**School of Population Health (Psychology)**

# Understanding the Role of Morningness/Eveningness in Physical Activity Engagement: A Mixed Methods Approach

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**This thesis is presented for the Degree of Master of Research (Psychology)**

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## Declaration

To the best of my knowledge and belief, this thesis contains no material previously published by any other person except where due acknowledgement has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

**Human Ethics:** The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated in March 2014. The proposed research study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262), HRE-2017-0730 (Chapter 2, Study 1) and HRE-2022-0250 (Chapters 3 and 4, Studies 2 and 3).

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**Acknowledgement of Country**

We acknowledge that Curtin University works across hundreds of traditional lands and custodial groups in Australia, and with First Nations people around the globe. We wish to pay our deepest respects to their ancestors and members of their communities, past, present and their emerging leaders. Our passion and commitment to work with all Australians and peoples from across the world, including our First Nations peoples are at the core of the work we do, reflective of our institutions' values and commitment to our role as leaders in the Reconciliation space in Australia.

**List of Journal Articles**

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## Thesis Summary

Physical inactivity is a growing concern as more than half of the Australian adult population does not meet the World Health Organisation's physical activity guidelines (Department of Health, 2021). Morningness/Eveningness is an individual difference that has only recently been included in physical activity research and has not been integrated into any health models. Additionally, combining health models is a new development in physical activity research. In this thesis, we combined and extended several health models to determine which factors were most important in impacting behaviour change.

In the first study, the factors from the health action process approach and self-determination theory were combined along with habit and morningness/eveningness. This prospective study showed that this combined and extended model was only partially supported, as self-efficacy and planning were the only significant predictors. We, therefore, wanted to explore if there might be other variables that were more important in predicting individuals' physical activity engagement. Therefore, in the second study, the theory of planned behaviour and temporal self-regulation theory were combined. Similarly, to study 1, we extended this combined model with the addition of enjoyment and morningness/eveningness. Again, this combined and extended model was only partially support, with perceived behavioural control, past behaviour, environmental cues, and habit being the only significant predictors. The non-significance of morningness/eveningness in both these studies lead to the design of the third study, as we wanted to gain a better understanding of individuals' experiences of morningness/eveningness. To our knowledge, this is the first qualitative study to explore morningness/eveningness in a physical activity context. The results suggested that the importance of morningness/eveningness in an individuals' physical activity routine is dependent on the flexibility of their commitments, the underpinning purpose of engaging in physical activity as well as the disruption and change that occurs as the result of external demands. Overall, these three studies highlight some of

the factors that are important in promoting physical activity behaviour, as well as providing further understanding of the role that morningness/eveningness plays.

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# Chapter 1: General Introduction

## Physical Activity Engagement

Regular physical activity is important for reducing poor health outcomes (Hisler et al., 2017). For example, physical activity has been shown to prevent and manage diseases such as cancer and diabetes, but also reduce symptoms related to depression and anxiety (World Health Organization, 2021). Overall, the Australian Institute of Health and Welfare (2020), reported that inactive individuals are 10-20% more likely to be diagnosed with chronic diseases. Being active can reduce the risk of cardiovascular disease (by 50%), diabetes (by 6%), and cancer (by 30-40%; Warburton et al., 2006). Additionally, it is reported that 2.5% of Australia's disease burden is due to inactivity (Australian Institute of Health and Welfare, 2020). Even though, individuals are aware of the health-related benefits, they struggle to engage consistently (Wilson et al., 2012). Only 55% of Australian adults meet the World Health Organisation's physical activity recommendations (i.e., 75-150 minutes of vigorous and 150-300 minutes of moderate physical activity per week; Department of Health, 2021). Physical activity is regarded as a complex behaviour as it consists of numerous behavioural components. This means that routines often need to be maintained long-term to receive the full benefits (Mullan & Novoradovskaya, 2018). Research has determined that because of the complexity of this behaviour, changing from inactivity to regular physical activity is difficult (Scholz et al., 2008). Due to this complexity, a considerable amount of research has been conducted to understand the factors that promote physical activity engagement.

