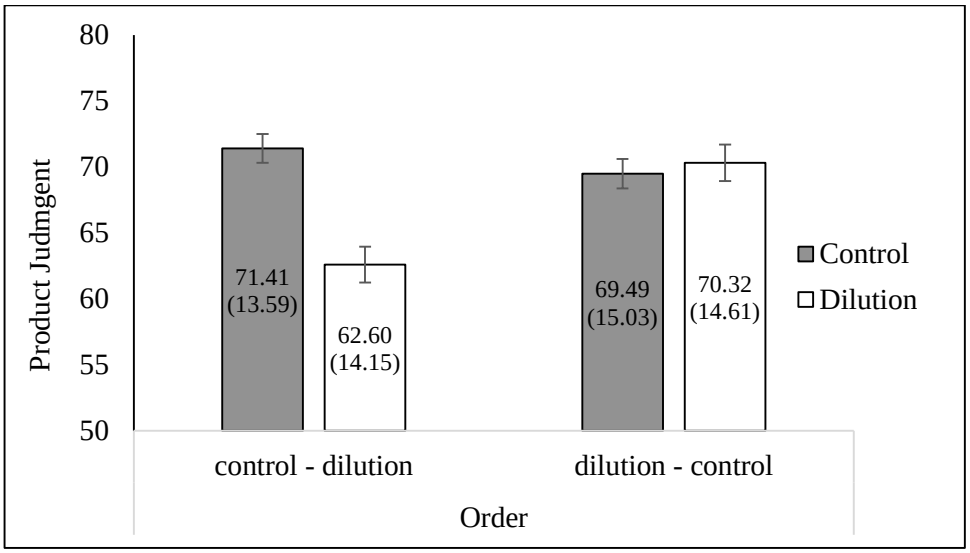


Figure 3-12. Effect of the type of information and the order on the product rating in seasoned runners

Within-subjects design, order: dilution-control. Participants who first saw the three dilution products followed by the three control products also didn't show a dilution effect, $M_{Control}$ = 69.49, $M_{Dilution}$ = 70.32, $t(106) = -.714$, $p = .477$ (Figure 3-12, right side). Their product ratings were the same for the control and the dilution replicates.

Within-subjects design, order: control-dilution. Interestingly, participants in this condition showed a dilution effect. They significantly lowered their product judgments when seeing irrelevant information, $M_{Control}$ = 71.41, $M_{Dilution}$ = 62.59, $t(166) = 7.22$, $p < .001$ (Figure 3-12, left side). This within-subjects manipulation might have particularly drawn people's attention to the content of the irrelevant information. After seeing three products with relevant information only, participants might have focused more on the additional irrelevant information for the following three products, and

attributed some sort of meaning to it, leading to a dilution effect. This explanation would be in accordance with the conversational norms explanation of the dilution effect (Igou, 2007; Igou & Bless, 2005). Table 3-6 provides an overview of the average product rating for the control and dilution replicates for each order condition.

Table 3-6. *Average product ratings across conditions and test statistics in study four*

Study 4 Parkrun UK $N = 274$		**Order**		
	Type of information	Control - Dilution	Dilution - Control	
	Relevant	$M = 71.41$	$M = 69.49$	Interaction: $F(1, 272) = 25.34$, $p < .001$
	Relevant + Irrelevant	$M = 62.59$	$M = 70.32$	
		$p < .001$	$p = .477$	

Time spent. For each of the six product judgments I recorded the time participants took to judge the products, while all information was available to them on the screen. Times below 250ms and more than three standard deviations above the mean were excluded from the analysis. I calculated the average time per product that was spent on the three control product judgments and three dilution product judgments. The two resulting variables were submitted to a 2 (order: control first, dilution first) x 2 (type of information: control, dilution) mixed design ANOVA with the type of information as the within-subjects factor. The result revealed a significant interaction effect between the order and the type of information, $F(1, 267) = 117.79$, $p < .001$. The result for the time data is illustrated in Figure 3-13.

Between-subjects design. Looking at the between-subjects part of the experiment, participants spent significantly longer to judge the dilution products than participants who judged the control products, $M_{Control} = 10.22$, $M_{Dilution} = 12.00$, $t(267) = -2.83$, $p = .005$ (Figure 3-13, dark bar on the left vs. light bar on the right side).

Within-subjects design, order: dilution-control. In this condition, participants also spent significantly more time to judge the dilution products than the control products, $M_{Control} = 7.93$, $M_{Dilution} = 12.00$, $F(1, 103) = 95.92$, $p < .001$ (Figure 3-13, right side).

Within-subjects design, order: control-dilution. However, in this condition participants spent significantly less time to judge the dilution products than the control

products, $M_{Control}$ = 10.22, $M_{Dilution}$ = 8.35, $F(1, 164) = 29.09$, $p < .001$ (Figure 3-13, left side). This is also the only condition in which participants showed a significant dilution effect. Similar to the time results of study three, it seems that people, even if they are physically active, exhibit a dilution effect if they take little time to screen the information and form a judgment.

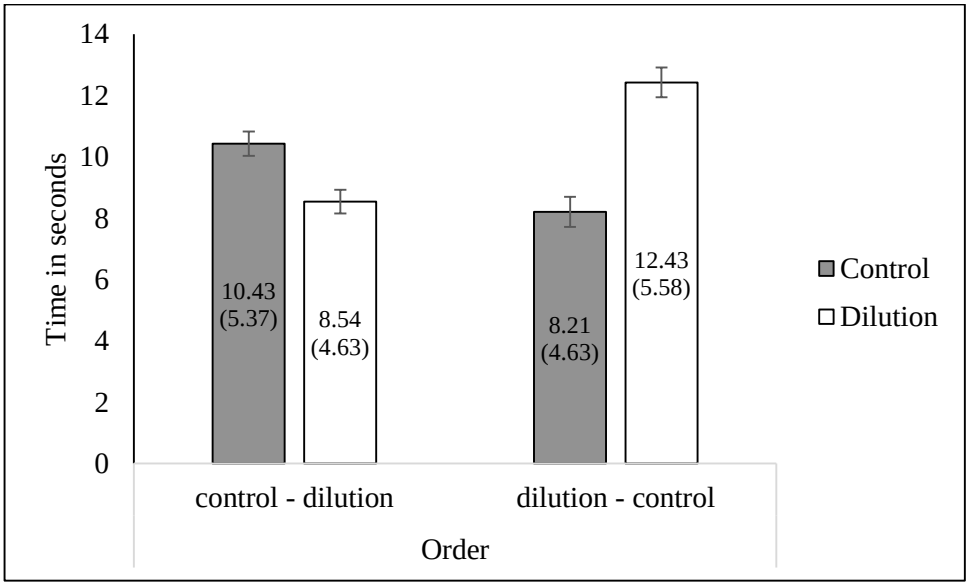


Figure 3-13. Effect of the type of information and the order on the time spent per product replicate in seasoned runners

Dilution score. I computed an individual dilution score as a measure of the extent to which each person lowered their product judgments when seeing irrelevant information compared to relevant product information only. The average of the z-scores for the three dilution product was subtracted from the average of the z-scores for the three control product (Dilution score = *M* (three control z-scores) – *M* (three dilution z-scores)). Higher values on this score represent a stronger dilution effect. Specifically, positive values represent a dilution effect, values around zero represent no difference in rating between the control and dilution products, and negative values represent an enhancement effect where products with irrelevant information are rated more positively than products with relevant information only.

The resulting dilution score was unrelated to participants' parkrun motivation (ideal-self and ought-self question). Further, the dilution score was not related to participants' general mood, and their scores on the vigour, anger and fatigue subscale of the POMS-SV (all *p*s = ns). Solely, the depression subscale was negatively correlated to the dilution score ($r(266) = -.124$, $p = .043$). Participants with higher scores on the

depression subscale tended to have lower dilution scores (i.e., the more depressed, the less they diluted their judgment).[16]

I performed a linear regression analysis to investigate whether the dilution score was associated with participants' running data. Of particular interest was participants' running frequency as an indicator of how regularly they had been physically active. The running frequency variable indicated how regularly people had participated in parkrun since they originally signed up to parkrun (running frequency = total number of runs completed / number of potential runs since the first run). Higher numbers indicated more regular participation. I regressed the dilution score on the running frequency, the order (dummy coded) and well as their interaction. Results showed a marginally significant interaction effect between the running frequency and the order condition on the dilution score (Model: $F(3) = 10.58$, $p < .001$, $\beta = -.781$, $SE = .405$, $t(264) = -1.93$, $p = .055$). Neither of the main effects were significant.

Looking at the correlation coefficient in each of the order conditions separately, I found a significant negative correlation between the running frequency and the dilution score in the 'dilution - control' condition, $r = -.248$, $p = .010$. The more regularly a person had run in the past, the lower their dilution score was, i.e. the less they diluted their judgment. In the 'order: control - dilution' condition, there was no association between the running frequency and the dilution score. The scatterplots of the dilution score and the running frequency for each of the order conditions is shown in Figure 3-14.

[16] As part of the unrelated study which was conducted concurrently, participants had been randomly assigned to an experimental condition that affected some of their feelings. Therefore, the result should be interpreted with care.

Figure 3-14. Scatterplot of the dilution score and the running frequency in each order condition

Discussion

The results of study four show the following. First, seasoned runners did not show a significant dilution effect when comparing the product judgments of participants who first saw the control replicates, to the product judgments of participants who first saw the dilution replicates (i.e., the between-subjects comparison). This replicates the finding from the previous studies. However, it must be noted that instead of using seven product replicates per type of information condition like in the previous studies, only three product replicates were used for this analysis. This means that the statistical power to detect a difference was lower.

Secondly, seasoned runners who first saw the three dilution replicates followed by the three control replicates, also did not show a dilution effect. An alternative explanation for this result is possible. Once participants had rated the dilution replicates at a certain level, they saw the control replicates with only relevant information. Participants in this order condition might have thought that they should rate the control replicates *at least as good* as the dilution replicates to make 'sensible' judgments.

Thirdly, participants who first saw the control replicates followed by the dilution replicates, judged the dilution replicates significantly lower than the control replicates. This was the only group which showed a significant dilution effect. When looking at the

time participants spent to judge the products, only this group spent less time to evaluate the dilution replicates than to evaluate the control replicates. The groups which did not dilute their judgments, spent less time to evaluate the control replicates than to evaluate the dilution replicates. Similar to the time results in study three, this indicates that the time people take to scrutinize the relevant and irrelevant information could be a moderating variable.

Finally, this study investigated seasoned runners' dilution score – an individual-level measure of the extent of dilution when being confronted with irrelevant information. The dilution score was negatively related to the running frequency, indicating that the more regularly runners had participated in parkrun, the less they diluted their judgments. However, this negative correlation was only present in the group which first saw the three dilution replicates followed by the three control replicates. The running frequency was used to operationalize how regularly participants had engaged in physical activity. This operationalization has obvious limitations. It is unclear whether and how often participants exercised independently of parkrun. Hence, this finding should be investigated further.

There are two key takeaways from study four. First, individuals' product judgments in the dilution paradigm can be investigated using a within-subjects design. But, it is important to note that the order matters in which individuals see the control and dilution products. It influences the time individuals spend on judging the products, and their susceptibility to dilute their judgments. Secondly, I found that the more regularly a person had participated in parkrun, the less they diluted their product judgment when seeing irrelevant information (i.e., a smaller within-subject dilution score).

The final dilution effect study was designed to add to the previous studies in the following way. It returns to investigating a single bout of physical activity, even though study three indicated that a single bout of physical activity might not have an effect on exercisers' product judgments. This finding however remains open to question since participants were not randomly allocated to a controlled physical activity condition. Controlled experiments are the gold standard for establishing causality. Therefore, it was important to conduct a controlled lab experiment which investigates the effect of a single bout of physical activity on people's product judgments.

3.5 Study 5: A Lab Experiment Manipulating Physical Activity

The aim of study five was to investigate the effect of a single bout of physical activity on participants' product judgments in the dilution task, as opposed to regular physical activity. I used an experimental design in this study in order to establish whether there is a causal relationship between a single bout of physical activity and people's product judgments in the dilution task. Participants were randomly assigned to one of three conditions, which manipulated physical activity experimentally (running vs. walking vs. sitting). After this manipulation participants completed the dilution product judgment task. The running condition involved jogging at moderate intensity in a nearby park. A walking control group was added in addition to a sitting control group to account for potential differences stemming from participants being outdoors. Study five tested the following hypothesis:

H6: A single bout of physical activity (outdoor running) leads to less or no dilution effect when seeing irrelevant product information, compared to sitting or walking.

As opposed to the previous studies, a process tracing version of the dilution product judgment task was implemented. The aim was to investigate the underlying process mechanism that might lead to differences in the product judgments after physical activity, by measuring people's search for information. As a further process measure, participants were asked to rate the importance of each piece of product information. Several control variables were also collected, including personality traits, regulatory focus as well as participants' lay belief about physical activity. The design and all measures are described in detail in the next section.

Methodology

Study five was conducted in the LSE Behavioural Research Lab during January and February 2017. Participants received a £10 payment for their participation. Physical activity was manipulated experimentally before participants completed the dilution product judgment task. The experiment followed a 3 (physical activity: running, walking, sitting) x 2 (type of information: control, dilution) between-subjects design. The experiment was presented to participants as consisting of two separate, unrelated studies

that were conducted together for administrative reasons: Study A was allegedly investigating people's attitudes towards having a 'leisure break' during the day (i.e., the physical activity manipulation), and Study B was investigating how consumers judge different products (i.e., the dilution product judgment task). This was done to reduce the likelihood of participants guessing the hypothesis and changing their responses in the product judgement task.

Before coming to the lab, participants were informed that as part of Study A some of them would be taking a leisure break. For some of them this leisure break would involve going to the nearby park (Lincoln's Inn Fields) and engaging in moderate physical activity. Participants were told that they would only be informed regarding whether or not they had been allocated to the 'leisure break' condition on the day of the experiment. Therefore, all participants who wanted to participate in the study had to be dressed appropriately or bring their exercise gear with them, even if some of them might not exercise in the end.

Part 1: Physical Activity Manipulation. Upon arrival in the lab participants were randomly assigned to one of three conditions (running, walking or sitting). Participants in the *running condition* first read and completed a health and safety statement which was based on the physical activity readiness questionnaire (Thomas, Reading, & Shephard, 1992). All participants successfully passed the risk assessment and were able to complete the physical activity manipulation. Participants in the running condition were informed that the first study was about people's attitudes towards having a leisure break of physical activity. During the first 30 minutes of the study they would jog to the nearby park and engage in moderate physical activity by running along the path of the park at least two times before coming back to the lab (the detailed instructions are shown in appendix F). If participants didn't know how to get to the park, they were given instructions and a map.

Participants in the *walking condition* were informed that during the first 30 minutes of the study they would go to the nearby park, slowly walk around the park one time and come straight back to the lab. As a cover story they were told that the researcher wanted to measure as objectively as possible how many steps it takes to cover this distance, and that this data would be used as a baseline measure for another study. Participants were asked to walk in a normal, unhurried manner and take slow, deliberate steps so that the researcher would get an honest calibration of the data (detailed instructions are shown in appendix F). This additional control group was added to account for differences potentially caused from being outdoors (Oppezzo & Schwartz, 2014).

Participants arrived at different time slots in the lab and were tested individually to avoid them walking or running together. As a manipulation check, participants in both conditions carried a Karrimor pedometer, which counted their overall steps starting from when they left the lab until they returned. After participants had returned to the lab, I collected their pedometers and entered the data manually in the computer. Participants were offered water for refreshment, and allowed time to recuperate. Finally, participants were seated at their allocated PC cubicle and completed the alleged unrelated second study. Participants in the *sitting condition* did not engage in any physical activity and only completed a series of unrelated online questionnaires on the lab computers.

Part 2: Computer tasks. First, participants completed four items measuring general mood (sad/happy, depressed/cheerful) and arousal (calm/excited, exhausted/ vigorous). This was included to control for potential differences in people's affective state after the physical activity manipulation. Participants were asked to indicate how they were feeling right now in this moment. Answers were provided on slider scales ranging from 0 to 100 with the following anchors at the endpoints: sad - happy, depressed - cheerful, calm - excited, and exhausted - vigorous. The starting point of the slider was set at the midpoint (i.e., 50).

Participants in the running and walking condition then completed the Borg RPE scale (Borg, 1998) to rate how hard or easy the physical activity had felt to them. This was followed by questions regarding their attitude towards the 'physical activity leisure break'. Participants provided answers to the following five questions, on a slider scale from 0 = strongly disagree, to 100 = strongly agree: *The physical activity leisure break I just did: was a positive experience, distracted me from more important things, was a hassle, will help me think more clearly later today, will help me make good decisions later today.*

Dilution Effect. Next, all participants proceeded to the 'product evaluation' part. As in the previous studies, participants were randomly assigned to a control condition with only relevant product information, or a dilution condition with relevant and irrelevant product information. The product judgment task was the same as in the previous studies apart from one change. Participants saw a *process tracing version* of the product information. All product information was hidden under opaque boxes. The information became visible once participants hovered the mouse cursor over the box. Once participants moved the mouse to another part of the screen, the information was hidden again under opaque boxes. In the control condition only one piece of information

(relevant) was hidden. In the dilution condition one relevant and three irrelevant pieces of information were hidden. When rating the products, participants could see the desired benefit, but the product information remained hidden, unless they scrolled over it again. The number of times participants scrolled over the relevant and irrelevant pieces of information was recorded. The product judgment task and all other computer tasks were programmed using authorware.

Importance rating. This was followed by an importance rating of the product information. For each product replicate, participants were asked to indicate how important the product information had been in determining their judgment (9-point Likert scale with 1 = extremely unimportant, 9 = extremely important). In the control condition, participants only rated the importance of the relevant information for the seven product replicates. In the dilution condition, participants rated the importance of all four pieces of information for the seven product replicates.[17] An average importance score was computed for the seven relevant attributes and for the 14 irrelevant attributes.

Controls. This was followed by several questionnaires that served as control variables. Participants answered questions regarding their personality traits (TIPI; Gosling et al., 2003) as well as two measures of regulatory focus: the Regulatory Focus Questionnaire (Higgins et al., 2001) and the Regulatory Mode Questionnaire (Kruglanski et al., 2000). All participants completed questions about demographics (gender, nationality, age, highest level of education, and annual salary). Lastly, participants completed the same five questions on lay beliefs about the effects of physical activity, as in study one. Upon completion, participants were debriefed, thanked and paid £10 for their participation, which lasted approximately one hour.

Results

Participants. Two hundred and thirty-three participants completed study five. Out of those, eighteen participants were excluded from the analysis. Eleven participants from the walking condition were excluded since they indicated to have done more than one lap around the park. Six participants were excluded since they completed the product judgment task unreasonably fast (the bottom five percentile with times below 25 seconds for seven product replicates), and one participant indicated to have had problems with the software of the experiment.

[17] Due to a recording error only data about three pieces of information were recorded per product replicate (importance ratings for one relevant and two irrelevant attributes)

This left two hundred and fifteen participants (64% female, 36% male) for the data analysis (running: n= 76, walking: n = 66, sitting*:* n = 73). Participants were on average 26 years old (SD = 7.84, range 19 - 65 years). The average annual salary, indicated by selecting one of nine categories, fell in the £0 - £25,000 range. 37% of participants indicated to have an undergraduate degree as their highest educational level, followed by 29% with a postgraduate degree.

Manipulation Checks. The pedometer data showed that participants in the running condition achieved a higher step count than participants in the walking condition (M_{run} = 2799, M_{walk} = 2108, t(136) = 7.764, p < .001). Further, participants in the running condition reported to have completed on average 2.51 laps around the park (M_{walk} = 0.89, t(140) = 12.58, p < .001). The physical activity in the running condition was perceived as significantly more exerting than in the walking condition, as indicated by participants' rating on the Borg RPE scale (M_{run} = 6.54, M_{walk} = 3.08, t(140) = 11.64, p < .001). However, the running manipulation was not perceived as very strenuous. A value of six on the Borg RPE scale corresponded to 'light' physical activity.

Mood. The physical activity manipulation did not have any significant effect on participants' mood for the following items: sad/happy, depressed/cheerful (all ps = ns). However, after running participants felt less calm (M_{run} = 49.30, M_{walk} = 35.42, F(2, 212) = 6.73, p = .001) and less vigorous (M_{run} = 53.32, M_{walk} = 60.41, F(2, 212) = 3.59, p < .029) than after walking. There was no difference to the rating in the sitting condition (M_{sit} = 42.65 and M_{sit} = 53.57, respectively).

Attitude towards physical activity leisure break. An average attitude score was computed over the five items (Cronbach's α = .98). Participants generally had a positive attitude towards the physical activity leisure break (M = 66.01). This attitude was more positive for participants in the walking condition than in the running condition (M_{run} = 63.85, M_{walk} = 68.49, t(140) = -2.06, p = .041).

Regulatory Focus. The physical activity manipulation did not affect participants' responses to the regulatory focus questionnaire or the responses to the regulatory mode questionnaire (all ps = ns).

Lay belief. An average lay belief score was calculated over the five items (Cronbach's α = .79). Overall, participants held strong lay beliefs about the positive effects of physical activity. The average rating was significantly above the scale midpoint (M = 59.21, t(213) = p < .001). Furthermore, there was a significant effect of the physical activity factor on the lay belief score (F(2, 211) = 3.37, p = .036). Planned contrasts

showed that participants in the walking condition had more positive lay beliefs than participants in the running condition (M_{run} = 57.69, M_{walk} = 61.82, t(214) = 2.45, p = .015), and in the sitting condition (M_{sit} = 58.40, t(214) = 2.02, p = .045). There was no difference between the sitting and running condition.

Product Judgments. The product judgments were first submitted to a 2 (type of information: control, dilution) x 7 (product replicate: car, toothpaste, package delivery service, stereo system, apartment, airline service, computer) mixed ANOVA. Since the higher order interaction effect involving the product replicate factor was not significant, the data were collapsed across this factor. As in previous studies, I found a significant dilution effect ($M_{Control}$ = 70.69, $M_{Dilution}$ = 66.26, t(213) = 2.88, p = .004).