Previous studies have aimed to address poor engagement in physical activity by exploring the factors that encourage individuals to be more active. Tierney et al. (2012) conducted a systematic review that assessed the effectiveness of strategies aimed at improving adherence to physical activity through improving self-efficacy and increasing social support. This study found that short-term physical activity engagement was associated with goal setting, problem-solving and feedback from health professionals or personal trainers (Tierney et al., 2012). Further findings showed that self-efficacy was

an important predictor of exercise behaviour, suggesting that it may influence the activities people choose to engage in, as well as the amount of energy they put into these chosen activities (Tierney et al., 2012). Furthermore, previous research has focused on strategies aimed at increasing physical activity in middle-aged and older adults (Lachman et al., 2018). This study established that long-term increases in physical activity could result from implementing behaviour change interventions involving the reframing of self-defeating attitudes and increasing social support, which further led to an improvement in individuals' exercise self-efficacy (Lachman et al., 2018). However, whilst these findings are important to consider for interventions aimed at increasing physical activity engagement, more physical activity research is needed to better understand the role of individual differences that are less amenable to change. This will allow for interventions to be tailored and targeted to those that need it most.

There is some research that has explored the impact of age and gender on engagement in and frequency of physical activity (Craft et al., 2014; Kao et al., 2014). These studies have demonstrated that as individuals grow older, they engage in less physical activity (Kao et al., 2014), while women tend to have higher levels of physical activity compared to men (Craft et al., 2014). However, there are some potentially important individual differences that have not been investigated to the same extent. Studies that aim to explain the association between psychosocial variables and physical activity have often excluded the individual difference of time-of-day preference (i.e., whether someone is more of a "morning person" or "evening person"; Hisler et al., 2017). Expanding the amount of research that incorporates this individual difference may be important as understanding when individuals are feeling at their best could influence when they should prioritise their physical activity engagement.

**Morningness/Eveningness**

Morningness/eveningness is a common way of referring to an individual's preferred time-of-day. This concept is based on individuals' peak functionality and internal body "clock" (circadian rhythm; Adan et al., 2012) as well as their societal and environmental demands (Hisler et al., 2017). Individual

differences in morningness/eveningness exist throughout the lifespan with some people preferring evening hours, others morning hours, whilst some do not have a preference at all (Zimmermann, 2011). Morningness/eveningness reflects peoples' preferences with regards to times of activity in the occupational, leisure and cognitive domains (Przepiórka et al., 2019). This is supported by previous literature exploring morningness/eveningness and peak activity, which demonstrated that morning-oriented individuals showed peaks in their activity earlier in the day, while evening-types peaked in their performance later in the day (Faßl et al., 2019). Therefore, this individual difference may impact when an individual prefers to engage in physical activity (Montaruli et al., 2021).

This concept has previously been explored as a predictor of academic performance as well as a variety of health-related behaviours (Akram et al., 2018; Phillips et al., 2021; Urbán et al., 2011). For example, Akram et al. (2018) found that morningness/eveningness did not impact individuals' academic performance directly. However, it did have an indirect effect as morning-types were more likely to use deep learning techniques and therefore achieved better academic outcomes, compared to evening-types (Akram et al., 2018). Furthermore, morningness/eveningness has also been studied in relation to medication adherence (Phillips et al., 2021). In this study, they suggested that morning-types were more consistent in taking their medication than evening-types (Phillips et al., 2021). Other research has investigated morningness/eveningness and unhealthy behaviours (Urbán et al., 2011), such as smoking and alcohol consumption. Morning- and intermediate-types (i.e., those that do not have a preference) were less likely to engage in smoking behaviours and consumed less alcohol (Urbán et al., 2011). Based on this previous morningness/eveningness research, it could be important to explore the importance of this concept in relation to physical activity engagement, as it could be used in more tailored interventions with the aim of increasing physical activity engagement.

***Morningness/Eveningness and Physical Activity.***

Whilst limited, previous research has established that time-of-day can play an important role in physical activity behaviour and habituation (Blazer et al., 2020). Overall physical activity engagement can be impacted as a misalignment between a person's preferred time of day and when they engage in physical activity can contribute to poor functioning (Escribano, 2020). Long-term poor physical functioning can lead to a decrease in physical activity, resulting in overall poor physical health and wellbeing (Escribano, 2020). Similarly, there is also research that suggests that engaging in physical activity at the same time each day, compared to different times of day, is important for consistent physical activity engagement (Kaushal & Rhodes, 2015; Schumacher et al., 2019).

Research investigating the effects of morningness/eveningness on motivation established it was higher at individuals' preferred time-of-day (Blazer et al., 2020). Additionally, a study looking at the effect of morningness/eveningness on physical exertion and performance, discovered that there was no difference between individuals preferred and non-preferred time of day (Mulè et al., 2020). Whereas, Roveda et al. (2020) also found, amongst adolescents, that morning-types performed better physically in the morning, whereas evening-orientated individuals performed better in the evening. However, research conducted by Brooker et al. (in press) established no difference in the time spent being physically active between morning and evening exercise groups.

Previous literature provides a foundation for the current thesis with regards to morningness/eveningness and physical activity. However, this thesis aims to expand on this by integrating morningness/eveningness into different theoretical frameworks. In doing so, it can help us gain a better understanding of the relations between morningness/eveningness and more established predictors of physical activity (e.g., self-efficacy, planning, environmental cues).

**Health Models and Physical Activity**

A number of theories of motivation and behaviour change have been used to inform the promotion of physical activity engagement (Ntoumanis et al., 2018). Three of the more common are self-determination theory, the transtheoretical model and the theory of planned behaviour (Ntoumanis et al., 2018). These have often been incorporated into literature focused on the motivational factors of physical activity engagement (Ntoumanis et al., 2018). Self-determination theory suggests that motivation results in the regulation of peoples' health behaviours through two domains (Deci & Ryan, 2000). The first domain explores individuals' engagement in autonomous behaviours, whereas the second domain describes how motivation can come from controlled reasons (e.g., feelings of guilt or peer pressure; Deci & Ryan, 2000). This theory is commonly used to determine individuals' motivation to engage in physical activity (Mullan et al., 2021; Teixeira et al., 2012). A systematic review suggested that self-determination theory (i.e., motivation) is important in both the initiation of and adherence to physical activity (Teixeira et al., 2012). Similarly, the theory of planned behaviour is influential in predicting and explaining physical activity engagement through individuals' intentions (Ajzen, 1991). The theory of planned behaviour successfully facilitates an increase in physical activity by improving individuals' attitudes, as well as changing their beliefs of how others perceive them and how much control they have over their physical activity engagement (Ntoumanis et al., 2018). The transtheoretical model suggests that individuals go through different stages of change, between the initiation of an activity and the maintenance of their engagement (Prochaska & Marcus, 1994). However, a meta-analysis conducted by Romain et al. (2018) suggested that the components of the transtheoretical model has no significant effect in modifying individuals' physical activity levels.

The health action process approach and temporal self-regulation theory have been used less frequently in physical activity research. The health action process approach suggests that health behaviours are formed through the motivational and volitional phases (Schwarzer, 1992). It consists of

motivation variables to predict intention, as well as variables that lead to the translation of individuals' intentions into actions (Schwarzer, 1992). Research has supported the use of the health action process approach in improving and predicting physical activity (Maxwell-Smith et al., 2018). Planning and self-efficacy are two variables in this health model that have been shown to be important in predicting physical activity engagement. For example, research by Teleki et al. (2021) has shown that action planning can prompt the initiation of physical activity, whereas coping planning can facilitate adherence to it. In addition, individuals with higher self-efficacy are more likely to engage in physical activity (Maher & Conroy, 2016). Similarly, temporal self-regulation theory has been integrated to explain the gap in the formation of intention and the execution of the intended behaviour (e.g., physical activity; Hall & Fong, 2007). This health model attempts to combine intention, behaviour prepotency and self-regulatory capacity to predict engagement in behaviour (Hall & Fong, 2007). Intention (Allom et al., 2016) as well as the components of behaviour prepotency (e.g., habit, environmental cues and past behaviour; Rhodes & Rebar, 2018) and self-regulatory capacity (e.g., planning; (de Bruijn et al., 2012) are important in addressing the intention-behaviour gap.

One of the key developments of health psychology and physical activity research, has been the integration of different theories (Hagger & Chatzisarantis, 2008; Liddelow et al., 2021a). By integrating and combining different health models, they can explain behaviour processes that the other may not (Hagger & Chatzisarantis, 2008).

**Measuring Physical Activity**

Apart from the combination of models, another key development in physical activity research is the way in which it is measured. While previous research has measured physical activity using pedometers or accelerometers, these can be costly in both time and resources. As an alternative, however, research shows that there has been an increase in the number of individuals who own fitness tracking watches (Henriksen et al., 2018). Furthermore, a study conducted by Lunney et al. (2016)

determined that 31% of fitness watch consumers identified themselves as “self-trackers” (i.e., people who monitor their health via wearable fitness trackers). Research has also been conducted to evaluate the accuracy of a variety of fitness watches in measuring fitness-related activities (Xie et al., 2018). According to the results of Xie et al’s. (2018) study, the accuracy of heart rate, step count and distance measurements were fairly high, with measurement of heart rate performing the best. Laranjo et al. (2021) also recently conducted a study evaluating the effectiveness physical activity trackers. Based on the results they suggested that the personalisation of physical activity trackers could further promote effective physical activity engagement.