Next, I submitted the product judgments to a 3 (physical activity: running, walking, sitting) x 2 (type of information: control, dilution) between-subjects ANOVA. The results showed a significant main effect of the type of information (F(1, 209) = 8.42, p = .004). However, there was no main effect or interaction effect involving the physical activity factor (F(2, 209) = 1.62, p = .200, and F(2, 209) = 0.35, p = .704, respectively). All participants significantly lowered their product judgment when faced with irrelevant product information. Hence, the physical activity manipulation did not impact participants' product judgments. Hypothesis six was therefore rejected.

Number of views. Next, I investigated the number of times participants hovered over the opaque boxes to see the relevant and irrelevant information in each condition. On average, participants had looked at the relevant piece of information 3.45 times (SD = 1.51), while each irrelevant piece of information had been viewed 3.71 times (SD = 1.17). This number was significantly larger, t(98) = -2.51, p = .013. The number of views of the relevant information was not affected by the dilution condition or by the physical activity condition (Model: F(5, 209) = 0.55, p = .735). Further, the number of views of the irrelevant information in the dilution condition was not affected by the physical activity condition (Model: F(2, 96) = 1.42, p = .247). Hence, the physical activity manipulation did not affect how many times participants hovered over the boxes to see the relevant and irrelevant information.

Importance rating. Not surprisingly, participants rated the relevant information as significantly more important than the irrelevant information for judging the products ($M_{Relevant}$ = 8.00, $M_{Irrelevant}$ = 3.58, t(99) = 27.99, p < .001).

Relevant information: I submitted the importance rating of the relevant information to a 3 (physical activity: running, walking, sitting) x 2 (type of information:

control, dilution) between-subjects ANOVA. The results showed a significant main effect of the type of information ($F(1, 209) = 148.37$, $p < .001$). Participants in the dilution condition rated the relevant information as more important ($M = 8.00$) than participants in the control condition ($M = 6.44$). Furthermore, there was a significant main effect of the physical activity manipulation on the importance rating of the relevant information ($F(2, 209) = 4.82$, $p = .009$). Planned contrasts showed that participants in the walking condition rated the relevant information as less important than in the running condition ($M_{run} = 7.37$, $M_{walk} = 6.89$, $t(215) = 2.32$, $p = .021$). There was no difference between the sitting condition ($M_{sit} = 7.21$) and the walking or running condition. Further, there was no interaction effect between the type of information and physical activity.

Irrelevant information: I submitted the importance rating of the irrelevant information to a between-subjects ANOVA with the three levels of the physical activity factor. The results showed that there were no differences in the importance rating of the irrelevant information between the three groups ($F(2, 97) = 0.15$, $p = .858$).

Discussion

The results of study five show that the physical activity manipulation did not affect people's product judgments when faced with irrelevant information. There were no differences between participants in the running, walking and sitting condition with regard to their product judgments in the control and dilution condition. Participants in all three groups significantly lowered their product judgments when seeing irrelevant information, compared to seeing only relevant information. Thus, there was no effect of the physical activity manipulation on the dilution effect and hypothesis six was rejected.

Furthermore, the physical activity manipulation did not impact how many times participants hovered over the opaque boxes to see the relevant and irrelevant information. The importance rating of the relevant and irrelevant product information also did not reveal any significant differences after engaging in a single bout of physical activity compared to a sitting or walking control group.

There are several possible explanations for this finding. First, a single bout of physical activity might not have an impact on people's product judgments in the dilution paradigm. It is possible that physical activity needs to be performed regularly over a longer period of time in order to affect people's product judgments in the dilution paradigm. A longitudinal randomized controlled trial would be an ideal design to investigate this.

Another possible explanation for the result of this study could be that the physical activity manipulation was not strong enough or not long enough to result in a change of the product judgments. Participants in the running condition rated the physical activity as 'light', and only took 25% more steps than participants in the walking control condition. Although the manipulation checks revealed significant difference between the running and walking condition in terms of the number of steps, the number of laps and the perceived exertion, the overall intensity and / or duration of the physical activity might not have been sufficient to lead to changes in participants' product judgments.

Thirdly, it is possible that physical activity which is performed as part of a lab experiment, is different from physical activity which is performed in real life, e.g. at the gym. A lab experiment might not represent adequately how and why people are exercising. Specifically, there might be differences with regard to the motivational drivers of the physical activity. Physical activity that is part of a lab experiment is performed for a payment. This does not apply to physical activity in real life, which is performed to achieve other goals. These motivations and associated perceptions of the physical activity might have to be present for an effect on product judgments in the dilution paradigm to occur.

I will provide an overall summary and discussion of the findings on physical activity and the dilution effect presented in this chapter, in the general discussion in Chapter 5. A summary of the different control variables and process measures that were collected in studies one to five can be seen in Table 3-7.

Table 3-7. *Control variables and process measures collected in studies one to five*

Study 1	• Demographics • Personality traits (BFI-10) • Mood (POMS-SV) • Reasoning skills (Remote associates test and Nonsense Syllogism test) • Lay belief in effects of physical activity
Study 2	• Demographics • Personality traits (TIPI) • Divergent thinking (Unusual Uses) • Decision making skills (Self-control scenarios and Inter-temporal choices) • Inhibitory functions (Stroop Colour-Word Interference test) • Attention control (Necker Cube Pattern Control test) • Product information memory test (recognition) • Product information attribute selection • Lay belief in effects of physical activity
Study 3	• Demographics • Visual search task (Where is Wally) • Product information attribute selection • Product goal memory (free recall) • Regulatory focus (friendship strategies) • Exercise motivation • Time spent on product ratings
Study 4	• Demographics • Time spent on product ratings • Mood • Parkrun motivation
Study 5	• Demographics • Mood • Arousal • Attitude towards physical activity ‘leisure break’ • Regulatory focus (RFQ and RMQ) • Lay belief in effects of physical activity • Importance rating of the product information • Number of times product information was viewed

Chapter 4. Physical Activity and Desirability-Feasibility Considerations

The objective of the three studies outlined in this chapter, was to investigate whether physical activity influences decision making in situations where all available information is relevant and should be considered. Specifically, I investigated decision situations in which consumers have to make a trade-off between different, conflicting attributes in order to make a choice. Trade-offs between desirability and feasibility attributes which are commonly observed in the consumption domain, were investigated in the following set of studies. Consumers frequently have to trade-off desirability against feasibility attributes in order to make optimal product choices. For example, if someone wants to buy a high quality product (i.e., high desirability), they usually have to pay a higher price (i.e. low feasibility) than for a low quality product. Under typical conditions in the consumption domain, people tend to put more emphasis on desirability attributes than on feasibility attributes (Cohen et al., 2008).

It should be noted that it isn't necessarily always better from a normative perspective to place more emphasis on the feasibility attribute. If the desirability attribute is more important than the feasibility attribute for the decision outcome then it should obviously receive a greater decision weight. The equal weighting of attributes isn't a normatively better decision strategy. However, both attributes should be considered in the decision making process if they are relevant for the decision outcome, if the attributes are negatively correlated and require a trade-off. There are several examples from the consumer domain which show that people tend to place more emphasis on desirability attributes at the expense of feasibility attributes (Cohen et al., 2008; Thompson et al., 2005). This can result in negative consumption experiences, for example when consumers buy overly complex products leading to reduced satisfaction and negative user experience.

Additionally, a more balanced weighting of desirability and feasibility attributes can be useful in situations where consumers underestimate the steps it takes to reach a goal or costs (e.g., monetary, temporal, effort) associated with a desired outcome (e.g., signing a contract for an iPhone X without being able to pay the monthly fees). Finally, a more balanced weighting of decision attributes can benefit consumers in situations where companies overstate the desirable benefits of a product and understate the associated costs

(e.g., most rebates go unredeemed which can lead to consumer complaints (Cohen et al., 2008)). In sum, although it is not recommendable to always give greater weight to feasibility features and less weight to desirability features, it is advisable in situations where consumers tend to underweight the former.

Study six - a quasi-experimental field study at a gym - investigates exercisers' considerations of such desirability and feasibility information in a decision scenario before and after a single bout of physical activity. This is followed by study seven which tests whether there is an association between regular physical activity and desirability and feasibility considerations using a correlational design. Study eight uses field data of seasoned runners to predict desirability-feasibility choices by looking at their past running performance. The control variables and process measures which were collected in each of the following studies can be seen in Table 4-5 at the end of this chapter.

4.1 Study 6: Physical Activity and Desirability-Feasibility Considerations – A Quasi-Experimental Field Study at the Gym

The aim of the first study in this chapter was to investigate whether a single bout of physical activity can influence how people make decisions in situations where they have to trade-off desirability against feasibility attributes. It is often observed in feasibility-desirability choice conflicts that decision makers overly focus on the desirability attributes and neglect the feasibility attributes. If physical activity benefits information integration in complex decisions with varying information, we would expect participants who had just engaged in physical activity to consider both desirability and feasibility features in their decision, instead of considering mostly one of the two features (typically desirability). Thus, I expected that a single bout of physical activity would lead to a more equal consideration of both attributes and less or no neglect of feasibility attributes in a product choice which requires making a trade-off between desirability and feasibility attributes.

H7: Participants focus more on feasibility and less on desirability information after a single bout of physical activity compared to beforehand.

I conducted a quasi-experimental field study at a gym and tested participants before or after their workout to investigate this proposition. Since construal level has been shown

to affect people's desirability-feasibility considerations (Liberman & Trope, 1998), I also included a measure of individuals' construal level, in case the physical activity manipulation affected people's level of construal. In addition I collected a number of control measures including participants' mood and arousal as well as demographics. All measures are described in detail in the following methodology section.

Methodology

This study was conducted with a sample of exercisers who visited the LSE Students' Union gym.[18] In addition to a free weights area, the Students' Union gym provides a range of exercise equipment both for endurance and resistance workouts to its members. The sample consisted mostly of LSE students but also university staff and visitors. The study was conducted in June 2016 and May 2017, with the majority of data being collected in June 2016. The results did not differ for the two periods of data collection.

I set up a 'testing station' outside the gym - after the changing rooms - so that people entering or leaving the gym would have to walk past. Exercisers passing by were approached and asked for their help in a five minute research study on physical activity and decision making. They were offered a snack or energy drink as an incentive to participate. If they agreed to take part they were given a tablet (an iPad mini) to complete the study. After they completed the study they were thanked for their participation and they could choose their snack or drink.

As a quasi-experimental manipulation of physical activity, roughly half of the participants were randomly approached when they entered the gym. The other half was approached on their way out of the gym after they had exercised and left the changing rooms.

After reading a short introduction and completing the informed consent, participants read a decision making scenario. Specifically, they had to make a choice which required making a trade-off between desirability and feasibility attributes. In addition, participants completed a task that was tapping into individuals' level of construal. Construal level has been shown to affect people's desirability-feasibility considerations (Liberman & Trope, 1998). Therefore, it was important to include a measure of construal level, in case the physical activity manipulation affected people's

[18] https://www.lsesu.com/gym/

level of construal. The order of the two tasks was counterbalanced. Since the order did not impact the results, it will not be reported in the results section.

Desirability / feasibility. Participants were shown a decision making scenario which was adapted from Liu (2008). They were asked to imagine that they wanted to go on a hiking trip during the weekend, and were presented with two options, Park A and Park B. One of the options was characterised by relatively high desirability *(scenery with creeks and waterfalls*) and relatively low feasibility (*limited parking and 70 miles away*). The other option was characterised by relatively low desirability (*scenery with boulders and bushes*) and relatively high feasibility (*plenty of parking and 40 miles away*). This information about the parks had been pretested extensively in the original paper for its desirability and feasibility. While the instructions remained on the screen, the information about both parks was presented simultaneously in a table. A screenshot of the instructions and stimuli is shown in appendix G. Participants were asked to make a choice between the two options.

On the next page, participants were asked to rate how much they had focused on the desirability attribute when making the decision (*How much did you focus on the scenery of the parks?*) and the feasibility attribute (*How much did you focus on the accessibility of the parks?*). The order of the desirability and feasibility focus questions was randomized. Answers were given on slider scales ranging from 0 = not at all, to 100 = very much.

Construal level. To investigate potential differences in construal level before and after engaging in physical activity, participants completed a 'city distance estimation' task similar to the one used by Alter and Oppenheimer (2008, study 1a). Participants were asked to estimate the distance from their current location in London to ten other European capitals. A more abstract, high-level construal mindset should lead to higher distance estimates. Before giving their estimates, participants could select whether they would feel more comfortable completing the task using miles or kilometres. As a clue, I informed participants that the longest distance in the list was 890 miles or 1432 km (see appendix H for the instructions).

Mood and Arousal. Following this, participants completed a short four item measure of general mood (sad - happy, depressed - cheerful) and arousal (calm - excited, and exhausted - vigorous). This measure was included to control for potential differences in people's affective state before versus after exercising. Participants were asked to indicate how they were feeling right now in this moment. Answers were provided on

slider scales ranging from 0 to 100 with the following anchors at the endpoints: sad - happy, depressed - cheerful, calm - excited, and exhausted - vigorous. The starting point of the slider was set to be at the midpoint (i.e., 50) for each item.

Gym session. Next, participants answered questions about the exercise session that they had just completed (in the post-exercise condition) or were about to start (in the pre-exercise condition). I collected the exercise duration (how long they had been exercising / were planning to exercise), the type of exercise (treadmill/cycling/cross trainer, lifting weights, stretching/toning, and classes) as well as the exercise intensity. Participants completed the Borg RPE scale (Borg, 1998) to indicate how hard or easy the physical activity felt / was going to feel to them on a 15 point scale ranging from 6 = no exertion at all, to 20 = maximal exertion.

Finally, participants completed several demographic questions (gender, age, location of origin).

Results

Participants. Ninety participants completed the study (45 females, mean age = 22 years, *SD* = 4.14), of which 47% completed the study before their exercise (*n* = 42). 40% of participants indicated to be from Europe, followed by 28% from North America, and 20% from Asia. There were no differences in terms of gender and age between participants tested before vs. after the gym. Further, there were no differences in terms of actual vs. planned duration of physical activity and exertion. On average, participants had exercised / were planning to exercise 77 minutes (*SD* = 26.72). Participants' average perceived exertion rating on the Borg RPE scale was 14 (*SD* = 1.87). This corresponds to an exertion level between 'somewhat hard' and 'hard'.

There were also no significant differences in participants' mood or arousal before and after exercise (all *p*s = ns). This suggests that the results with regard to desirability-feasibility considerations were not driven by affective differences before and after engaging in physical activity.

Desirability / feasibility. In the choice task, participants clearly preferred the high desirability-low feasibility option over the low desirability-high feasibility option. 73% of participants chose the high desirability-low feasibility option. After a single bout of physical activity, participants chose the high desirability-low feasibility option slightly less often than beforehand (before: 76% vs. after: 71%). However, this difference was not statistically significant, $\chi^2(1) = .329$, $p = .566$.

Next, I submitted participants' ratings of how much they had focused on the desirability and feasibility information to a 2 (time: before gym, after gym) x 2 (information: desirability vs. feasibility) mixed design ANOVA, with time as the between-subjects factor and information as the within-subjects factor.

The results showed a significant interaction effect between the time of testing and the information, $F(1, 88) = 4.64$, $p = .034$. Further, there was a significant main effect of the information, $F(1, 88) = 48.99$, $p < .001$. There was no main effect of the physical activity manipulation on the information focus rating, $F(1, 88) = 0.81$, $p = .777$. The average rating of participants' focus on the desirability and the feasibility information before and after exercising can be seen in Figure 4-1.

Independent samples t-tests showed that participants significantly reduced their focus on the desirability information when tested after the gym compared to beforehand ($M_{before} = 80.7$, $M_{after} = 72.2$, $t(86.5) = 2.02$, $p = .046$, grey bars in Figure 4-1). Conversely, participants increased their focus on the feasibility information when tested after the gym compared to beforehand. This difference was marginally significant ($M_{before} = 41.8$, $M_{after} = 51.6$, $t(85.8) = -1.88$, $p = .063$, white bars in Figure 4-1). In both conditions, participants focused significantly less on the feasibility information than on the desirability information (before gym: $t(41) = 7.70$, $p < .001$; after gym: $t(47) = 3.11$, $p = .003$).

Comparing the average desirability-feasibility rating per condition indicates that although the desirability information was always more important than the feasibility information, the gap between the two types of information became smaller after participants had exercised.

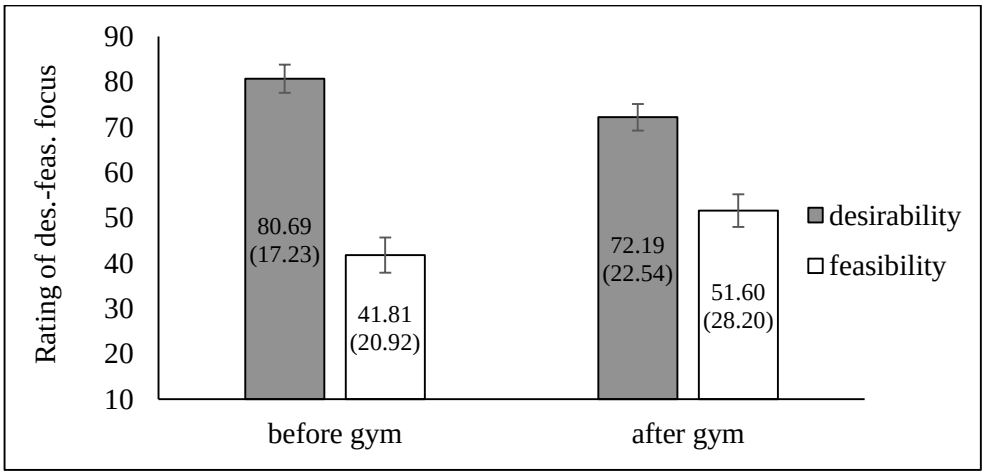


Figure 4-1. Effect of a single bout of physical activity on the desirability and feasibility focus

As an individual measure of how much participants focused on only one versus both of the decision criteria in making their choice, I subtracted the feasibility rating from the desirability rating. Positive numbers indicate that participants focused more on the desirability information than the feasibility information. When tested before exercising, the gap between the desirability and feasibility focus rating was significantly larger than when tested after exercising, (M_{before} = 38.8, M_{after} = 20.58, t(84.8) = 2.20, p = .030). Table 4-1 shows the average rating of desirability and feasibility focus across the physical activity condition and the associated test statistics obtained in study six.

Table 4-1. *Average focus on desirability and feasibility information and test statistics in study six*

Study 6 Gym N = 90		Before the gym	After the gym	
	Desirability Focus	M = 80.69	M = 72.19	Interaction: F(1, 88) = 4.64, p = .034
		p = .046		
	Feasibility Focus	M = 41.81	M = 51.60	
		p = .063		

Controls. I added age and gender as control variables, but neither variable was associated with the desirability / feasibility focus, nor did they impact the effect of physical activity. Adding mood and arousal as covariates to the ANOVA model did not impact the results either. The effect of the physical activity manipulation remained significant, F(1, 80) = 4.97, p = .029.

Construal level. All responses in the city distance estimation task were converted to kilometres and an average distance estimate was calculated over the ten items. I excluded five outliers from the analysis whose average distance estimate was above 1500km. An independent samples t-test showed that there was no significant difference in the average distance estimate for the time of testing, M_{before} = 752.80, M_{after} = 825.07, t(83) = 1.63, p = .106.

I restricted the analysis to include only participants who had indicated to be from Europe. Those participants, presumably, had a better understanding of the distances between European capitals (n = 34). An independent samples t-test showed that the average distance estimates were significantly larger after engaging in physical activity compared to beforehand (M_{before} = 730.99, M_{after} = 884.94, t(32) = -2.29, p = .029).

However, this finding must be interpreted with caution since the sample size per condition is relatively small (n_{before} = 14, n_{after} = 20).

Importantly, the distance estimate was not correlated with the desirability-feasibility focus (European sample: r = -.161, p = .362; total sample: r = .084, p = .445). Further, adding the distance estimate to the ANOVA model as a covariate did not impact the effect of the time of testing on the desirability-feasibility focus (F(1, 82) = 5.23, p = .025).[19]

Discussion

Study six provides evidence that a single bout of physical activity influences consumers' desirability and feasibility considerations. Using a quasi-experimental manipulation of a single bout of physical activity, the following attribute weighing pattern was found. Individuals who had just engaged in a single bout of physical activity, considered the feasibility and desirability information more equally in their decision compared to individuals who were tested before exercising. This finding supports hypothesis 7. Although the desirability attribute was always more important than the feasibility attribute to the participants, the gap between the two attributes became smaller after participants had exercised. The choice data also followed this trend with a lower percentage of participants choosing the high desirability-low feasibility option after exercising compared to beforehand. However, overall participants still preferred the highly desirable option, even though it was lower in terms of feasibility.

I could refute the possibility that this effect was driven by individual differences between the two groups with regard to gender and age. Further, controlling for participants' mood and arousal did not impact the result. Therefore, it is unlikely that the differences in desirability-feasibility focus were caused by differences in people's affect after engaging in a single bout of physical activity.

In the city distance task, I found a slightly larger average distance estimate in participants after physical activity compared to participants that were tested beforehand. This suggests that physical activity might have led to a higher, more abstract level of construal. However, this was only the case for the smaller European sample. More importantly, the average distance estimate was not associated with participants' desirability-feasibility focus. Physical activity might lead to slight differences in construal

[19] N = 85. This excludes outliers in the distance estimates task but includes European and non-European participants.

level, specifically a more abstract level of construal. However, this was independent of the results with regard to the desirability-feasibility considerations. Although people's desirability-feasibility trade-offs can be affected by their construal level as shown in previous studies (Liberman & Trope, 1998), this did not seem to be the case here. Physical activity - irrespective of construal level - led to a more equal consideration of desirability and feasibility information.

To summarize, the key finding in study six is that a single bout of physical activity can lead to a more equal focus on desirability and feasibility attributes in the decision making process, irrespective of someone's construal level, mood and arousal. Study seven was conducted to investigate whether the results from study six would extend beyond a single bout of physical activity to a population of regularly physically active individuals. A number of studies has shown that regular physical activity can have similar or stronger effects on cognitive test than a single bout of physical activity (Barenberg et al., 2011; Best, 2010; Hopkins et al., 2012).

4.2 Study 7: Regular Physical Activity and Desirability-Feasibility Considerations

The aim of study seven was to investigate whether the effect of a single bout of physical activity on consumers' desirability and feasibility considerations could be extended to regular physical activity. I used a between-subjects manipulation of a desirability-feasibility consumer trade-off. Specifically, Liberman & Trope's (1998) between-subjects manipulation of a desirability-feasibility consumer trade-off was chosen to test this idea. Participants evaluated an option that was either high in desirability and low in feasibility or an option that was low in desirability and high in feasibility. This design was crossed with self-reported regular physical activity.

I expected to find a similar attribute weighing pattern in regular exercisers than in individuals that had just engaged in a single bout of physical activity. Specifically, I hypothesized that regularly physically active participants would place more emphasis on the feasibility information than inactive individuals, and therefore not overly prefer the high desirability-low feasibility option. More formally:

H8: People who are regularly physically active during leisure time consider feasibility (desirability) information more (less) than inactive people in

their evaluation; specifically, they rate a high-desirability low-feasibility option similarly to a low-desirability high-feasibility option, while inactive participants rate a high-desirability low-feasibility option more favourably than a low-desirability high-feasibility option.

Several control variables were collected to eliminate or reduce the effect of any confounding variables. Specifically, I collected information on demographics and personality traits. Further, a measure of individuals' prevailing construal level was included. All measures are described in detail in the following methodology section.

Methodology

An individual differences approach was combined with an experimental manipulation of desirability and feasibility information to investigate trade-offs in inactive versus regularly physically active individuals. Participants were recruited online via Amazon's Mechanical Turk and received a payment of $1.20. The data was collected in October 2016. Participants were informed that they would take part in a five minute research study about how people make choices in a variety of domains.

Order. Participants were randomly assigned to one of two order conditions. Participants either completed the demographics and physical activity section first, followed by the decision making tasks, or vice versa (decision making tasks followed by demographics and physical activity questions). This was done to eliminate the possibility that the findings were driven by a demand effect. There was no main or higher level effect involving the order manipulation. Hence, I collapsed the data across the order factor and will not report it in the results section.

Desirability / feasibility. The desirability-feasibility trade-off measure used in this study was adapted from Liberman and Trope (1998). After participants gave informed consent, they were shown a decision making scenario. Participants were asked to imagine that a friend was offering them two tickets for the concert of a band. The concert tickets varied in terms of their feasibility (price) and desirability (liking of the band). Participants' task was to evaluate how likely it was that they would buy the concert tickets in this situation. Participants were randomly assigned to see one of two between-subjects conditions in which the desirability and feasibility was varied (HDLF condition: high desirability / low feasibility tickets; LDHF condition: low desirability / high feasibility tickets).

In the high desirability / low feasibility condition the concert tickets were *for a band that the participant **liked very much**, but the tickets were also **more expensive than expected, $30**.* In the low desirability / high feasibility condition, the concert tickets were *for a new band that the participant **was not very familiar with and was not sure he/she would like the kind of music** the band was playing. But since the tickets were part of a special deal they **only cost $8** each instead of their usual price of $30.*

Participants rated how likely it was that they would buy the tickets if they were in this situation. Responses were given on a slider scale ranging from 0 = highly unlikely, to 100 = highly likely. The specific wording and format of the stimuli in each condition is shown in appendix G.

Action identification level. As a common measure of individual's prevailing level of construal, participants completed thirteen items from the Behaviour Identification Form (BIF; Vallacher & Wegner, 1989). The BIF asks subjects to choose between a concrete description and an abstract description of different everyday behaviours. For example, subjects have to indicate whether they prefer the description of locking a door as *"putting a key in the lock"* (concrete construal) or *"securing the house"* (abstract construal) by selecting one of the two options. Originally, the BIF has 25 forced-choice items which distinguish between two construal of different everyday behaviours. Specifically, the low-level, concrete construal describes the action of a behaviour (e.g., the means and details of a behaviour). The high-level, abstract construal emphasises the goal of a behaviour or why a certain behaviour takes place (e.g., the motives and meaning of a behaviour). For the sake of time, I used the shorter 13 item version of the BIF (for a similar approach and the individual items see Fujita, Henderson, Eng, Trope, & Liberman, 2006). The instructions are shown in appendix H. Selecting the abstract identification was coded as 1, while selecting the concrete identification was coded as 0. The scores were summed up to create an index ranging from zero to 13. A higher number represents a preference for high-level identifications and a more abstract level of construal.

Other variables. Participants then moved on to complete questions regarding their personality traits (TIPI; Gosling et al., 2003) to account for individual differences between regularly physically active and inactive participants. This was followed by an adapted version of the IPAQ. Specifically, I only asked questions regarding participants' leisure time physical activity but not their work-related physical activity since the previous studies did not yield any additional insights based on those questions. Finally, participants completed a section on demographics (age, gender, education and salary).

Results

Participants. Two hundred and seventy individuals living in the US were recruited. Thirteen individuals failed to provide the correct answer to attention filter questions and were removed from the data analysis, resulting in a final sample of two hundred fifty-seven participants (121 females). Participants had an average age of 34 years (*SD* = 11.61). The average annual salary, as indicated by selecting one out of eight categories, fell in the $25,001 - $50,000 range. 45% of participants indicated to have a college degree as their highest educational level, followed by 31% with 'some college'.

As in previous studies, the physical activity responses were processed and truncated according to the guidelines for data processing and analysis for the IPAQ. A person was classified to be physically active during leisure time if he/she met the same criteria as in the previous studies. Based on those criteria 36% of all participants were classified as regularly physically active ($n = 92$). *Table 4-2* shows the descriptive statistics of regularly physically active and inactive participants for the demographic variables and personality traits.

There was no difference between regular exercisers and people who didn't exercise regularly in terms of their age ($t(254) = .102$, $p = .919$). The regularly physically active group indicated to have a higher income ($t(250) = -3.71$, $p < .001$) and education level ($t(255) = -2.76$, $p = .006$).[20] Income and education were correlated ($r = .341$, $p < .001$). To avoid multicollinearity, I added only one of the two variables as covariates to the ANOVA model. Although not statistically significant by the conventional level, the regularly physically active group had a slightly higher percentage of males ($\chi^2(1) = 3.63$, $p = .057$).

In terms of personality traits, the regularly physically active group had a marginally higher score on extraversion ($M_{PA} = 3.80$, $M_{No\text{-}PA} = 3.37$, $t(255) = -1.94$, $p = .054$) and openness ($M_{PA} = 5.15$, $M_{No\text{-}PA} = 4.81$, $t(255) = -1.85$, $p = .066$). There were no differences with regard to conscientiousness, emotional stability and agreeableness (all *p*s = ns).

[20] Using chi-square tests or ordinal regression analysis for these ordinal variables instead of t-tests showed the same results.

Table 4-2. *Descriptive statistics of regularly physically active and inactive participants in study seven*

	No Physical Activity (N = 165)	**Regular Physical Activity** (N = 92)	Test statistics
Demographics			
Age	M = 34	M = 34	$t(254) = 0.10$, $p = .919$
Female	51%	39%	$\chi^2(1) = 3.63$, $p = .057$
Highest Education	Mdn = 3 (Some College)	Mdn = 5 (4-year College Degree)	$t(255) = 2.76$, $p = .006$
Income	Mdn = 2 ($25,001-$50,000)	Mdn = 2 ($25,001-$50,000)	$t(250) = 3.71$, $p < .001$
Personality traits			
Extraversion	M = 3.37	M = 3.80	$t(255) = 1.94$, $p = .054$
Agreeableness	M = 5.40	M = 5.29	$t(255) = 0.64$, $p = .525$
Conscientiousness	M = 5.40	M = 5.56	$t(255) = 1.02$, $p = .310$
Openness	M = 4.81	M = 5.15	$t(255) = 1.85$, $p = .066$
Emotional Stability	M = 5.03	M = 5.31	$t(255) = 1.47$, $p = .144$

Desirability / feasibility. The dependent variable in the desirability / feasibility trade-off task – the rating of the likelihood to buy the concert tickets – was submitted to a 2 (regular physical activity: yes, no) x 2 (type of ticket: high desirability-low feasibility, low desirability-high feasibility) between-subjects ANOVA. There was a significant main effect of the type of ticket, $F(1, 253) = 4.38$, $p = .037$. Participants' rating of the 'likelihood to buy' was higher for the high desirability-low feasibility tickets than for the low desirability-high feasibility tickets ($M_{HDLF} = 57.06$ vs. $M_{LDHF} = 48.89$). This indicates that overall the high desirability-low feasibility concert tickets were more attractive, and participants generally placed more emphasis on the desirability than the feasibility of the concert tickets.

Furthermore, the results yielded a significant interaction effect between regular physical activity and the type of ticket, $F(1, 253) = 4.24$, $p = .041$. Looking at the simple main effects I found the following pattern. In the inactive group, the rating of the

'likelihood to buy' was significantly higher for the high desirability-low feasibility tickets than for the low desirability-high feasibility tickets (M_{HDLF} = 61.00 vs. M_{LDHF} = 44.79, $t(163) = 3.56$, $p < .001$). This indicates that inactive participants place more emphasis on the desirability attribute (liking of the band) than the feasibility attribute (price of the tickets).

Conversely, in the regularly physically active group, the rating of the 'likelihood to buy' was not significantly different for the high desirability-low feasibility tickets and the low desirability-high feasibility tickets (M_{HDLF} = 53.11 vs. M_{LDHF} = 52.89, $t(90) = .020$, $p < .984$). Regular exercisers valued the tickets that were highly desirable but low in feasibility similarly to the tickets that were less desirable but high in feasibility. This finding supports hypothesis 8.

Further pairwise comparisons showed that in the HDLF condition the difference in the 'likelihood to buy' rating between physically active and inactive individuals was not statistically significant ($t(126) = 1.47$, $p = .143$). This was also the case in the LDHF condition ($t(127) = -1.44$, $p < .151$). The rating of the 'likelihood to buy' in physically active and inactive individuals for each condition is shown in Figure 4-2.

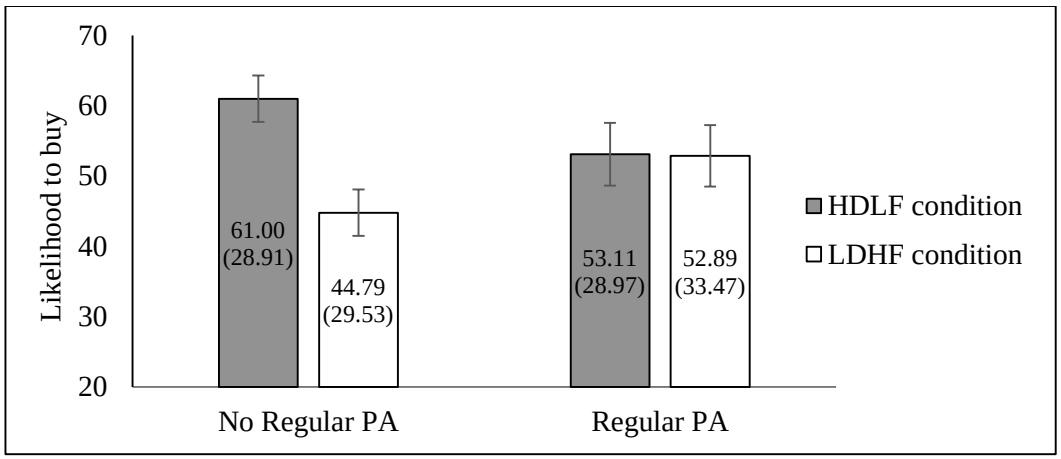


Figure 4-2. Likelihood to buy in the desirability-feasibility conditions for physically active and inactive individuals

Controls. Including income as a covariate in the ANOVA model did not impact the interaction between regular physical activity and the type of ticket (interaction: $F(1, 247) = 4.39$, $p = .037$). Income was not associated with the dependent variable. Neither was education or gender associated with the 'likelihood to buy'. Further, including personality traits as covariates did not impact the interaction between physical activity and the type of ticket (interaction: $F(1, 248) = 4.87$, $p = .028$). Extraversion and

openness were positively related to the 'likelihood to buy' (extraversion: β = 2.76, *SE* = 1.19, *p* = .021, openness: β = 3.03, *SE* = 1.43, *p* = .035). Table 4-3 shows the average rating of the 'likelihood to buy' for the ticket options in physically active and inactive participants together with the test statistics.

Table 4-3. *Likelihood to buy across conditions in study seven*

Study 7 Mturk *N* = 257		No physical activity	Regular physical activity	
	HDLF option	*M* = 61.00	*M* = 53.11	Interaction: *F*(1, 253) = 4.24, *p* = .041
	LDHF option	*M* = 44.79	*M* = 52.89	
		p < .001	*p* = .984	

Note. HDLF = high desirability low feasibility, LDHF = low desirability high feasibility

Action identification level. Regularly physically active participants had a marginally higher BIF score than inactive participants (M_{PA} = 8.82, M_{No_PA} = 7.84, *t*(255) = -1.96, *p* = .051). Regularly physically active participants had selected the abstract identification slightly more often than inactive participants. I added the BIF score as a covariate to the model. However, the results showed that the BIF score was not associated with the rating of the 'likelihood to buy', and the BIF score did not impact the interaction effect between regular physical activity and the type of ticket, which remained significant (*F*(1, 252) = 4.16, *p* = .042).

Discussion

Study seven provides evidence that regular physical activity is associated with consumers' desirability and feasibility considerations. Inactive individuals had a stronger preference for a product characterized by high desirability and low feasibility, than for a product characterized by low desirability and high feasibility. Regularly physically active individuals on the other hand, showed similar 'likelihood to buy' ratings for both products. This supports hypothesis 8 and suggests that regularly physically active individuals considered the feasibility information as equally important as the desirability information when making this trade-off. Inactive individuals however, seemed to have placed more emphasis on the desirability information than the feasibility information.

Importantly, these results could not be explained by differences in personality traits or demographics (age, gender, income and education) between regularly physically active and inactive individuals.

Additionally, I found that regularly physically active individuals had a slightly higher score on the BIF compared to inactive individuals, suggesting a higher, more abstract level of construal in this group. However, the BIF score was unrelated to participants' 'likelihood to buy' rating for the concert tickets. Similar to the distance estimate results in study six, I found that regular physical activity was associated with a slightly more abstract, high-level construal. This difference seems to be small, and does not account for the desirability-feasibility trade-off findings. Irrespective of participants' construal level, regular physical activity was associated with the rating of the desirability-feasibility options.

To summarize the key findings, regularly physically active individuals rated an option that was high in feasibility but low in desirability similarly to an option that was low in feasibility but high in desirability. This indicates that regularly physically active individuals tend to place more emphasis on the feasibility information and less emphasis on the desirability information compared to inactive individuals.

For the next study I was interested to see whether people's choice between a high desirability-low feasibility option and a low desirability-high feasibility option could be predicted by looking at their physical activity performance. I collected data on a desirability-feasibility choice in a sample of seasoned runners participating in parkrun UK to investigate this idea.

4.3 Study 8: Predicting Desirability-Feasibility Choice by Running Performance

Study eight was conducted in collaboration with parkrun UK, as an add-on to study four, within a smaller sub-sample. As noted previously, the study was conducted together with a different, larger study on motivation and exercise performance. For this larger study, data was collected in two waves. While the majority of the data was collected in the first wave, a smaller sample completed the study in a second wave in August 2016. During this second wave, I collected the data for study eight. As described in more detail in study four, after receiving approval from the parkrun research board to conduct the study, parkrunners received an email inviting them to take part in a short research study

on the effects of various goals and ways of thinking on performance in parkrun. The participants received a £5 electronic gift card for Amazon.co.uk as payment for their participation.

The aim of the study was to investigate whether people's choice between a high desirability-low feasibility option and a low desirability-high feasibility option could be predicted by their past running performance. I expected that having a better running performance – indicating regular workouts – would increase someone's odds of choosing a low desirability-high feasibility option over a high desirability-low feasibility option. More formally:

H9: More regular physical activity (and therefore better running performance) is associated with a lower chance of choosing a high-desirability-low-feasibility option over a low-desirability-high-feasibility option (i.e. a higher chance of choosing a low-desirability-high-feasibility option over a high-desirability-low-feasibility option).

Methodology

Participants completed the same hiking trip task as described in study six. In addition but unrelated to this study, participants completed the dilution product rating for study four as well as another questionnaire which was part of a different study. The order of the tasks was as follows. Participants first completed the dilution product rating (study four), followed by the hiking trip task (study eight), and finally an unrelated study on parkrun exercise motivation.

Desirability / Feasibility. In the hiking trip task, participants were asked to imagine they were going on a hiking trip and that they could choose between two parks. The two parks varied in terms of their desirability and feasibility (Park A: high desirability, low feasibility; Park B: low desirability, high feasibility). The information was presented in a table layout. As in study five, after choosing one of the parks participants rated how much they focused on the scenery of the parks (desirability rating) and the accessibility of the parks (feasibility rating). Answers were given on slider scales ranging from 0 = not at all to 100 = very much. The order of the questions was randomised.

Participants also completed questions regarding their parkrun motivation and their current mood. First, participants answered one general mood item (*How are you feeling right now?).* Answers were given on a seven point Likert scale ranging from 'very bad'

to ‘very good’. Next, participants completed thirteen items from the Profile of Mood States (three to four items each from the depression, vigour, anger and fatigue subscales (Cranford et al., 2006)). This was followed by two question about participants’ motivation to take part in parkrun (ideal self and ought self). Participants indicated their agreement to the following statements. Ideal self: *I do parkrun to be the person I would ideally like to be.* Ought self: *I do parkrun because I feel I should.* The questions were presented on separate screens and in random order. Answers were given on slider scales ranging from 1 = disagree to 9 = agree.

Each participant’s data was then matched with their parkrun online profile. I collected whether participants had taken part in a run on the day they completed the study, and if so, their running time. I further collected their total number of runs, their average time, their personal best, and their slowest time. I computed their running frequency by dividing the total number of runs they had done by the total number of possible runs since they signed up. Additionally, I noted how many times they had run in the last two month prior to taking the survey (from zero to a maximum of eight). I also collected their gender and age group from their parkrun online profile.

Results

Participants. Fifty-nine individuals participated in this study (25 females). The average age, as indicated by one of thirteen categories, fell in the 40-44 years range. Participants’ average running time across all of their five kilometre runs was 28 minutes (*SD* = 5.01). On average, runners had completed 83 runs (*SD* = 89.3) with parkrun, and 4.9 runs (*SD* = 2.09) in the last two month prior to the survey (out of a maximum of 8 runs). Female participants had a slower average running time than male participants (M_{female} = 30.21, M_{male} = 26.23, $t(53) = -3.13$, $p = .003$). The average running time was not significantly correlated with participants’ age ($r = .205$, $p = .134$).

Desirability / Feasibility. Overall, participants chose the high desirability-low feasibility option more often than the low desirability-high feasibility option (HDLF: 58% vs. LDHF: 42%). There was no difference between people who chose the high desirability-low feasibility option vs. low desirability-high feasibility option in terms of their age ($t(53) = 1.60$, $p = .114$) and gender ($\chi^2(1) = 1.00$, $p = .752$). Table 4-4 contrasts the descriptive statistics of participants who chose the high desirability-low feasibility option to participants who chose the low desirability-high feasibility option in terms of demographics, mood and the average running time across all of their five kilometre runs.

Table 4-4. *Differences in running time, mood and demographics by desirability-feasibility choice*

	Chose the HDLF option	**Chose the LDHF option**	**Test-statistics**
5k running time	*M* = 29.10	*M* = 26.21	$F(1, 53) = 4.77$, $p = .033$
Mood			
General mood	*M* = 5.18	*M* = 5.16	$F(1, 56) = .010$, $p = .936$
Fatigue	*M* = 1.85	*M* = 2.15	$F(1, 56) = 1.82$, $p = .183$
Vigour	*M* = 2.55	*M* = 2.59	$F(1, 56) = .030$, $p = .858$
Depression	*M* = 1.27	*M* = 1.53	$F(1, 56) = 1.99$, $p = .164$
Anger	*M* = 1.21	*M* = 1.39	$F(1, 56) = 1.45$, $p = .234$
Demographics			
Age category	*Mdn* = 8 (45-49 years)	*Mdn* = 7 (40-44 years)	$F(1, 53) = 2.57$, $p = .114$
Female	44.1%	40%	$\chi^2(1) = 1.00$, $p = .752$

Note. HDLF = high desirability low feasibility, LDHF = low desirability high feasibility

I performed a binary logistic regression with the park choice (coded as HDLF option = 0, LDHF option = 1) as the dependent variable and participants' average five kilometre running time as a predictor. The results revealed that the average five kilometre running time was significantly associated with the runners' choice (Model: $\chi^2(1) = 4.87$, $p = .027$, $R^2 = .085$ (Cox & Snell), .114 (Nagelkerke)). Regular runners with better average five kilometre performance (i.e., lower running time) were less likely to choose the high desirability-low feasibility option than runners with slower running times ($\beta = -.134$, $SE = .066$, $p = .042$, $exp(\beta) = .875$, 95% CI = [.768, .995]). Every one-minute increase in running time decreased the odds of choosing the low desirability-high feasibility option over the high desirability-low feasibility option by 12%. Using participants' personal best five kilometre performance or their running time on the day of the survey as the predictors instead of the average five kilometre running time, yielded similar results.[21]

I added the general mood item to the binary logistic regression as a predictor. However, participants' general mood was not associated with their choice ($\beta = -.076$, $SE = .282$, $p = .786$). Furthermore, neither of the POMS subscales were associated with participants' choice when added to the logistic regression (all *p*s = ns) nor did controlling

[21] All three variables were highly correlated with each other ($r = .75$ to $r = .94$). Therefore only the result for participants' average running time across all of their five kilometre runs are presented.

for the POMS subscales impact the association between the running performance and the odds of choosing the low desirability-high feasibility option.

Participants' ratings of their focus on the desirability and feasibility attribute indicated that they focused more on the desirability attribute than on the feasibility attribute (M_{des} = 73.46 vs. M_{feas} = 56.86, $t(55) = 3.11$, $p = .003$). There was no correlation between participants' rating of the desirability and feasibility information and their average five kilometre running time. Participants' desirability rating was negatively correlated with the total number of runs participants had completed with parkrun, $r = -.347$. $p = .016$. Hence, the more often people had run in the past (i.e., exercised), the less they indicated to have focused on the desirability information.

Discussion

The results from study eight suggest that regular runners with better average running performance over five kilometres were less likely to choose the high desirability-low feasibility option over the low desirability-high feasibility option than runners with slower running times. This finding supports hypothesis 9. There were no differences between runners who chose the low desirability-high feasibility option and the high desirability-low feasibility option in terms of their age, gender and mood. Therefore, the findings cannot be attributed to individual differences for those variables. Of course, this does not eliminate the possibility that some other third variable was driving both people's running performance and their desirability-feasibility choice. However, in light of the findings on physical activity and desirability-feasibility considerations from the previous two studies, the results from study eight add to the evidence that physical activity can influence how people make trade-offs between desirability and feasibility attributes.

An overview of the different control variables and process measures that were collected in studies six to eight can be seen in Table 4-5. An overall summary and discussion of the findings on physical activity and desirability-feasibility considerations presented in this chapter, will be provided in the general discussion in Chapter 5.

Table 4-5. *Control variables and process measures collected in studies six to eight*

Study 6	• Demographics • Construal Level: Distance estimates • Mood • Arousal
Study 7	• Demographics • Personality traits (TIPI) • Construal Level: Behaviour Identification Form
Study 8	• Demographics • Mood

Chapter 5. General Discussion

This chapter will summarize how the research presented in the previous chapters contributes to the empirical knowledge of effects of physical activity on judgment and decision making in the consumer domain. First, this chapter will present a summary of the key findings and provide an overview of the alternative explanations which were ruled out. I will further discuss findings regarding potential process mechanisms in light of the relevant empirical literature. Following this, I will discuss the limitations of the studies and present further avenues for future research. Finally, specific implications of the findings for public policy, management and marketing will be discussed.

5.1 Summary of Findings

The present research aimed to extend the current understanding of whether physical activity may influence consumer decision making. The empirical evidence demonstrates a novel benefit of physical activity. First, I show that regularly physically active individuals differ from inactive individuals in consumer decisions that require ignoring irrelevant product information, irrespective of a number of individual-level and situational control variables. The results point towards the direction that regularly physically active individuals are better able to focus on relevant product information, and therefore don't dilute their judgments. I did not find support for the hypothesis that regular physical activity aids the ignoring of irrelevant information because of improved inhibitory functions. A single bout of physical activity did not influence people's ability to deal with irrelevant product information.

Second, I show that a single bout of physical activity can influence attribute weighting in consumer decisions that require decision makers to make trade-offs between feasibility and desirability attributes. A single bout of physical activity led to a more equal consideration of both attributes in a product choice (as opposed to a typically stronger emphasis on desirability attributes). This attribute weighting pattern was also found in regularly physically active individuals.

Overall, the results indicate that physical activity improves reliance on relevant product information and leads consumers to weight information that deals with feasibility

considerations more heavily. The specific findings of each study are outlined in more detail in the following section.

The research makes several contributions to existing knowledge. First and foremost, it adds to the physical activity literature, and extends the benefits of engaging in regular physical activity to a new domain – consumer information processing. Secondly, this research advances the literature on consumer spillover effects by providing new insight into the effect of a single bout of physical on subsequent, unrelated consumer trade-offs. Thirdly, this work contributes to the de-biasing literature in judgment and decision making and suggests that physical activity may have a significant influence on attribute weighting biases.

Findings on Physical Activity and the Dilution Effect

In Chapter 3 of this thesis, four out of five studies reveal that physical activity is associated with consumers' product judgements when they are faced with irrelevant product information. Specifically, regular physical activity is associated with a reduction of the classic dilution bias in product judgments. Participants who indicated to be regularly physically active, did not lower their product judgments after seeing irrelevant information while inactive individuals showed a significant dilution effect. This spillover benefit of regular physical activity for consumer decision making in the dilution task was directly replicated in study two.

Study three investigated regular exercisers before or after their workout at a gym. The results showed that after their workout, regular exercisers did not dilute their product judgments when faced with irrelevant information. However before their workout, they did show a dilution effect. Participants who weren't regularly physically active, showed the classic dilution effect no matter when they were tested. The average time participants took to judge the products revealed that this three-way interaction could potentially be explained by participants being in a rush when tested before their workout. When tested after the gym session, participants took more time to look at the product information, potentially allowing the spillover benefit of regular physical activity to occur in this condition.

Study four tested a sample of seasoned runners using a within-subjects version of the dilution product judgment task. When comparing the product judgments of runners that first saw the control products, to the product judgments of runners that first saw the dilution products, there was no dilution effect. This finding replicates the result of the

previous studies and shows that regular runners did not exhibit a (between-subjects) dilution effect when facing irrelevant product information. Further, runners who first saw the dilution products followed by the control products also did not dilute their judgments. Only when the runners first saw the control products followed by the dilution products did they show a significant dilution effect.

The average time that runners took to judge the products in each condition was used to interpret these findings. The condition in which runners showed a significant dilution effect, was the only condition in which participants spent less time on the dilution products than on the control products. In all other conditions runners spent more time evaluating the dilution products than the control products, and showed no significant dilution effect.

Further, I computed an individual dilution score - a measure of the extent to which each participant's product rating differed between the control products and dilution products. This dilution score was negatively correlated with participants' running frequency, as a measure of how regularly they had participated in parkrun. The more regularly runners had participated in parkrun, the less they diluted their judgments when seeing irrelevant information.

Study five was a lab experiment, which investigated the effect of a single bout of physical activity on participants' product judgments using an experimental manipulation of physical activity. The results showed that the physical activity manipulation did not affect people's product judgments when faced with irrelevant information. Participants in all groups (running, walking and sitting control conditions) significantly lowered their product judgments when seeing irrelevant information. Thus, there was no effect of the physical activity manipulation on the dilution effect in this study. Potential reasons for this include the physical activity manipulation not being strong enough in terms of intensity and duration, or the context not being realistic enough in comparison to the real world, leading to motivational differences. Asides from that, a single bout of physical activity might simply not impact people's product judgments in the dilution paradigm. Physical activity might need to be performed regularly over a longer period of time in order to affect people's product judgments.

Findings on Physical Activity and the Desirability-Feasibility Choice Conflict

In Chapter 4 of this thesis, three studies reveal that physical activity is associated with consumers' attribute weighting in decisions that require trade-offs between

feasibility and desirability features. Decision makers tend to place too much emphasis on the desirability attributes, often at the expense of feasibility attributes. The findings indicate that physical activity leads consumers to not overly focus on desirability, and consider feasibility criteria more in choices that require trade-offs between them. Study six compared the desirability-feasibility considerations of exercisers before and after their gym workout in a choice that required making a trade-off. While participants always focused more on the desirability attribute than the feasibility attribute, the gap between the two attributes became smaller after participants had exercised. Participants focused less on the desirability attribute after engaging in physical activity, and considered the feasibility attribute more in their choice.

Study seven extends the findings on desirability-feasibility trade-offs from a single bout of physical activity to regular physical activity. For inactive participants, the 'likelihood to buy' rating was significantly higher for a product of high desirability and low feasibility in comparison to a product of low desirability and high feasibility. This difference did not exist when asking regular exercisers to indicate their likelihood to buy. When asking people who indicated to be regularly physically active, their 'likelihood to buy' for the two options did not differ from each other. This suggests that regular exercisers valued the feasibility attribute equally to the desirability attribute in their decision. The typical 'neglect' of feasibility features was not observed in regular exercisers.

Finally, study eight investigated a sample of seasoned runners and their choice between two options varying along the dimensions of desirability and feasibility. Supporting the results from the previous studies, study eight finds that regular runners with better average running performance over five kilometres were less likely to choose a high desirability-low feasibility option over a low desirability-high feasibility option compared to runners with slower running times.

5.1.1 Ruled Out Alternative Explanations

A variety of different samples were used in this thesis and the results consistently showed an effect of physical activity. Both US samples (studies one, two and seven) and UK samples (studies three, four, six and eight) showed a spillover benefit of physical activity for consumer decision making. Across the different studies, physical activity was associated with consumer decision making in Mturk workers, university students, people from socially diverse backgrounds, and seasoned runners. Thus, physical activity seems

to influence consumer behaviour not only in a specific population but in people with varying backgrounds.

In the dilution product judgment task, a benefit of physical activity was found across seven differing replicates of products and services which were presented in a random order. Hence, the findings could be applicable to a range of consumer products, and potentially even beyond the consumer product domain. Further, study one and two are direct replications of each other and consolidate the findings. Additionally, I found the same results using two different, albeit very similar physical activity questionnaires (the GPAQ in study one and the IPAQ in the remaining studies).

To refute the possibility that the findings were driven by demand effects or hypothesis guessing I varied the order of the different tasks and scales in some of the studies (i.e., physical activity questions first, followed by consumer decision making tasks and vice versa). In neither of the studies did the order of the tasks impact the results. I further asked questions regarding people's lay beliefs about the effect of physical activity. Generally, participants held a strong, positive belief that physical activity has beneficial effects for decision making. This belief was particularly positive among regular exercisers. However, these lay beliefs were not associated with participants' responses in the consumer decision making tasks.

People who engage in regular physical activity are different from sedentary people in terms of their demographics (Bauman et al., 2012). Men and younger people are more likely to be regularly physically active. Higher socioeconomic status is also positively associated with more physical activity. Therefore, it was important to rule out individual differences in demographics as third variables influencing both physical activity behaviour and decision making behaviour. I controlled for several demographic variables including education, income, age and gender to account for these individual differences. The results show that the effect of physical activity on consumer decision making persisted even after taking into account demographic differences.

Further, it was important to account for personality trait differences between people who engage in regular physical activity and those who don't. Meta-analysis have shown that physical activity is associated with higher levels of extraversion and conscientiousness, and lower levels of neuroticism (Rhodes & Smith, 2006). I controlled for personality traits using two commonly used personality scales: the BFI-SV (study one) and the TIPI (study two and seven). Conscientiousness was the most obvious personality trait which could be associated with people's information processing, as well

as their exercise habits. However, I did not find support for this alternative explanation. Accounting for conscientiousness did not affect the results. Additionally, none of the other personality trait variables (emotional stability, extraversion, openness, and agreeableness) impacted the key findings.

Study two rules out two further individual-level differences as potential alternative explanations. First, participants' generalized self-control was tested using scenarios from multiple decision domains including eating behaviour, saving money, and partying. Secondly, participants' ability for delay of gratification was tested using inter-temporal choices between hypothetical monetary payoffs received now or in the future. Neither of the two measures yielded significant differences between the physically active and inactive participants. This suggests that physically active individuals are not simply 'better' at any general form of decision making which requires self-control.

A potential motivational component, which was important to refute as an alternative explanation, was regulatory goal focus. Malaviya and Sternthal (2009) showed that depending on the fit between regulatory focus and the means of goal pursuit, irrelevant information can have different effects on product evaluations (enhancement, dilution or no effect). With regard to physical activity, promotion orientation has also been described as a motivational determinant of engaging in physical activity, and promotion oriented messages have been shown to increase physical activity participation (Joireman, Shaffer, Balliet, & Strathman, 2012; Latimer et al., 2008). I tested this idea in study three, four and eight but found no indication of differences in exercisers' promotion and prevention focus.

Physical activity has benefits for people's mood. Positive effects on mood have been shown for a single bout of physical activity (e.g., Hansen, Stevens, & Coast, 2001) as well as for regular physical activity (e.g., Lathia et al., 2017). In study one the POMS-SV was used to account for potential differences in mood amongst regularly physically active and inactive participants. Indeed, I found that regularly physically active participants had a significantly higher average score on the vigour-activity subscale and a marginally lower 'total mood disturbance' score than inactive participants. Controlling for these variables however, did not affect the key findings on physical activity and product judgments. In study four, seasoned runners' mood was also not associated with their dilution score, nor with their desirability-feasibility choice in study eight. I also measured mood and arousal in study six which investigated the effect of a single bout of physical activity on desirability-feasibility considerations. Participants' mood and arousal

were measured before versus after engaging in physical activity. In contrast to the literature, I found no significant differences in affective states before versus after exercising, and no association with exercisers' choice behaviour. The overall findings indicate that the effects of physical activity on consumer behaviour were not driven by differences in people's mood.

5.1.2 Process Findings

Several findings, which give insight into the process or processes driving the results, are noteworthy to mention. First, the key finding presented in Chapter 3 – physical activity leading to a reduced dilution effect – seems not to be driven by an *improved inhibition of irrelevant information* among the physically active group. A number of studies have found that physical activity can lead to improved inhibitory functions (Barenberg et al., 2011). This in turn could be beneficial in the dilution task where irrelevant information should *not* be taken into account. The idea that physical activity leads to a reduced dilution effect because of an improved inhibition of irrelevant information, was tested in study two. A common measure of inhibitory functions was used – the Stroop Colour Word Interference test. In the Stroop test participants have to inhibit their pre-potent response of reading a colour word on the screen, and instead report the ink colour of the word. Typically, people take more time and make more mistakes during incongruent trials (when ink colour and word don't match) than during congruent trials. I replicated this classic Stroop effect. However, I found no indication that regular exercisers performed any better or worse on the Stroop test than inactive individuals. The analysis included the reaction time and the percentage of correct responses.

Furthermore, if physically active participants were inhibiting the irrelevant information more strongly than inactive participants, I would have expected to find a difference in their memory for the product information. Specifically, I would have expected worse recognition rates and slower reaction times for the irrelevant information in exercisers, in comparison to inactive participants. However, the memory recognition data indicated that this was not the case. There were no differences in recognition rates and reaction times for any type of product information (relevant and irrelevant) between regularly physically active and inactive individuals. This indicates that instead of inhibiting the irrelevant information, regular exercisers possibly considered the irrelevant information in their evaluation of the products but 'down-weighed' the importance to such an extent that it didn't influence their judgments.

Complementary to this, the reduced dilution effect in physically active participants seems to be driven at least partially by a *stronger focus on the relevant information.* In study two I asked participants in the dilution condition directly which information they considered when judging the products. The responses indicated that physically active participants considered a greater number of relevant information than inactive participants. The difference in product rating between physically active and inactive participants became insignificant when I added this variable to the analysis. For the irrelevant information on the other hand, there was no difference between physically active and inactive individuals. Similarly, results from the Necker Cube Pattern Control test in study two indicate that physically active individuals might have generally exerted more directed attention and effort to focus on the task, even when they were not specifically instructed to do so.

The findings in study three also support the notion that the benefit of physical activity in the dilution task is driven by a stronger focus on the relevant information, instead of an inhibition of irrelevant information. Regular exercisers were more likely to indicate they considered the relevant information after they had exercised compared to beforehand (the condition in which they didn't dilute their judgments). Again, there was no difference with regard to the irrelevant information. In the visual search task (where is Wally) regular exercisers performed worse after exercising compared to beforehand. As opposed to the dilution task, an increased focus on the relevant information (i.e., patterns of red and white stripes) can lead to worse performance in the visual search task since it is designed to distract from finding the target. Overall, these results indicate that physically active individuals seem to be better at identifying and focusing on what is important – the relevant piece of information, and were therefore less likely to dilute their product judgments.

Data of the *time* it took participants to make a judgment in study four also sheds light on the potential underlying process which relates physical activity to product judgments in the dilution task. Regular runners did not show a dilution effect when they spent more time on the dilution products than the control products. However, if they took little time to evaluate the information - less time than for the control products - they lowered their product judgments compared to the control products. It seems that people, even if they are physically active, exhibit a dilution effect if they take little time to scrutinize the information and form a judgment. It seems intuitively reasonable to spend more time evaluating the dilution products since four times more information is provided,

even though the information is obviously irrelevant. In contrast to this, Glover (1997) found that time pressure can reduce the dilution effect. However, his finding was in the domain of fraud risk assessments and much more information was provided than for the products used in this thesis.[22] Therefore the results may not be comparable.

Another interesting finding from studies one and two is that the reduced dilution effect seems to be driven by physical activity *during leisure* only and not during work. The GPAQ and IPAQ distinguish between leisure-time physical activity (playing sports, exercising etc.) and physical activity that is part of people's paid or unpaid work (loading furniture, gardening, labouring etc.). I found no indication that physical activity at work has similar effects to leisure time physical activity. As outlined in the discussion of study one, a potential explanation for this could be that the types of physical activity performed during leisure and work are quite different from each other. Leisure time physical activity might entail more prolonged, aerobic activities, while work activity tends to entail shorter strength based activities. Additionally, there are motivational differences between work and leisure time physical activity. Leisure time physical activity requires self-motivated planning and implementation. People who are regularly physically active during their leisure time have the choice not to exercise - but they decide to do it. In order to achieve the goal of engaging in regular leisure time physical activity, they repeatedly have to ignore unimportant information and focus on important information of their decision environment. People who are active as part of their work, usually don't have that choice - being active is a must for them. Decision making that is being trained by engaging in regular leisure time physical activity, might not benefit from engaging in physical activity during work. However, it also has to be noted that the sample size of individuals who indicated to be regularly active at work was relatively small.

The result from Chapter 4 – physical activity leading to a more equal consideration of desirability and feasibility information – could be driven by a shift in individuals' *construal level* after physical activity. It has been shown empirically that people assign greater weight to desirability concerns compared to feasibility concerns with increasing psychological distance (Liberman, Sagristano, & Trope, 2002; Liberman & Trope, 1998). A lower (higher) level of construal should lead to more focus on feasibility (desirability) because desirability represents an abstract construal while feasibility represents a concrete construal. If participants were in a more concrete, low-level mindset after exercising, they

[22] The given time limit in the time pressure condition was three minutes which is much longer than the average amount of time participants spent to judge the product replicates.

should perform better on tasks which require focusing on feasibility features. However in study six and seven, I found no associations between the construal level measures and participants' desirability-feasibility considerations. Although study six and seven indicate that physical activity might lead to a slightly more abstract level of construal, the results were inconclusive. Further, participants' construal level was unrelated to the physical activity effect on desirability-feasibility considerations. If anything, I found the opposite pattern – a more abstract mindset was accompanied by a more equal consideration of desirability and feasibility.

The results on physical activity and desirability-feasibility trade-off considerations could also be explained by an 'economy of action' account, at least partially. This account states that a person's bodily potential to pursue an action can influence the evaluation of opportunities (Proffitt, 2006; Witt, 2011). Possibly, people's bodily potential is lower after physical activity. This might lead to a stronger focus on feasibility attributes since this information indicates how hard or easy it will be to reach the desired object or goal. After an exhausting session of physical activity people's bodily potential could be lower and feasibility information could become more important to consider in the decision making process, even for decisions that apply to future actions. However, this economy of action account can only explain the findings of study six, which investigates the effect of a single bout of physical activity on desirability-feasibility trade-off considerations. It cannot explain the finding that regular physical activity is also associated with a more equal consideration of feasibility and desirability information.

One potential explanation could follow a narrative similar to *the build hypothesis* of positive emotions (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008). Every time people engage in regular physical activity, the feasibility of future actions becomes more important in their decisions. If they exercise regularly, over time this feasibility focus becomes a more chronic way of thinking, leading to less neglect of feasibility information even in situations when no physical activity was performed. In other words, one could argue that over time physical activity makes exercisers become more 'boring' decision makers, who focus more on how *feasible* a future action would be, instead of deciding mostly based on how *desirable* a future action would be. An ideal design to test this proposition would be a longitudinal randomized trial.

5.2 Limitations and Future Research

The set of studies presented in this thesis has a number of limitations which I would like to acknowledge. Instead of relying on more objective measures of regular physical activity like pedometer or accelerometer data, I used an easily applicable and cost-effective self-report questionnaire. Self-reported physical activity data is subjective and can be biased because of people's memory limitations. The reliability and validity of physical activity questionnaires varies with how well people can recall their own behaviour. It is therefore important to specify a time range when asking about people's physical activity habits (e.g. during the last week, how many days did you…). Moreover, the instructions and terms used in the physical activity questionnaire can be misunderstood. Hence, detailed descriptions and pictures of what exactly is meant by moderate and vigorous physical activity in different domains should always be included. Despite the disadvantages, self-report questionnaires offer an easy and inexpensive way to assess physical activity in large samples. Not only can self-report questionnaires provide data on duration, frequency and intensity of physical activity but also on the mode (e.g., physical activity during work or leisure time).

Future studies on the relationship between physical activity and consumer behaviour could complement self-report questionnaires with more objective measures of physical activity, which avoid bias and inaccuracy. Nowadays numerous smartphone applications and wearable devices such as Fitbit and track their owners' physical activity levels and can provide reliable, high-resolution data for researchers (Case, Burwick, Volpp, & Patel, 2015). Relating objective physical activity data to consumer behaviour could help investigate the associations uncovered in this thesis further.

For example, Fitwell[23] is a smartphone application that offers personal fitness coaching. Daily physical activity is measured through the smartphone and personal workouts based on customers' goals and their performance are suggested. Such continuous data of physical activity could be used for a future study in the following way. First, one could investigate whether there is a linear relationship between physical activity and the dilution effect (e.g., a dose response relationship where the more people exercise, the less they dilute their judgments when seeing irrelevant information). Users of the app could be sent an online link to a study investigating product judgments in the dilution paradigm. Data from the study could then be matched with users' physical activity data

[23] www.fitwell.co

in order to run linear regressions. It would be interesting to see whether there exists a linear association between the product ratings in the dilution condition and users physical activity levels (e.g., the more active the users are, the more similar are their ratings are in the dilution and control condition).

Secondly, one could investigate the product judgements of new users who were previously inactive and now started a workout plan. Would their product judgements change over the course of their training? And how long would it take for the physical activity effect on product judgments to eventuate, i.e. when does one become a regular exerciser with associated changes in product judgments? Additionally, one could investigate single bouts of physical activity at different intensities by sending the users a questionnaire just after they have completed a workout. Overall, there is a range of exciting possibilities to leverage the power of physical activity applications in order to investigate the effect of physical activity on consumer decision making.

Study three and six used a quasi-experimental manipulation of physical activity by testing participants before or after they exercised at a gym. It has to be noted that participants were not randomly assigned to the treatment of physical activity. Therefore, I cannot make strict causal inferences about the direction of the effect. While conducting research in the field achieves greater external validity than lab studies, it is also associated with lower internal validity. Investigating the effect of physical activity on consumer behaviour is an important applied research question, hence external validity was a relevant concern to me.

I used an experimental design in study five in order to establish whether there is a causal relationship between a single bout of physical activity and people's product judgments in the dilution task. However, the results showed that the physical activity manipulation did not affect people's product judgments. Using a longer, more vigorous physical activity manipulation would potentially have led to different results, although this remains hypothetical and should be investigated further. Since randomized experiments are the gold standard for establishing causality, future studies should ideally use such experimental designs and randomly assign participants to different, controlled manipulations of physical activity versus a control group. In addition, future studies could conduct experimental field studies in order to establish causality whilst maintaining an environment with a high level of realism.

This could also help to identify potential moderators of the relationship between physical activity and information processing in consumer decision making. In particular,

it would be important to uncover the shape of the relationship. For example, are there any boundary conditions to the amount of exercise? Does exercising too much, to the point of fatigue and exhaustion, lead to poorer decisions? In addition, it would be useful to know whether different types of leisure time physical activity have the same or different effects. More studies investigating moderation effects are needed to identify different boundary conditions (e.g., the type and amount of exercise required to influence information processing).

Moreover, it would be interesting to see whether the benefit of physical activity for information processing can be extended from consumer behaviour to different applied domains which require attribute weighting. For example, future studies could test whether physical activity is also associated with a reduction of the dilution effect in the domain of social perception which Nisbett et al. (1981) originally investigated. Another interesting field for future study could be decision making in situations when particular information should be ignored or not overly influence judgments. One example of this would be hiring decisions. HR personnel often receive information that is not relevant for evaluating a person's job qualification (e.g. religion, marital status etc.). Legal decision making could be another interesting domain to investigate where certain information should not overly influence judgments.

All product judgments and decisions made by participants in the reported studies were hypothetical. This approach, commonly used in psychology, has been criticized for being unrealistic and leading to different choice behaviour than in real situations. Future studies should investigate the effect of physical activity on real choice behaviour. For example, for a real choice desirability-feasibility trade-off, participants could be offered tickets to one of two theme parks as a payment for their participation – with the theme parks varying in terms of their desirability and feasibility. The level of desirability and feasibility of different theme parks would have to be determined by pre-tests of course. Alternatively, after completing an unrelated questionnaire, participants could be given the possibility to complete an additional study. They could be offered the choice between three options: 1) finishing immediately without additional payment; 2) completing an additional *easy* task, such as evaluating ads, for a *low* payment (low desirability, high feasibility); or 3) completing an additional *difficult* task, such as making calculations, for a *high* payment (high desirability, low feasibility). Choice rates could be compared for different physical activity manipulations (single bout or regular physical activity vs. sedentary).

Another limitation of the research in this thesis is that it does not specify the exact process or processes through which physical activity influences consumer decision making. Chapter 2 outlines existing empirical evidence from neuroscience for the effect of physical activity on neurotransmitters as well as physiological brain changes in response to physical activity. It was beyond the scope of this thesis to investigate how these changes triggered by physical activity might specifically relate to information processing in consumer decision making. Drawing on neuro-scientific evidence, I proposed an improvement in information integration as a potential mechanism through which physical activity can influence consumer judgments and decision making. But this theoretical explanation remains hypothetical and is not necessarily the only potential explanation for the findings in this thesis. I tried to shed light on the underlying mechanism by including different process measures and measures of confounding variables. This helped to eliminate a range of potential alternative explanations such as improved inhibition of irrelevant information and differences in construal level.

Several results point to the direction that regular physical activity leads to no or less dilution effect because of an increased focus on relevant information. Instead of asking participants to report how much they focused on the relevant information, a future study could establish a causal direction by manipulating the mediator experimentally (Spencer, Zanna, & Fong, 2005). Below is an outline of potential experimental manipulations of participants' focus on the relevant information. These manipulations can be crossed with measured regular physical activity or other physical activity manipulations (similar to study five).

First, one could introduce a 'working memory load' condition to reduce participants' selective attention on the relevant information (Awh, Vogel, & Oh, 2006; Gazzaley & Nobre, 2012). Participants in this condition would be asked to memorize a certain combination of letters or numbers to tax their working memory whilst they complete the product judgement task. It would be expected that such a manipulation reduces the 'benefit' of regularly physically active participants in the dilution paradigm over inactive participants. Both groups should show a dilution effect under distraction if an improved focus on relevant information is mediating the relationship between regular physical activity and the product judgements.

Secondly, one could introduce a 'goal salience manipulation' similar to Ratneshwar, Warlop, Mick, and Seeger (1997), and add this to the physical activity - dilution paradigm design. Participants in a *high* goal salience condition could receive a

reminder about the importance of the product goal after every product replicate (*"Please remember it is important that you judge the products according to how good they are at delivering the desired benefit. Only focus on what is relevant for the desired benefit").* Such a design would test whether increasing people's focus on goal relevant information also reduces the dilution effect in inactive participants.

Less obtrusively, a disfluency manipulation like using difficult-to-read letters or unusual fonts could be used to draw people's attention to the relevant information. Such disfluency manipulations have been shown to reduce people's reliance on peripheral, irrelevant cues in persuasion. (Alter, Oppenheimer, Epley, & Eyre, 2007).

It is also important to mention that regular physical activity and a single bout of physical activity can be seen as different (although related) independent variables leading to similar results, with regard to desirability-feasibility trade-offs. Two miscellaneous processes could theoretically be responsible for similar outcomes. Future research should try to tackle the underlying process mechanism(s) which is (are) responsible for the changes in consumer decision making caused by physical activity.

As mentioned earlier, future studies could investigate the interplay between a single bout of physical activity, regular physical activity and consumer decision making using a longitudinal, randomized trial, assigning inactive individuals to a long-term physical activity intervention or a waiting-list control group. Altogether there are many exciting directions for future research to investigate.

5.3 Practical Implications

The findings presented in this thesis have important practical implications in the domains of health policy, consumer behaviour as well as management. The presented studies are some of the first to establish an effect of physical activity on judgment and decision making in exercise-unrelated domains. Particularly, an effect of physical activity on decision makers' ability to ignore irrelevant information and to make difficult trade-offs between desirability and feasibility attributes has, to the best of my knowledge, not been shown before in the literature. The findings highlight physical activity as a potential remedy against judgment and decision making biases. Specifically, physical activity can aid decision making in situations where people tend to overestimate the importance of desirability attributes over feasibility attributes, and dilute their judgments when faced with irrelevant information.

Policy implications

The results can be useful to promote uptake of physical activity amongst people who aren't sufficiently motivated by the health benefits. It is a pivotal public policy goal to promote physical activity amongst sedentary people. Physical activity benefits health and reduces the health care costs caused by illnesses which could be avoided by lifestyle changes. The British Heart Foundation (2017) estimates that there are more than 20 million physically inactive adults in the UK. This inactivity leads to annual costs of approximately £1.2 billion for the National Health System. Finding new, creative ways to promote physical activity is crucial to reduce the number of inactive people. The results presented in this thesis can be used to communicate benefits of physical activity that go beyond the continuously reported health messages of physical activity campaigns. Indeed, there seems to be much interest for information about benefits of physical activity that go beyond physical health. For example, among 'The New York Times most-read stories of 2016' is an article on 'which type of exercise is best for the brain'.[24] It is the fifth most read story in 2016 in the science section (Isaacman Bevacqua, Bhaskar, & Debelius, 2016). People are generally interested in research on the benefits of physical activity in new domains. Communicating these benefits might also encourage people who are already physically active to continue their exercise regime.

Marketing implications

Furthermore the results presented in this thesis extend the benefits of physical activity to a new and unrelated domain – consumer product judgments and decision making. Marketing managers can take the findings into account when promoting products to regular exercisers or at exercise facilities such as gyms. For example, instead of focusing primarily on desirability features of products, their feasibility features should be highlighted. This could lead to a more positive product evaluation and higher purchase likelihoods. Additionally, platforms which provide physical activity tracking services, can use this data to advertise 'feasibility products' (e.g., healthy convenience food) after their users show individual peaks of physical activity. For marketers it is also useful to know that regular exercisers might be better able to focus on a particular benefit in products and ignore other benefits that are concurrently advertised. Such an advertisement strategy might lead to less favourable product evaluations among inactive people.

[24]https://well.blogs.nytimes.com/2016/02/17/which-type-of-exercise-is-best-for-the-brain/?mcubz=0

Managerial implications

The findings of this thesis could also have implications for general management since physical activity at work might affect employees' work performance. Improving employees' health and wellbeing has become a trend in the corporate world (Pronk & Kottke, 2009). The National Institute for Health and Care Excellence (2008) published a public health guidance report on how employers and professionals can encourage their employees to be physically active in the workplace. Numerous business organisations already incorporate physical activity initiatives in their workplace environment. Their goal is to reduce workplace stress, to improve physical and mental health, and to prevent work absence of their employees. US businesses spend approximately £3.47 billion per year on employee wellness programs (Spicer & Cederstrom, 2015). Many of them offer cut-price gym fees or work-based exercise facilities. According to Coulson, McKenna, and Field (2008) 48% of "the 100 best companies to work for 2006" provided either an on-site gym, or a subsidised gym membership for their employees. This number increased drastically to 81% over the last nine years.[25] The results from Chapter three indicate that physically active employees might be better equipped to focus on relevant information in their work environment and tune out irrelevant distractions. Employees could time their work-out to occur before tasks which require focused attention and dismissal of irrelevant distractions. It would be interesting to examine these propositions empirically.

The findings in this thesis might also have implication for physically active individuals in leadership positions. Neck and Cooper (2000) report that two thirds of executives from the top 3000 US businesses indicated to exercise at least three times per week, and that they believed this enhanced their ability to lead their companies. The positive effects of physical activity on executives' leadership performance have typically been attributed to reduced levels of stress and anxiety, higher energy levels, and better mental performance. Increased stamina and mental focus is important in leadership since it increases physical and psychological resilience towards work stress. The finding that physical activity can influence how people process different types of information in unrelated domains supports this notion. In highly stressful and demanding work environments, being able to concentrate on what is relevant, while ignoring distractions, can lead to a significant competitive advantage.

[25] http://fortune.com/best-companies/list

The finding that work-related physical activity has no effects on unrelated decision making, highlights the importance of construing physical activity as being an enjoyable activity which is performed for leisure. Companies which require their employees to be physically active during work, could frame the performed work activity as being similar to engaging in leisure physical activity with its associated health benefits. Furthermore, physical activity providers or platforms such as gyms and apps should try to create an environment in which their customers perceive the physical activity as enjoyable and recreational as opposed to seeing it as an unpleasant chore.

To summarize, the finding that physical activity can influence judgments and decision making in unrelated consumer domains could be interesting to physically active individuals and those that want to be physically active, as well as to public health officials who promote physical activity. Furthermore, the results could be also useful to marketers who are advertising their products to physically active individuals, and to managers who encourage their employees to be physically active.

5.4 Concluding Remarks

This thesis documents a novel benefit of engaging in physical activity for judgment and decision making in the consumer domain. This area of research has received very little attention in the past by physical activity researchers as well as psychologists. The results presented in this thesis indicate that engaging in physical activity can change the way consumers 1) form judgments when faced with irrelevant product information, and 2) make decisions that require making trade-offs between desirability and feasibility attributes. Across seven studies it appears that physical activity leads decision makers to weigh different pieces of information more appropriately, controlling for a range of confounding variables. These findings have important implications since they extend the benefits of physical activity to a novel domain – information processing in consumer decision making. Clearly, we need further empirical studies to deepen our understanding of the process mechanism and boundary conditions of this spillover benefit of physical activity on consumer decision making. In the meantime, the findings presented in this thesis should be of interest to anyone who is physically active, or is planning to be so in the future.

References

Ahlskog, J. E., Geda, Y. E., Graff-Radford, N. R., & Petersen, R. C. (2011). Physical Exercise as a Preventive or Disease-Modifying Treatment of Dementia and Brain Aging. *Mayo Clinic Proceedings, 86*(9), 876-884.

Alter, A. L., & Oppenheimer, D. M. (2008). Effects of fluency on psychological distance and mental construal (or why New York is a large city, but New York is a civilized jungle). *Psychological Science, 19*(2), 161-167.

Alter, A. L., Oppenheimer, D. M., Epley, N., & Eyre, R. N. (2007). Overcoming intuition: Metacognitive difficulty activates analytic reasoning. *Journal of Experimental Psychology-General, 136*(4), 569-576.

Awh, E., Vogel, E. K., & Oh, S. H. (2006). Interactions between attention and working memory. *Neuroscience, 139*(1), 201-208.

Balcombe, A., Jones, H., & Deane, A. (2006). Health of the Nation: An in-depth report into UK consumer attitudes to physical exercise. London: Deloitte & Touche LLP.

Barenberg, J., Berse, T., & Dutke, S. (2011). Executive functions in learning processes: Do they benefit from physical activity? *Educational Research Review, 6*(3), 208-222.

Baskin, E., Wakslak, C. J., Trope, Y., & Novemsky, N. (2014). Why Feasibility Matters More to Gift Receivers than to Givers: A Construal-Level Approach to Gift Giving. *Journal of Consumer Research, 41*(1), 169-182.

Bassuk, S. S., & Manson, J. E. (2005). Epidemiological evidence for the role of physical activity in reducing risk of type 2 diabetes and cardiovascular disease. *Journal of Applied Physiology, 99*(3), 1193-1204.

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., Martin, B. W., & Workin, L. P. A. S. (2012). Correlates of physical activity: why are some people physically active and others not? *Lancet, 380*(9838), 258-271.

Beilock, S. L., Carr, T. H., MacMahon, C., & Starkes, J. L. (2002). When paying attention becomes counterproductive: impact of divided versus skill-focused attention on novice and experienced performance of sensorimotor skills. *Journal of Experimental Psychology: Applied, 8*(1), 6.

Best, J. R. (2010). Effects of physical activity on children's executive function: Contributions of experimental research on aerobic exercise. *Developmental Review, 30*(4), 331-351.

Bhargave, R., Chakravarti, A., & Guha, A. (2015). Two-stage decisions increase preference for hedonic options. *Organizational Behavior and Human Decision Processes, 130*, 123-135.

Borg, G. A. V. (1998). *Borg's Perceived Exertion and Pain Scales*. Champaign, IL: Human Kinetics.

Bradley, D. R., & Petry, H. M. (1977). Organizational Determinants of Subjective Contour - Subjective Necker Cube. *American Journal of Psychology, 90*(2), 253-262.

British Heart Foundation. (2017). Physical Inactivity and Sedentary Behaviour Report 2017.

Bull, F. C., Maslin, T. S., & Armstrong, T. (2009). Global Physical Activity Questionnaire (GPAQ): Nine Country Reliability and Validity Study. *Journal of Physical Activity & Health, 6*(6), 790-804.

Case, M. A., Burwick, H. A., Volpp, K. G., & Patel, M. S. (2015). Accuracy of Smartphone Applications and Wearable Devices for Tracking Physical Activity Data. *Jama-Journal of the American Medical Association, 313*(6), 625-626.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical-Activity, Exercise, and Physical-Fitness - Definitions and Distinctions for Health-Related Research. *Public Health Reports, 100*(2), 126-131.

Chang, C. C. A., & Lin, Y. C. (2015). Physical activity and food consumption: The moderating role of individual dieting tendency. *Journal of Health Psychology, 20*(5), 490-499.

Cohen, J. B., Belyavsky, J., & Silk, T. (2008). Using visualization to alter the balance between desirability and feasibility during choice. *Journal of Consumer Psychology, 18*(4), 270-275.

Coulson, J. C., McKenna, J., & Field, M. (2008). Exercising at work and self-reported work performance. *International Journal of Workplace Health Management, 1*(3), 176-197.

Cranford, J. A., Shrout, P. E., Iida, M., Rafaeli, E., Yip, T., & Bolger, N. (2006). A procedure for evaluating sensitivity to within-person change: Can mood measures

in diary studies detect change reliably? *Personality and Social Psychology Bulletin, 32*(7), 917-929.

Crum, A. J., & Langer, E. J. (2007). Mind-set matters: Exercise and the placebo effect. *Psychological Science, 18*(2), 165-171.

Davies, S., Burns, H., Jewell, T., & McBride, M. (2011). Start Active, Stay Active. A report on physical activity for health from the four home countries: Chief Medical Officers.

Davis, C. L., Tomporowski, P. D., McDowell, J. E., Austin, B. P., Miller, P. H., Yanasak, N. E., . . . Naglieri, J. A. (2011). Exercise Improves Executive Function and Achievement and Alters Brain Activation in Overweight Children: A Randomized, Controlled Trial. *Health Psychology, 30*(1), 91-98.

de Vries, G., Terwel, B. W., & Ellemers, N. (2014). Spare the details, share the relevance: The dilution effect in communications about carbon dioxide capture and storage. *Journal of Environmental Psychology, 38*, 116-123.

deDreu, C. K. W., Yzerbyt, V. Y., & Leyens, J. P. (1995). Dilution of stereotype-based cooperation in mixed-motive interdependence. *Journal of Experimental Social Psychology, 31*(6), 575-593.

Dietrich, A., & Audiffren, M. (2011). The reticular-activating hypofrontality (RAH) model of acute exercise. *Neuroscience and Biobehavioral Reviews, 35*(6), 1305-1325.

Ekstrom, R. B., French, J. W., Harman, H. H., & Dermen, D. (1976). *Manual for kit of factor-referenced cognitive tests*. Princeton, NJ: Educational testing service.

Erickson, K. I., & Kramer, A. F. (2009). Aerobic exercise effects on cognitive and neural plasticity in older adults. *British Journal of Sports Medicine, 43*(1), 22-24.

Escalas, J. E., & Luce, M. F. (2004). Understanding the effects of process-focused versus outcome-focused thought in response to advertising. *Journal of Consumer Research, 31*(2), 274-285.

Fenzl, N., Bartsch, K., & Koenigstorfer, J. (2014). Labeling exercise fat-burning increases post-exercise food consumption in self-imposed exercisers. *Appetite, 81*, 1-7.

Floel, A., Ruscheweyh, R., Kruger, K., Willemer, C., Winter, B., Volker, K., . . . Knecht, S. (2010). Physical activity and memory functions: Are neurotrophins and cerebral gray matter volume the missing link? *Neuroimage, 49*(3), 2756-2763.

Fontana, F. E., & Pittsburgh, U. o. (2007). *The Effects of Exercise Intensity on Decision Making Performance of Experienced and Inexperienced Soccer Players*: University of Pittsburgh.

Fox, K. R. (1999). The influence of physical activity on mental well-being. *Public Health Nutrition, 2*(3a), 411-418.

Fredrickson, B. L., Cohn, M. A., Coffey, K. A., Pek, J., & Finkel, S. M. (2008). Open Hearts Build Lives: Positive Emotions, Induced Through Loving-Kindness Meditation, Build Consequential Personal Resources. *Journal of Personality and Social Psychology, 95*(5), 1045-1062.

Freitas, A. L., Gollwitzer, P., & Trope, Y. (2004). The influence of abstract and concrete mindsets on anticipating and guiding others' self-regulatory efforts. *Journal of Experimental Social Psychology, 40*(6), 739-752.

Fujita, K., Henderson, M. D., Eng, J., Trope, Y., & Liberman, N. (2006). Spatial distance and mental construal of social events. *Psychological Science, 17*(4), 278-282.

Furley, P., & Memmert, D. (2011). Studying cognitive adaptations in the field of sport: broad or narrow transfer? A comment on Allen, Fioratou, and McGeorge (2011). *Perceptual and Motor Skills, 113*(2), 481-488.

Gazzaley, A., & Nobre, A. C. (2012). Top-down modulation: bridging selective attention and working memory. *Trends in Cognitive Sciences, 16*(2), 129-135.

Gierl, H., & Huettl, V. (2012). How does verbal non-diagnostic information affect product evaluation? *Review of Managerial Science, 6*(2), 131-159.

Gigerenzer, G. (2008). Why Heuristics Work. *Perspectives on Psychological Science, 3*(1), 20-29.

Glover, S. M. (1997). The influence of time pressure and accountability on auditors' processing of nondiagnostic information. *Journal of Accounting Research, 35*(2), 213-226.

Goodman, J. K., & Malkoc, S. A. (2012). Choosing Here and Now versus There and Later: The Moderating Role of Psychological Distance on Assortment Size Preferences. *Journal of Consumer Research, 39*(4), 751-768.

Gosling, S. D., Rentfrow, P. J., & Swann, W. B. (2003). A very brief measure of the Big-Five personality domains. *Journal of Research in Personality, 37*(6), 504-528.

Green, C. S., & Bavelier, D. (2006). Enumeration versus multiple object tracking: the case of action video game players. *Cognition, 101*(1), 217-245.

Grice, P. H. (1975). Logic and conversation. In P. Cole & J. L. Morgan (Eds.), *Speech Acts* (pp. 41-58). New York: Academic Press.

Guilford, J. P. (1967). Creativity - Yesterday, Today, and Tomorrow. *Journal of Creative Behavior, 1*(1), 3-14.

Hackenbrack, K. (1992). Implications of Seemingly Irrelevant Evidence in Audit Judgment. *Journal of Accounting Research, 30*(1), 126-136.

Hafenbrack, A. C., Kinias, Z., & Barsade, S. G. (2014). Debiasing the Mind Through Meditation: Mindfulness and the Sunk-Cost Bias. *Psychological Science, 25*(2), 369-376.

Hagstromer, M., Oja, P., & Sjostrom, M. (2006). The International Physical Activity Questionnaire (IPAQ): a study of concurrent and construct validity. *Public Health Nutrition, 9*(6), 755-762.

Hansen, C. J., Stevens, L. C., & Coast, J. R. (2001). Exercise duration and mood state: How much is enough to feel better? *Health Psychology, 20*(4), 267-275.

Heisz, J. J., Clark, I. B., Bonin, K., Paolucci, E. M., Michalski, B., Becker, S., & Fahnestock, M. (2017). The Effects of Physical Exercise and Cognitive Training on Memory and Neurotrophic Factors. *Journal of Cognitive Neuroscience, 29*(11), 1895-1907.

Higgins, E. T., Friedman, R. S., Harlow, R. E., Idson, L. C., Ayduk, O. N., & Taylor, A. (2001). Achievement orientations from subjective histories of success: promotion pride versus prevention pride. *European Journal of Social Psychology, 31*(1), 3-23.

Higgins, E. T., Roney, C. J. R., Crowe, E., & Hymes, C. (1994). Ideal Versus Ought Predilections for Approach and Avoidance - Distinct Self-Regulatory Systems. *Journal of Personality and Social Psychology, 66*(2), 276-286.

Hillman, Erickson, K. I., & Kramer, A. F. (2008). Be smart, exercise your heart: exercise effects on brain and cognition. *Nature Reviews Neuroscience, 9*(1), 58-65.

Hillman, C. H., Pontifex, M. B., Castelli, D. M., Khan, N. A., Raine, L. B., Scudder, M. R., . . . Kamijo, K. (2014). Effects of the FITKids Randomized Controlled Trial on Executive Control and Brain Function. *Pediatrics, 134*(4), e1063-e1071.

Hoffman, V. B., & Patton, J. M. (1997). Accountability, the dilution effect, and conservatism in auditors' fraud judgments. *Journal of Accounting Research, 35*(2), 227-237.

Hopkins, M. E., Davis, F. C., Vantieghem, M. R., Whalen, P. J., & Bucci, D. J. (2012). Differential Effects of Acute and Regular Physical Exercise on Cognition and Affect. *Neuroscience, 215*, 59-68.

Igou, E. R. (2007). Additional thoughts on conversational and motivational sources of the dilution effect. *Journal of Language and Social Psychology, 26*(1), 61-68.

Igou, E. R., & Bless, H. (2005). The conversational basis for the dilution effect. *Journal of Language and Social Psychology, 24*(1), 25-35.

Ilicic, J., & Webster, C. M. (2013). Celebrity co-branding partners as irrelevant brand information in advertisements. *Journal of Business Research, 66*(7), 941-947.

Isaacman Bevacqua, A., Bhaskar, S., & Debelius, D. (2016). The Most-Read Stories of 2016. from https://www.nytimes.com/interactive/2016/12/19/business/media/top-stories.html

Jacobson, J., & Matthaeus, L. (2014). Athletics and executive functioning: How athletic participation and sport type correlate with cognitive performance. *Psychology of Sport and Exercise, 15*(5), 521-527.

Johnson, J. G. (2006). Cognitive modeling of decision making in sports. *Psychology of Sport and Exercise, 7*(6), 631-652.

Johnson, J. G., & Raab, M. (2003). Take the first: Option-generation and resulting choices. *Organizational Behavior and Human Decision Processes, 91*(2), 215-229.

Joireman, J., Shaffer, M. J., Balliet, D., & Strathman, A. (2012). Promotion Orientation Explains Why Future-Oriented People Exercise and Eat Healthy: Evidence From the Two-Factor Consideration of Future Consequences-14 Scale. *Personality and Social Psychology Bulletin, 38*(10), 1272-1287.

Kamijo, K., Pontifex, M. B., O'Leary, K. C., Scudder, M. R., Wu, C. T., Castelli, D. M., & Hillman, C. H. (2011). The effects of an afterschool physical activity program on working memory in preadolescent children. *Developmental Science, 14*(5), 1046-1058.

Kemmelmeier, M. (2007a). Does the dilution effect have a conversational basis? *Journal of Language and Social Psychology, 26*(1), 48-60.

Kemmelmeier, M. (2007b). Is diagnostic evidence on the dilution effect weakened when nondiagnostic objections are added? A response to Igou (2007). *Journal of Language and Social Psychology, 26*(1), 69-74.

Khan, U., & Dhar, R. (2006). Licensing effect in consumer choice. *Journal of Marketing Research, 43*(2), 259-266.

Kim, H., Lee, S. H., Kim, S. S., Yoo, J. H., & Kim, C. J. (2007). The influence of maternal treadmill running short-term memory and hippocampal cell during pregnancy on survival in rat pups. *International Journal of Developmental Neuroscience, 25*(4), 243-249.

Kramer, A. F., & Erickson, K. I. (2007). Capitalizing on cortical plasticity: influence of physical activity on cognition and brain function. *Trends in Cognitive Sciences, 11*(8), 342-348.

Kruglanski, A. W., Pierro, A., & Sheveland, A. (2011). How many roads lead to Rome? Equifinality set-size and commitment to goals and means. *European Journal of Social Psychology, 41*(3), 344-352.

Kruglanski, A. W., Thompson, E. P., Higgins, E. T., Atash, M. N., Pierro, A., Shah, J. Y., & Spiegel, S. (2000). To "do the right thing" or to "just do it": Locomotion and assessment as distinct self-regulatory imperatives. *Journal of Personality and Social Psychology, 79*(5), 793-815.

Lathia, N., Sandstrom, G. M., Mascolo, C., & Rentfrow, P. J. (2017). Happier People Live More Active Lives: Using Smartphones to Link Happiness and Physical Activity. *Plos One, 12*(1), e0160589.

Latimer, A. E., Rivers, S. E., Rench, T. A., Katulak, N. A., Hicks, A., Hodorowski, J. K., . . . Salovey, P. (2008). A field experiment testing the utility of regulatory fit messages for promoting physical activity. *Journal of Experimental Social Psychology, 44*(3), 826-832.

Lee, C. S., Huggins, A. C., & Therriault, D. J. (2014). A Measure of Creativity or Intelligence? Examining Internal and External Structure Validity Evidence of the Remote Associates Test. *Psychology of Aesthetics Creativity and the Arts, 8*(4), 446-460.

Liberman, N., Sagristano, M. D., & Trope, Y. (2002). The effect of temporal distance on level of mental construal. *Journal of Experimental Social Psychology, 38*(6), 523-534.

Liberman, N., & Trope, Y. (1998). The role of feasibility and desirability considerations in near and distant future decisions: A test of temporal construal theory. *Journal of Personality and Social Psychology, 75*(1), 5-18.

Liu, F. Q., Sulpizio, S., Kornpetpanee, S., & Job, R. (2017). It takes biking to learn: Physical activity improves learning a second language. *Plos One, 12*(5).

Liu, W. (2008). Focusing on Desirability: The Effect of Decision Interruption and Suspension on Preferences. *Journal of Consumer Research, 35*(4), 640-652.

Malaviya, P., & Sternthal, B. (2009). Parity Product Features Can Enhance or Dilute Brand Evaluation: The Influence of Goal Orientation and Presentation Format. *Journal of Consumer Research, 36*(1), 112-121.

Mann, D. T. Y., Williams, A. M., Ward, P., & Janelle, C. M. (2007). Perceptual-cognitive expertise in sport: A meta-analysis. *Journal of Sport & Exercise Psychology, 29*(4), 457-478.

McMorris, T., & Graydon, J. (1996a). The effect of exercise on the decision-making performance of experienced and inexperienced soccer players. *Research Quarterly for Exercise and Sport, 67*(1), 109-114.

McMorris, T., & Graydon, J. (1996b). Effects of exercise on soccer decision-making tasks of differing complexities. *Journal of Human Movement Studies, 30*, 177-193.

McMorris, T., & Graydon, J. (1997). The effect of exercise on cognitive performance in soccer-specific tests. *Journal of Sports Sciences, 15*(5), 459-468.

McMorris, T., Myers, S., MacGillivary, W. W., Sexsmith, J. R., Fallowfield, J., Graydon, J., & Forster, D. (1999). Exercise, plasma catecholamine concentrations and decision-making performance of soccer players on a soccer-specific test. *Journal of Sports Sciences, 17*(8), 667-676.

Mednick, S. A. (1968). Remote Associates Test. *Journal of Creative Behavior, 2*(3), 213-214.

Meyvis, T., & Janiszewski, C. (2002). Consumers' beliefs about product benefits: the effect of obviously irrelevant product information. *Journal of Consumer Research, 28*(4), 618-635.

Moore, S. C., Lee, I. M., Weiderpass, E., Campbell, P. T., Sampson, J. N., Kitahara, C. M., . . . Patel, A. V. (2016). Association of Leisure-Time Physical Activity With Risk of 26 Types of Cancer in 1.44 Million Adults. *Jama Internal Medicine, 176*(6), 816-825.

Morris, J. N., Heady, J. A., Raffle, P. A. B., Roberts, C. G., & Parks, J. W. (1953). Coronary Heart-Disease and Physical Activity of Work. *Lancet, 265*(Nov28), 1111-1120.

Mullen, S. P., & Hall, P. A. (2015). Editorial: Physical activity, self-regulation, and executive control across the lifespan. *Frontiers in Human Neuroscience, 9*.

National Institute for Health and Care Excellence. (2008). Promoting physical activity in the workplace.

Neck, C. P., & Cooper, K. H. (2000). The fit executive: Exercise and diet guidelines for enhancing performance. *Academy of Management Executive, 14*(2), 72-83.

Neuberg, S. L., & Newsom, J. T. (1993). Personal Need for Structure - Individual-Differences in the Desire for Simple Structure. *Journal of Personality and Social Psychology, 65*(1), 113-131.

Nigg, C., Jordan, J., & Atkins, A. (2012). Behavioral Measurement in Exercise Psychology. In G. Tenenbaum, R. Eklund, & A. Kamata (Eds.), *Measurement in Sport and Exercise Psychology* (pp. 455-464). Champaign, IL: Human Kinetics.

Nisbett, R. E., & Wilson, T. D. (1977). Telling More Than We Can Know - Verbal Reports on Mental Processes. *Psychological Review, 84*(3), 231-259.

Nisbett, R. E., Zukier, H., & Lemley, R. E. (1981). The dilution effect: Nondiagnostic information weakens the implications of diagnostic information. *Cognitive Psychology, 13*(2), 248-277.

Nokia, M. S., Lensu, S., Ahtiainen, J. P., Johansson, P. P., Koch, L. G., Britton, S. L., & Kainulainen, H. (2016). Physical exercise increases adult hippocampal neurogenesis in male rats provided it is aerobic and sustained. *Journal of Physiology-London, 594*(7), 1855-1873.

Northey, J. M., Cherbuin, N., Pumpa, K. L., Smee, D. J., & Rattray, B. (2017). Exercise interventions for cognitive function in adults older than 50: a systematic review with meta-analysis. *British Journal of Sports Medicine*.

Oppezzo, M., & Schwartz, D. L. (2014). Give your ideas some legs: the positive effect of walking on creative thinking. *J Exp Psychol Learn Mem Cogn, 40*(4), 1142-1152.

Pereira, A. C., Huddleston, D. E., Brickman, A. M., Sosunov, A. A., Hen, R., McKhann, G. M., . . . Small, S. A. (2007). An in vivo correlate of exercise-induced neurogenesis in the adult dentate gyrus. *Proceedings of the National Academy of Sciences of the United States of America, 104*(13), 5638-5643.

Peters, E., & Rothbart, M. (2000). Typicality can create, eliminate, and reverse the dilution effect. *Personality and Social Psychology Bulletin, 26*(2), 177-187.

Proffitt, D. R. (2006). Embodied Perception and the Economy of Action. *Perspect Psychol Sci, 1*(2), 110-122.

Pronk, N. P., & Kottke, T. E. (2009). Physical activity promotion as a strategic corporate priority to improve worker health and business performance. *Preventive Medicine, 49*(4), 316-321.

Raab, M., & Johnson, J. G. (2008). Implicit Learning as a Means to Intuitive Decision Making in Sports. *Intuition in Judgment and Decision Making*, 119-133.

Raichlen, D. A., Bharadwaj, P. K., Fitzhugh, M. C., Haws, K. A., Torre, G. A., Trouard, T. P., & Alexander, G. E. (2016). Differences in Resting State Functional Connectivity between Young Adult Endurance Athletes and Healthy Controls. *Front Hum Neurosci, 10*, 610.

Rammstedt, B., & John, O. P. (2007). Measuring personality in one minute or less: A 10-item short version of the Big Five Inventory in English and German. *Journal of Research in Personality, 41*(1), 203-212.

Ratneshwar, S., Warlop, L., Mick, D. G., & Seeger, G. (1997). Benefit salience and consumers' selective attention to product features. *International Journal of Research in Marketing, 14*(3), 245-259.

Raue, M., Streicher, B., Lermer, E., & Frey, D. (2015). Being active when judging risks: bodily states interfere with accurate risk analysis. *Journal of Risk Research*, 1-18.

Rhodes, R. E., & Smith, N. E. I. (2006). Personality correlates of physical activity: a review and meta-analysis. *British Journal of Sports Medicine, 40*(12), 958-965.

Ruscheweyh, R., Willemer, C., Kruger, K., Duning, T., Warnecke, T., Sommer, J., . . . Floel, A. (2011). Physical activity and memory functions: An interventional study. *Neurobiology of Aging, 32*(7), 1304-1319.

Sagristano, M. D., Trope, Y., & Liberman, N. (2002). Time-dependent gambling: Odds now, money later. *Journal of Experimental Psychology-General, 131*(3), 364-376.

Shacham, S. (1983). A Shortened Version of the Profile of Mood States. *Journal of Personality Assessment, 47*(3), 305-306.

Simoes, E. J., Byers, T., Coates, R. J., Serdula, M. K., Mokdad, A. H., & Heath, G. W. (1995). The Association between Leisure-Time Physical-Activity and Dietary-Fat in American Adults. *American Journal of Public Health, 85*(2), 240-244.

Simonson, I., Nowlis, S., & Simonson, Y. (1993). The effect of irrelevant preference arguments on consumer choice. *Journal of Consumer Psychology, 2*(3), 287-306.

Skinner, J. S., & Mclellan, T. H. (1980). The Transition from Aerobic to Anaerobic Metabolism. *Research Quarterly for Exercise and Sport, 51*(1), 234-248.

Smith, H. D., Stasson, M. F., & Hawkes, W. G. (1998). Dilution in legal decision making: Effect of non-diagnostic information in relation to amount of diagnostic evidence. *Current Psychology, 17*(4), 333-345.

Smith, P. J., Blumenthal, J. A., Hoffman, B. M., Cooper, H., Strauman, T. A., Welsh-Bohmer, K., . . . Sherwood, A. (2010). Aerobic Exercise and Neurocognitive Performance: A Meta-Analytic Review of Randomized Controlled Trials. *Psychosomatic Medicine, 72*(3), 239-252.

Spencer, S. J., Zanna, M. P., & Fong, G. T. (2005). Establishing a causal chain: Why experiments are often more effective than mediational analyses in examining psychological processes. *Journal of Personality and Social Psychology, 89*(6), 845-851.

Sperber, D., & Wilson, D. (1986). *Relevance : communication and cognition*. Cambridge, Mass.: Harvard University Press.

Spicer, A., & Cederstrom, C. (2015). Under the whip of wellness. *New Scientist, 225*(3009), 26-27.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18*, 643-662.

Sullivan, J. R., Riccio, C. A., & Castillo, C. L. (2009). Concurrent validity of the tower tasks as measures of executive function in adults: a meta-analysis. *Applied Neuropsychology, 16*(1), 62-75.

Sweeney, A. M., & Freitas, A. L. (2014). Relating action to abstract goals increases physical activity reported a week later. *Psychology of Sport and Exercise, 15*(4), 364-373.

Tenenbaum, G., Yuval, R., Elbaz, G., Bareli, M., & Weinberg, R. (1993). The Relationship between Cognitive Characteristics and Decision-Making. *Canadian Journal of Applied Physiology-Revue Canadienne De Physiologie Appliquee, 18*(1), 48-62.

Tetlock, P. E., & Boettger, R. (1989). Accountability - a Social Magnifier of the Dilution Effect. *Journal of Personality and Social Psychology, 57*(3), 388-398.

Thomas, S., Reading, J., & Shephard, R. J. (1992). Revision of the Physical-Activity Readiness Questionnaire (Par-Q). *Canadian Journal of Sport Sciences-Revue Canadienne Des Sciences Du Sport, 17*(4), 338-345.

Thompson, D. V., Hamilton, R. W., & Rust, R. T. (2005). Feature fatigue: When product capabilities become too much of a good thing. *Journal of Marketing Research, 42*(4), 431-442.

Tomporowski, P. D. (2003). Effects of acute bouts of exercise on cognition. *Acta Psychologica, 112*(3), 297-324.

Trope, Y., & Liberman, N. (2010). Construal-Level Theory of Psychological Distance. *Psychological Review, 117*(2), 440-463.

Troutman, C. M., & Shanteau, J. (1977). Inferences Based on Nondiagnostic Information. *Organizational Behavior and Human Performance, 19*(1), 43-55.

Tuk, M. A., Zhang, K. J., & Sweldens, S. (2015). The Propagation of Self-Control: Self-Control in One Domain Simultaneously Improves Self-Control in Other Domains (vol 144, pg 639, 2015). *Journal of Experimental Psychology-General, 144*(3).

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty - Heuristics and Biases. *Science, 185*(4157), 1124-1131.

Vallacher, R. R., & Wegner, D. M. (1987). What Do People Think Theyre Doing - Action Identification and Human-Behavior. *Psychological Review, 94*(1), 3-15.

Vallacher, R. R., & Wegner, D. M. (1989). Levels of Personal Agency - Individual Variation in Action Identification. *Journal of Personality and Social Psychology, 57*(4), 660-671.

van Kleef, E., Shimizu, M., & Wansink, B. (2011). Food compensation: do exercise ads change food intake? *International Journal of Behavioral Nutrition and Physical Activity, 8*.

Voss, M. W., Kramer, A. F., Basak, C., Prakash, R. S., & Roberts, B. (2010). Are Expert Athletes 'Expert' in the Cognitive Laboratory? A Meta-Analytic Review of Cognition and Sport Expertise. *Applied Cognitive Psychology, 24*(6), 812-826.

Wan, E. W., & Agrawal, N. (2011). Carryover Effects of Self-Control on Decision Making: A Construal-Level Perspective. *Journal of Consumer Research, 38*(1), 199-214.

Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: the evidence. *Canadian Medical Association Journal, 174*(6), 801-809.

Weber, E. U., Baron, J., & Loomes, G. (2001). *Conflict and tradeoffs in decision making*. Cambridge, U.K. ; New York: Cambridge University Press.

Wegner, D. M., Vallacher, R. R., Kiersted, G. W., & Dizadji, D. (1986). Action Identification in the Emergence of Social-Behavior. *Social Cognition, 4*(1), 18-38.

Werle, C. O. C., Wansink, B., & Payne, C. R. (2011). Just thinking about exercise makes me serve more food. Physical activity and calorie compensation. *Appetite, 56*(2), 332-335.

Werle, C. O. C., Wansink, B., & Payne, C. R. (2015). Is it fun or exercise? The framing of physical activity biases subsequent snacking. *Marketing Letters, 26*(4), 691-702.

Wiltermuth, S. S., & Neale, M. A. (2011). Too Much Information: The Perils of Nondiagnostic Information in Negotiations. *Journal of Applied Psychology, 96*(1), 192-201.

Witt, J. K. (2011). Action's Effect on Perception. *Current Directions in Psychological Science, 20*(3), 201-206.

Woods, A. T., Velasco, C., Levitan, C. A., Wan, X. A., & Spence, C. (2015). Conducting perception research over the internet: a tutorial review. *Peerj, 3*.

World Health Organization. (2010) *Global Recommendations on Physical Activity for Health*. Geneva.

Zhou, R. R., & Pham, M. T. (2004). Promotion and prevention across mental accounts: When financial products dictate consumers' investment goals. *Journal of Consumer Research, 31*(1), 125-135.

Appendices

Appendix A. Dilution Effect Stimuli

General instructions for the product judgment task

You will now receive information about seven different products or services. Your task is to indicate whether the product or service delivers a particular benefit.

First, you will receive information about what kind of product you are looking for. Next, you will see a description of the product. Then you will have to judge whether the product delivers a particular benefit on a rating scale ranging from 0 to 100.

The information you receive about the product or service may or may not be helpful for the decisions that you have to make.

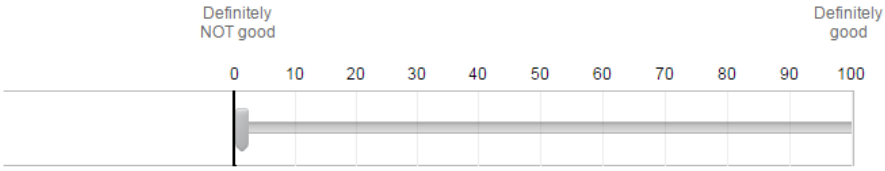
Example product replicate in the control condition (relevant information only)

You are looking for a toothpaste that is good at fighting cavities.

Toothpaste description:

Recommended by the American Dental Association

Is this toothpaste good at fighting cavities?



Example product replicate in the dilution condition (relevant + irrelevant information)

You are looking for a toothpaste that is good at fighting cavities.

Toothpaste description:

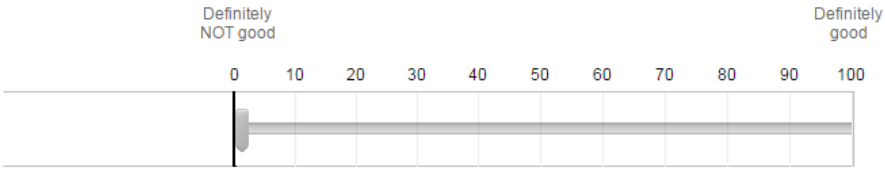
Recommended by the American Dental Association

Comes in 6 oz. tubes

Brand is owned by P&G

Comes in kid and adult version

Is this toothpaste good at fighting cavities?



Overview of product information; changes for UK samples in brackets

Product category	Apartment
Desired benefit	Safe
Supportive information	24 hours on-site security
Irrelevant information	Complex name: Haywood Park
	40-year old manager
	Both 1 & 2 bedroom apartments
Product category	Airline
Desired benefit	Superior service
Supportive information	Number 1 in JD Power & Associates survey on airline service
Irrelevant information	Sponsors the New York City Marathon
	Company founded in 1978
	Corporate headquarters in Boston
Product category	Computer
Desired benefit	Fast
Supportive information	Very powerful processor
Irrelevant information	Manufactured in the USA
	Air commercials on NBC and CBS *(BBC and Channel 4)*
	Can be ordered on-line
Product category	Stereo System
Desired benefit	Reliable
Supportive information	Lifetime warranty
Irrelevant information	Original design
	Includes double tape *(CD)* deck
	Comes in black and grey
Product category	Package Delivery Service
Desired benefit	Fast
Supportive information	14 hour delivery or money-back guarantee
Irrelevant information	Sponsors art events
	Corporate headquarters in Chicago
	Company founded in 1972

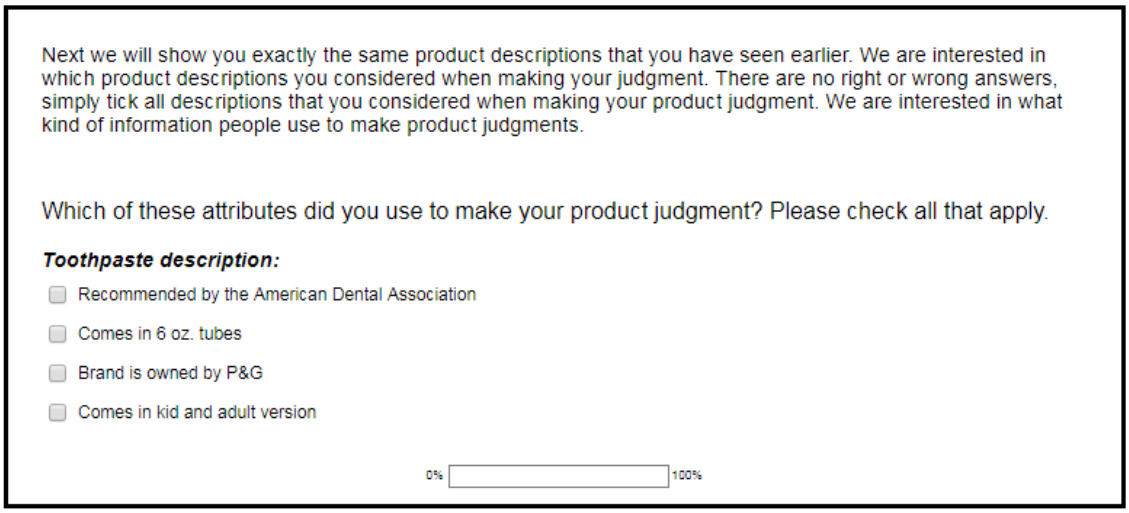
Product category	Toothpaste
Desired benefit	Good at fighting cavities
Supportive information	Recommended by the American *(British)* Dental Association
Irrelevant information	Comes in 6 oz. tubes
	Brand is owned by P&G *(Unilever)*
	Comes in kid and adult version
Product category	Car
Desired benefit	Sporty
Supportive information	Very powerful engine
Irrelevant information	Dark blue colour
	Dual airbags
	Average resale value

Product information recognition task: overview of information

Product category	Toothpaste
Supportive old	Recommended by the American Dental Association
Supportive new	Contained fluoride and calcium
Irrelevant old	Comes in 6 oz. tubes
Irrelevant new	Available in most grocery stores
Product category	Car
Supportive old	Very Powerful Engine
Supportive new	Fast Acceleration
Irrelevant old	Dark Blue Colour
Irrelevant new	Comes with a spare tire
Product category	Apartment
Supportive old	24 hour on-site security
Supportive new	Located in a gated community
Irrelevant old	40-year old manager
Irrelevant new	Has a parking space

Product category	Airline
Supportive old	Number 1 in JD Power & Associates survey on airline service
Supportive new	Provided hot towels to freshen up
Irrelevant old	Corporate headquarters in Boston
Irrelevant new	Offers international and domestic flights
Product category	Computer
Supportive old	Very powerful processor
Supportive new	Lot of RAM
Irrelevant old	Manufactured in the USA
Irrelevant new	Has a DVD player
Product category	Stereo system
Supportive old	Lifetime warranty
Supportive new	Produced with high-quality materials
Irrelevant old	Comes in black and grey
Irrelevant new	Named after a popular musician
Product category	Delivery service
Supportive old	14 hour delivery or money-back guarantee
Supportive new	Specialized in urgent same day deliveries
Irrelevant old	Founded in 1972
Irrelevant new	Family-owned business

‘Information considered’ instructions and sample item



Product information goal recall instructions and sample item

Now we want you to remember **what kind** of product you were looking for.

For example, you were looking for a toothpaste that is ___?___.

Please click "next" to see the product.

You were looking for a **delivery service** that is _____.

Please remember **what kind of delivery service** you were looking for and answer in the text box. If you don't know the answer, leave the text box empty.

Appendix B. International Physical Activity Questionnaire

IPAQ instructions

PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The following questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**.

Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal.

Moderate physical activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

Example question for vigorous intensity physical activity during leisure time

The next questions exclude the work and transport activities that you have already mentioned.
Now I would like to ask you about **sports, fitness and recreational activities (leisure)**.

Vigorous Intensity Activities make you breathe much harder than normal.

Examples for **VIGOROUS** activities during **LEISURE TIME:**

- Soccer
- Rugby
- Tennis
- High-impact aerobics
- Aqua aerobics
- Ballet dancing
- Fast swimming
- Fast running, sprinting

The images that were shown here can be found on page 3 under:

http://www.who.int/ncds/surveillance/steps/GPAQ_GenericShowCards.pdf?ua=1

Do you do any vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate like running or football, for at least 10 minutes continuously?

- ○ Yes
- ○ No

Questions on frequency and duration of vigorous-intensity leisure activity per week

In a typical week, on how many days do you do vigorous- intensity sports, fitness or recreational (leisure) activities?

How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on such a typical day?

Hours	
Minutes	

0% 100%

Example question for moderate intensity physical activity during leisure time

Moderate intensity activities make you breathe somewhat harder than normal.

Examples for **MODERATE** activities during **LEISURE** TIME:

- Cycling, Jogging
- Dancing
- Horse-riding
- Tai chi, Yoga, Pilates
- Low-impact aerobics
- Cricket

The images that were shown here can be found on page 4 under:

http://www.who.int/ncds/surveillance/steps/GPAQ_GenericShowCards.pdf?ua=1

Again, think about only those physical activities that you did for at least 10 minutes at a time.

During the **last 7 days**, on how many days did you do **moderate** physical activities like dancing at a regular pace, swimming at a regular pace, and doubles tennis in your **leisure** time?

Questions on duration of moderate-intensity leisure activity per week

How much time did you usually spend on one of those days doing **moderate** physical activities in your **leisure** time?

Hours per day:

0 hours

Minutes per day:

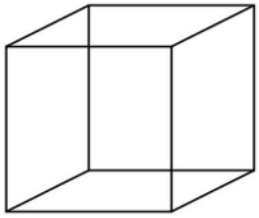
0 minutes

Appendix C. Necker Cube Pattern Control Test

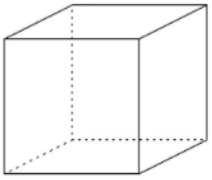
Instructions

Visual Perception Study

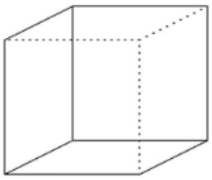
The next study is about people's spatial perception of simple drawings. Below you can see a drawing of a **cube** which will be used for this next task. If you look at the cube long enough it will seem to flip between two patterns. Some people find it easier to see the change in patterns if the first focus in the middle of the image. Try it out yourself!



For some people the two patterns flick back and forth quickly, and for other the change in orientation happens slowly. Below you find two drawing which illustrate the two different perspectives you can see the cube from.



'Left facing' cube



'Top facing' cube

0% 100%

Instruction in the baseline condition

YOU ARE NOW READY TO DO THE ACTUAL TASK

When you click the "next" button below you will be taken to a new page where the cube will appear and stay on the screen for 30 seconds.

Once the cube appears your task is to note when the pattern changes by pressing the "1" key at the top of your keyboard.

When you are ready to start the task, click the "next" button.

Instructions in the pattern control condition

PLEASE READ THE NEW INSTRUCTION BELOW

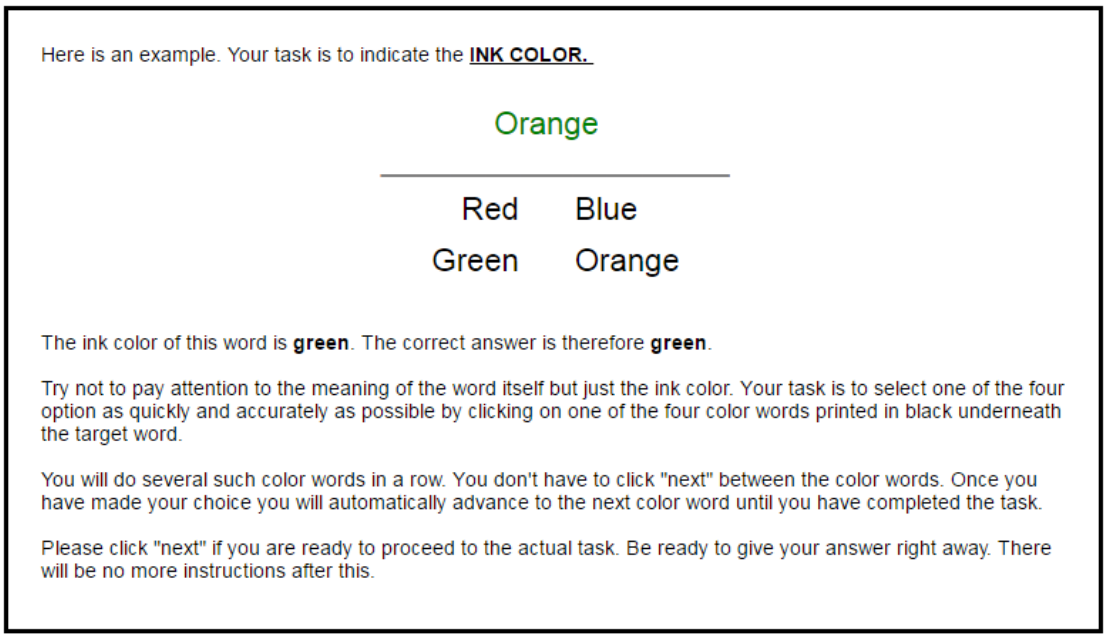
The next task is different.

Now you should **try to keep the cube from changing patterns.** Try to hold each pattern for as long as you possibly can, but keep track of how many times the pattern changes by pressing the "1" key at the top of your keyboard.

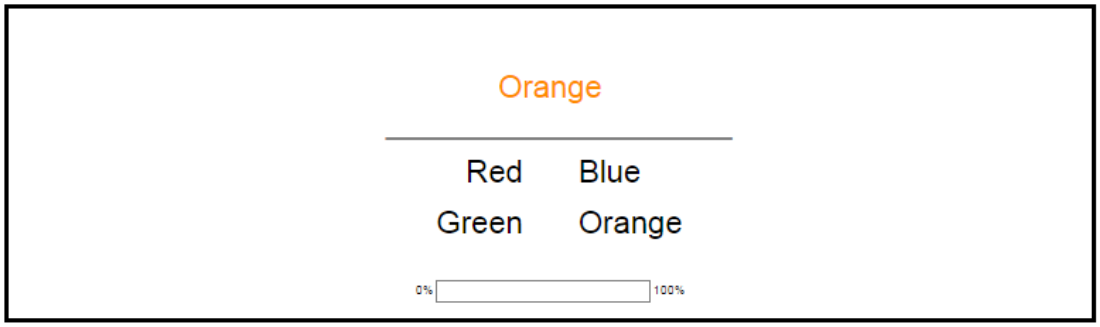
When you are ready to start this new task, click the "next" button. The cube will appear and stay on the screen for 30 seconds.

Appendix D. Stroop Colour Word Interference test

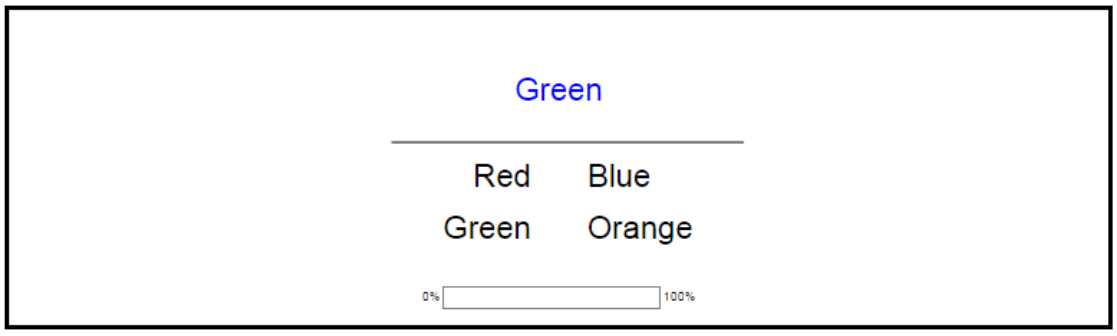
Instructions



Example item from a congruent trial



Example item from an incongruent trial:



Appendix E. Visual Search Task

Instructions

This is Wally. He's off to an adventure on a busy beach. Your next task is to find Wally among the beach goers. Once you have found Wally, simply click on him. You have one minute to find him before the page automatically advances to the next part.

Please click 'next' to see the beach scene.

The image of Wally that was used here can be found under:

http://clipart-library.com/clipart/33957.htm

'Where is Wally' beach scene

Where is Wally? Can you find him? Once you have found Wally, simply click on him.

The image of the scene that was used here can be found under:

http://clipart-library.com/clipart/34005.htm

Appendix F. Lab Experiment Material

Lab experiment materials

Health and Safety Statement

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they engage in physical activity. Overall, the physical activity you will undertake as part of this study has minimum risks. However, to minimize the potential risks even further, we would like you to read the health and safety statements below and put your signature at the bottom of the sheet, thus indicating that you agree with the statements and accept to comply with them.

Existing Injuries or Health Issues
It is your responsibility to tell us if you have any current injuries or acute or chronic health issues that make exercising undesirable—if this is indeed the case, you should not engage in physical activity to avoid any negative impacts on your health and well-being and minimize the risk of another injury. Please read the questions carefully and answer each one honestly.

YES	NO		
☐	☐	1.	Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
☐	☐	2.	Do you feel pain in your chest when you do physical activity?
☐	☐	3.	In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4.	Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	5.	Is your doctor currently prescribing drugs for your blood pressure or heart condition?
☐	☐	6.	Do you know of any other reason why you should not do physical activity?

Exercise Intensity
We ask you to engage in **moderate** intensity physical activity such as jogging or brisk walking. It is neither meant to induce discomfort nor push you beyond your own physical capacity. You should exercise with an intensity that does not cause you any discomfort or pain, and it is your own responsibility to stop exercising if you feel any discomfort or pain to avoid the risk of injuries.

Refreshments
Water will be available before and after the physical activity. Feel free to refresh yourself, especially if you feel tired, exhausted, or you simply want to recuperate from physical activity.

☐ **Please tick the box to confirm you comply with the health and safety statements above, and provide your name, signature, and date:**

Name **Signature** **Date**

Instructions for the physical activity manipulation

Running condition:

Welcome to the Behavioural Research Lab!

Thank you for participating in this study, which is run by Laura Zimmermann (a PhD student in Management) and Prof Amitav Chakravarti.

The first part of the study is about people's attitudes towards having a **leisure break of physical activity** during the day. In the first 30 minutes of the study we would like you to briskly walk to Lincoln's Inn Fields, and engage in physical activity of moderate intensity **by running along the path of the park.**

Please run on your own along the path of the park, without any distractions from your mobile phone or other people. You will take a pedometer with you which counts your steps. Please run around the park **at least two times** and come straight back to the Behavioural Research Lab.

The speed of running will depend on your personal fitness level. Moderate physical activities make you breathe somewhat harder than normal. You're active at a moderate intensity if you're able to talk but unable to sing the words to a song. (If you feel the exercise is too strenuous you can do intervals of brisk walking and running).

Take a look at the clock and make sure that you are back at the BRL in approximately 25 minutes to complete the second part of the study. We will ask about your running experience. If you need a map to get to Lincoln's Inn Fields let the researcher know.
Enjoy the run!

Walking condition:

Welcome to the Behavioural Research Lab!

Thank you for participating in this study, which is run by Laura Zimmermann (a PhD student in Management) and Prof Amitav Chakravarti.

In the first 30 minutes of the study we would like you to go to Lincoln's Inn Fields, and slowly walk along the path of the park; please walk around the park **one time** and come straight back to the Behavioural Research Lab. We want to measure as objectively as possible how many steps it takes to cover this distance. You will take a pedometer with you which counts your steps. This data will be used as a baseline for another study group.

Please walk in a normal, unhurried manner and take slow, deliberate steps so we get an honest calibration of the data. Please walk on your own, without any distractions from your mobile phone or other people. Take a look at the clock and ensure that you are back at the BRL in approximately 25 minutes to complete the second, unrelated part of the study. If you need a map to get to Lincoln's Inn Fields let the researcher know.
Enjoy the walk!

Appendix G. Desirability-Feasibility Trade-off Tasks

Desirability-Feasibility Choice (Hiking Trip task)

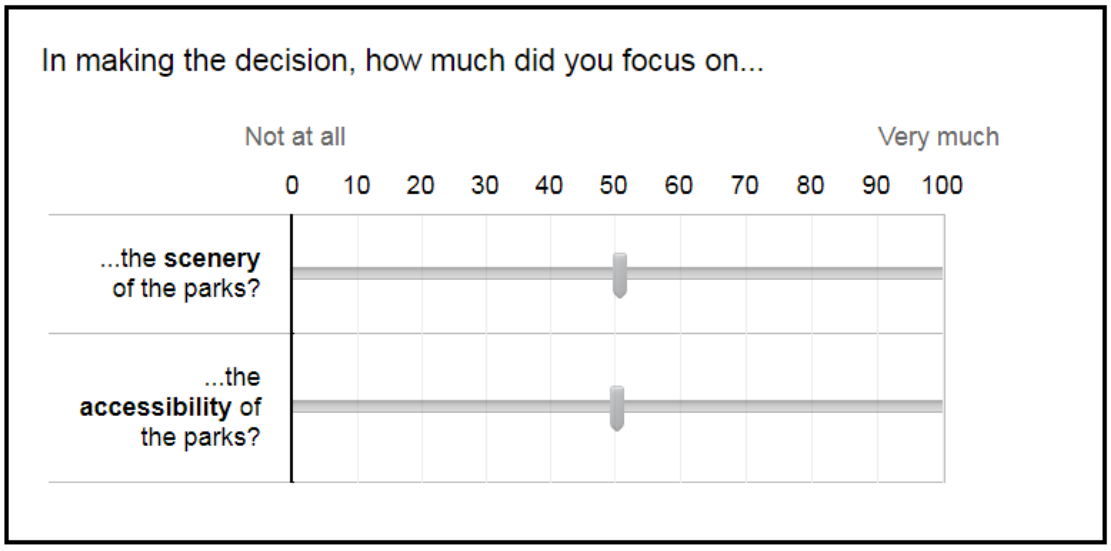
Imagine you are choosing a destination for a hiking trip during the weekend. Here's a description of the two possible parks you could go to.

Park A	Park B
Scenery with creeks and waterfalls	Scenery with boulders and bushes
70 miles away (112 km)	40 miles away (64 km)
Limited parking	Plenty of parking

Which park would you choose?

Park A ○ Park B ○

Desirability-Feasibility focus rating

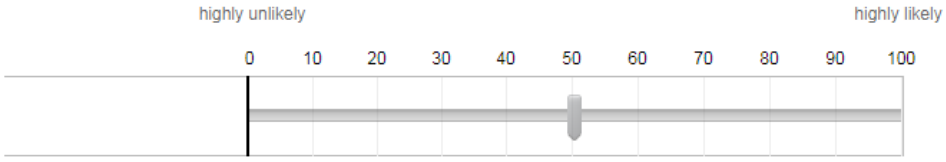


Concert tickets rating task

High desirability-low feasibility condition

Imagine that a friend will offer you two tickets for a concert of a new band that you are not very familiar with and you are not sure you'll like the kind of music they play. Your friend cannot go to the concert himself because of an unexpected event, and offers you his tickets. Since he had a special deal for the tickets, they cost only $8 each, instead of their usual price, which is $30.

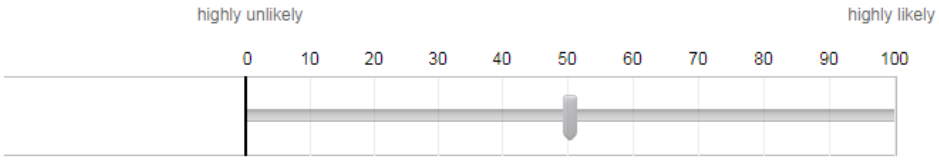
In this situation, how likely is it that you'll buy the tickets?



Low desirability-high feasibility condition

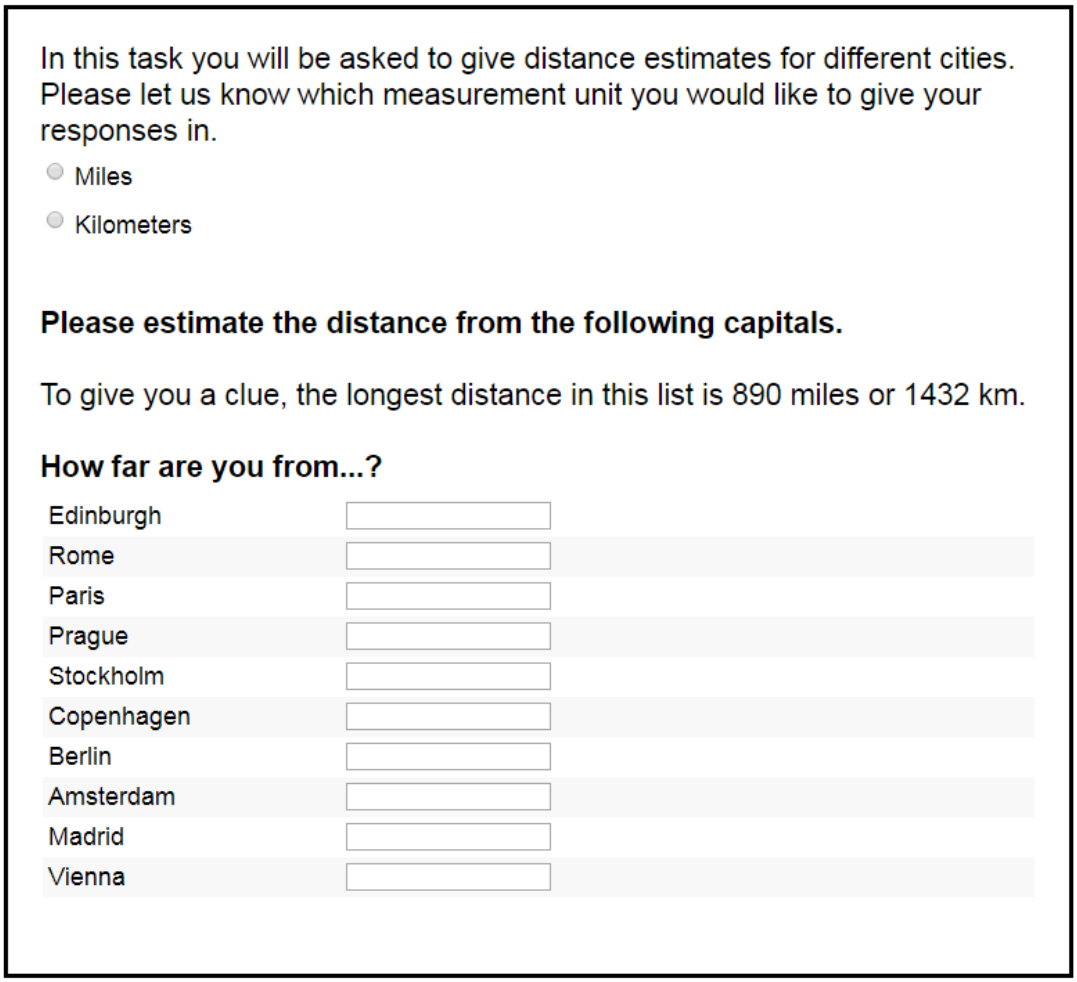
Imagine that a friend will offer you two tickets for a concert of a band that you like very much. Your friend cannot go to the concert himself because of an unexpected event, and offers you his tickets. The tickets are more expensive than you thought, $30.

In this situation, how likely is it that you'll buy the tickets?



Appendix H. Construal Level Measures

City distance estimation task


In this task you will be asked to give distance estimates for different cities. Please let us know which measurement unit you would like to give your responses in.

Miles

Kilometers

Please estimate the distance from the following capitals.

To give you a clue, the longest distance in this list is 890 miles or 1432 km.

How far are you from...?

Edinburgh	
Rome	
Paris	
Prague	
Stockholm	
Copenhagen	
Berlin	
Amsterdam	
Madrid	
Vienna	

Behaviour Identification Form instructions and sample items

Any behavior can be described in many ways. For example, one person might describe a behavior as "writing a paper", while another person might describe the same behavior as "pushing keys on the keyboard". Yet another person might describe it as "expressing thoughts".

The next task focuses on your personal preferences for how a number of different behaviors should be described. Below you will find several behaviors listed. After each behavior will be two different ways in which the behavior might be identified.

For example:

1. Attending class:
   - sitting in a chair
   - looking at a teacher

Your task is to choose the identification that best describes the behavior for you. Simply tick the option you prefer. Mark the description that you personally believe is more appropriate.

Reading

- ○ Following lines of print
- ○ Gaining knowledge

Washing clothes

- ○ Removing odors from clothing
- ○ Putting clothes into the machine

Picking an apple

- ○ Getting something to eat
- ○ Pulling an apple off a branch

Measuring a room for carpeting

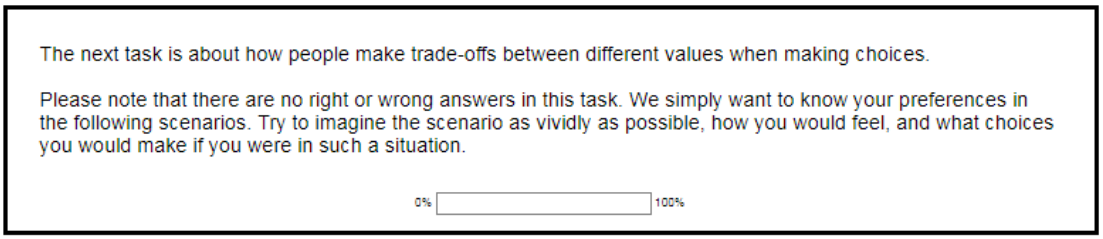
- ○ Getting ready to remodel
- ○ Using a yard stick

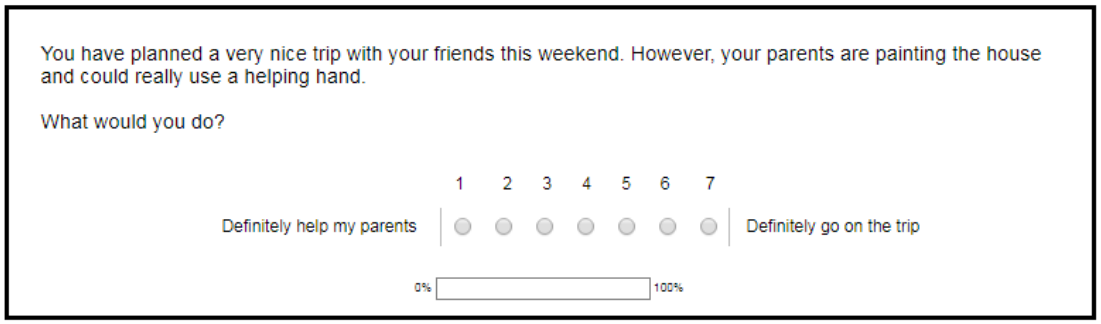
Painting a room

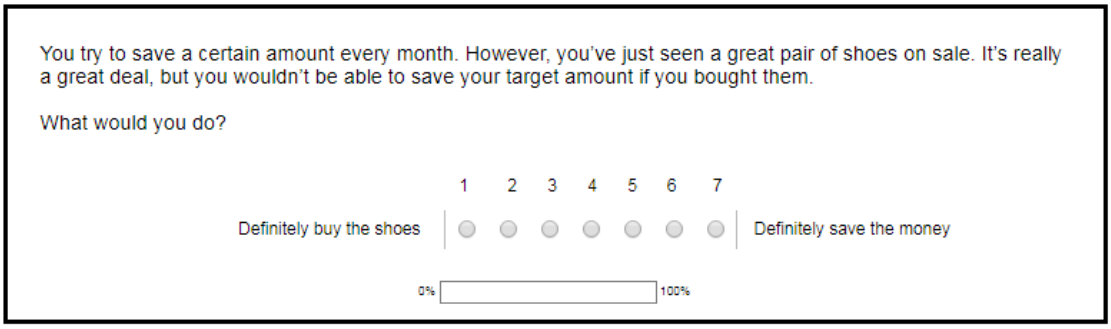
- ○ Applying brush strokes
- ○ Making the room look fresh

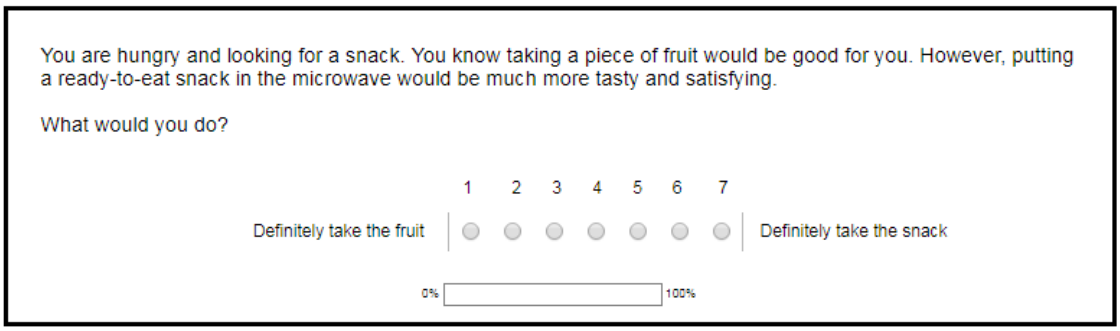
Appendix I. Self-Control Decision Making Measures

Self-control scenarios









Intertemporal choices

You will now have to choose between different amounts of money available after different delays. These questions are measuring individual preferences for outcomes over time. Please note that there are no right or wrong answers, and each question should be considered independently.

Please click "next" to see the first question.

Which of the two options do you prefer at this moment?

Receiving $10 tomorrow ○ ○ Receiving $12 in 25 days from now

Which of the two options do you prefer at this moment?

Receiving $67 tomorrow ○ ○ Receiving $85 in 70 days from now

Which of the two options do you prefer at this moment?

Receiving $34 tomorrow ○ ○ Receiving $35 in 43 days from now

Which of the two options do you prefer at this moment?

Receiving $48 tomorrow ○ ○ Receiving $55 in 45 days from now

Which of the two options do you prefer at this moment?

Receiving $40 tomorrow ○ ○ Receiving $70 in 20 days from now

Which of the two options do you prefer at this moment?

Receiving $16 tomorrow ○ ○ Receiving $30 in 35 days from now

Which of the two options do you prefer at this moment?

Receiving $30 tomorrow ○ ○ Receiving $35 in 20 days from now

Which of the two options do you prefer at this moment?

Receiving $15 tomorrow ○ ○ Receiving $35 in 10 days from now

Appendix J. Other Control Measures

Nonsense Syllogism Test

The next task tests your ability to tell whether the conclusion drawn from certain statements is correct or incorrect.

Although all of the statements are really nonsense, you have to assume that the first two statements in each problem are correct. The conclusion drawn from them may or may not show good reasoning. You have to think only about the reasoning.

Example 1: All trees are fish. All fish are horses. Therefore all trees are horses.

Answer: Good reasoning

Example 2: All trees are fish. All fish are horses. Therefore all horses are trees.

Answer: Poor reasoning

If the conclusion drawn from the statement shows good reasoning, tick the "good reasoning" box. If the conclusion drawn from the statement shows poor reasoning, tick the "poor reasoning" box. You will have to answer 15 items in total.

0% 100%

If the conclusion drawn from the statement shows good reasoning, select the "good reasoning" box. If the conclusion drawn from the statement shows poor reasoning, tick the "poor reasoning" box.

	Good reasoning	Poor reasoning
All birds have purple tails. All cats are birds. Therefore all cats have purple tails.	○	○
	Good reasoning	Poor reasoning
No singer is a pogo stick. All pogo sticks are movie stars. Therefore no singer is a movie star.	○	○
	Good reasoning	Poor reasoning
All cars have sails. Some swimming pools are cars. Therefore some swimming pools have sails.	○	○
	Good reasoning	Poor reasoning
No chipmunks are clowns. Some mushrooms are chipmunks. Therefore some mushrooms are not clowns.	○	○
	Good reasoning	Poor reasoning
No skunks have green toes. All skunks are pigs. Therefore no pig has green toes.	○	○

0% 100%

If the conclusion drawn from the statement shows good reasoning, select the "good reasoning" box. If the conclusion drawn from the statement shows poor reasoning, tick the "poor reasoning" box.

	Good reasoning	Poor reasoning
All horses have wings. No turtle has wings. Therefore no turtle is a horse.	○	○
	Good reasoning	Poor reasoning
No hummingbirds fly. Some tractors fly. Therefore some tractors are not hummingbirds.	○	○
	Good reasoning	Poor reasoning
All apes are houseflies. Some houseflies are not snails. Therefore some apes are not snails.	○	○
	Good reasoning	Poor reasoning
Some dogs like to sing. All dogs are snowdrifts. Therefore some snowdrifts like to sing.	○	○
	Good reasoning	Poor reasoning
All doctors are sea horses. Some doctors are tornadoes. Therefore some tornadoes are sea horses.	○	○

0% 100%

If the conclusion drawn from the statement shows good reasoning, select the "good reasoning" box. If the conclusion drawn from the statement shows poor reasoning, tick the "poor reasoning" box.

	Good reasoning	Poor reasoning
Some people who like Alice do not like Robert. Everyone who likes Sue likes Alice. Therefore some people who like Robert do not like Sue.	○	○
	Good reasoning	Poor reasoning
All trains are coal mines. Nothing above 5,000 feet is a train. Therefore no coal mine is above 5,000 feet.	○	○
	Good reasoning	Poor reasoning
Some men are purple. Everything which is purple is a horse. Therefore some horses are men.	○	○
	Good reasoning	Poor reasoning
Some dogs are seals. Some seals bark. Therefore some dogs bark.	○	○
	Good reasoning	Poor reasoning
All elephants are pink. This animal is pink. Therefore this animal is an elephant.	○	○

0% 100%

Remote Associates Test

In the next task you will be presented with 15 problems, each consisting of three "clue" words. Your task is to think of a forth word that relates to each of the other three "clue" words.

What word is related to these three words?

Example: Elephant – Lapse – Vivid

Answer: Memory

You have 15 seconds to provide an answer before you will automatically move on to the next page.

Word 1	Word 2	Word 3	Solution
dream	break	light	DAY
cane	daddy	plum	SUGAR
cracker	fly	flight	FIRE
aid	rubber	wagon	BAND
duck	fold	dollar	BILL
cream	skate	water	ICE
opera	hand	dish	SOAP
worm	shelf	end	BOOK
safety	cushion	point	PIN
fountain	baking	pop	SODA
flake	mobile	cone	SNOW
fur	rack	tail	COAT
preserve	range	tropical	FOREST
print	berry	bird	BLUE
political	surprise	line	PARTY

Profile of Mood States – Short Version

Below is a list of words that describe feelings people have. Please read each one carefully. Then fill in one space under the answer to the right which best describes HOW YOU HAVE BEEN FEELING DURING THE PAST WEEK INCLUDING TODAY.

	Not at all	A little	Moderately	Quite a bit	Extremely
	0	1	2	3	4
Tense	○	○	○	○	○
Angry	○	○	○	○	○
Worn out	○	○	○	○	○
Unhappy	○	○	○	○	○
Lively	○	○	○	○	○
	0	1	2	3	4
Confused	○	○	○	○	○
Peeved	○	○	○	○	○
Sad	○	○	○	○	○
Active	○	○	○	○	○
On edge	○	○	○	○	○
	0	1	2	3	4
Blue	○	○	○	○	○
Energetic	○	○	○	○	○
If you read this please select 'Not at all'	○	○	○	○	○

0% 100%

HOW YOU HAVE BEEN FEELING DURING THE PAST WEEK INCLUDING TODAY?

	Not at all	A little	Moderately	Quite a bit	Extremely
	0	1	2	3	4
Worthless	○	○	○	○	○
Uneasy	○	○	○	○	○
Restless	○	○	○	○	○
Unable to concentrate	○	○	○	○	○
Fatigued	○	○	○	○	○
	0	1	2	3	4
Annoyed	○	○	○	○	○
Discouraged	○	○	○	○	○
Resentful	○	○	○	○	○
Nervous	○	○	○	○	○
Miserable	○	○	○	○	○
	0	1	2	3	4
Cheerful	○	○	○	○	○
Bitter	○	○	○	○	○
Exhausted	○	○	○	○	○

0% 100%

HOW YOU HAVE BEEN FEELING DURING THE PAST WEEK INCLUDING TODAY?

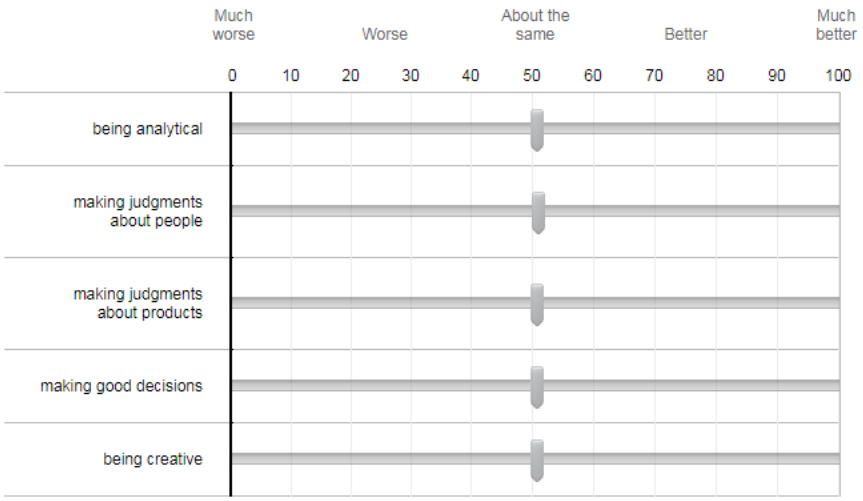
	Not at all	A little	Moderately	Quite a bit	Extremely
	0	1	2	3	4
Helpless	○	○	○	○	○
Weary	○	○	○	○	○
Bewildered	○	○	○	○	○
Furious	○	○	○	○	○
	0	1	2	3	4
Full of pep	○	○	○	○	○
Forgetful	○	○	○	○	○
Vigorous	○	○	○	○	○
Uncertain about things	○	○	○	○	○
	0	1	2	3	4
Bushed	○	○	○	○	○
Grouchy	○	○	○	○	○
Hopeless	○	○	○	○	○
Anxious	○	○	○	○	○

0% 100%

Lay Belief Questions

Do you think a person, who exercises a lot, is worse, about the same or better than a person who doesn't exercise in terms of the following skills?

Please indicate your judgment on the scale below from 0 = much worse than a person who does not exercise, to 100 = much better than a person who does not exercise.



If you would like to explain any of your answers, please use the text box below to do so.

0% 100%

Regulatory Focus: Friendship Strategies

The next question is about how people maintain friendships over time and which strategies they use to do so.

When you think about strategies for friendship, which **THREE** of the following strategies would you choose?

- ☐ Be loving and attentive.
- ☐ Stay in touch. Don't lose contact with friends.
- ☐ Be supportive to your friends. Be emotionally supportive.
- ☐ Try to make time for your friends and not neglect them.
- ☐ Be generous and willing to give of yourself.
- ☐ Keep the secrets friends have told you and don't gossip about friends.

Unusual Uses Test

In the following task you will be asked to generate as many creative uses for an everyday use product as you can think of.

Please refrain from listing both typical uses and uses that are virtually impossible. Here is an example:

Please name all the uses for a brick you can think of:

1. A paperweight
2. A doorstop
3. A mock coffin at a Barbie funeral
4. To throw through a window
5. To use as a weapon
6. To hit a burglar on the head with
7. …
8. …

You will be given 2 minutes to generate such a list. A countdown timer will pop up on the screen for the last 15 seconds so you can finish your last point. The page will automatically advance after this.

0% 100%

Please name all the uses for a **ping pong ball** you can think of. Please refrain from listing both typical uses and uses that are virtually impossible. You will have 2 minutes for this.

0% 100%

Big Five Inventory – 10

How well do the following statements describe your personality?

I see myself as someone who...

	Disagree strongly				Agree strongly
	1	2	3	4	5
... is reserved					
... is generally trusting					
... tends to be lazy					
... is relaxed, handles stress well					
... has few artistic interests					
... is outgoing, sociable					
... tends to find faults with others					
... does a thorough job					
... gets nervous easily					
... has an active imagination					

0% 100%

Ten Item Personality Trait Inventory

Here are a number of personality traits that may or may not apply to you. Please select a number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

I see myself as:

	Disagree strongly			Neither agree nor disagree			Agree strongly
	1	2	3	4	5	6	7
Extraverted, enthusiastic							
Critical, quarrelsome							
Dependable, self-disciplined							
Anxious, upset							
Open to new experiences, complex							
Please select disagree strongly							
Reserved, quiet							
Sympathetic, warm							
Disorganised, careless							
Calm, emotionally stable							
Conventional, uncreative							