**The Current Thesis**

The main objective of this thesis is to explore the psychosocial factors that may prevent or promote individuals to engage in physical activity. In doing so, this thesis will highlight some of the variables that could help individuals increase their engagement in physical activity. These factors can then be incorporated into future interventions, targeted at specific groups. Additionally, the focus of this thesis (Chapters 2, 3 and 4) was to enhance our understanding of the impact that morningness/eveningness may have on individuals’ physical activity routines. Overall, this thesis consists of five chapters (including this introductory one), each addressing the main objective and focus.

**Chapter 2** outlines study one*: Investigating the role of morningness/eveningness in physical activity engagement* (published in Health Psychology and Behavioural Medicine; Nicholson et al., 2022). This study addresses the main objective of this thesis by creating a model that incorporated variables from the health action process approach (i.e., self-efficacy and planning; Schwarzer, 1992) and self-determination theory (i.e., motivation; Deci & Ryan, 2000), in addition to habit and morningness/eveningness. By applying these constructs, the aim of this predictive study was to determine which were the strongest predictors of physical activity engagement.

**Chapter 3** discusses study two: *Combining theoretical approaches to explore individuals' physical activity engagement.* This study contributes to the overall aim of this thesis by applying a combined and extended model, that integrates the pre-intention variables of the theory of planned behaviour (i.e., attitude, subjective norm, and perceived behavioural control; Ajzen, 1991) and the post-intention components of temporal self-regulation theory (i.e., behaviour prepotency and self-regulatory capacity; Hall & Fong, 2007), along with enjoyment and morningness/eveningness. This study was designed based on the results of study 1. The results of study 1 showed the motivation was not a significant predictor. This led to the incorporation of enjoyment in this study, to determine whether motivation was less important for individuals who enjoyed being physically active. We again wanted to explore the effects of a combined model on physical activity, as we wanted to continue to expand on this new development. However, due to only two variables being significant predictors in study 1 (i.e., self-efficacy and planning), we combined two different models to determine if they could better explain the factors that lead to individuals being physically active. Similar to study one, the aim of this predictive study was to investigate which of these constructs were the most important predictors of physical activity engagement. This study also contributes to this evolving topic of research.

**Chapter 4** depicts the third study: *Individuals' experiences of preferred time of day in their physical activity routines: A qualitative study*. This qualitative study speaks to the overarching aim of this thesis by looking to discover the meaning that individuals give to morningness/eveningness and physical activity. This was done by exploring how individuals conceptualise morningness/eveningness and their experiences of preferred time of day in their physical activity routines.

**Chapter 5** provides a general discussion of the findings of this thesis, including theoretical and practical implications, strengths and limitations, recommendations for future research as well as an overall conclusion.

## Chapter 2: Investigating the Role of Morningness/Eveningness in Physical Activity Engagement


### Abstract

**Objective:** Despite being aware of the positive health-related outcomes of physical activity, many people remain inactive. The aim of this study is to apply a combination of constructs from the health action process approach and self-determination theory, as well as habit and morningness/eveningness, to predict physical activity engagement.

**Methods:** A prospective design was used to collect data from 136 participants (16 to 64), at two-time points, one week apart. The sample consisted of 99 women, 36 men and 1 individual who identified as non-binary. Participants' preferred time-of-day was measured using the Morningness-Eveningness Stability Scale (MESSi; Randler et al., 2016), while physical activity engagement was measured using the International Physical Activity Questionnaire (short-version; Craig et al., 2003). Two hierarchical, multiple regressions were conducted, to predict motivation to engage and to directly predict physical activity engagement. Furthermore, a mediation analysis was conducted to determine the effect of planning on physical activity engagement.

**Results:** Results showed that younger individuals and those with greater self-efficacy were more motivated to engage while planning directly predicted physical activity engagement. However, morningness/eveningness did not significantly predict engagement. Additionally, planning was found to mediate the motivation-engagement relationship.

**Conclusion:** This study demonstrates how planning influences individuals' physical activity engagement, as well as the role self-efficacy and age play in their motivation to engage. Even though morningness/eveningness was not an important predictor, behaviour change techniques related to action planning and the use of multi-component approaches to behaviour change, could be used in interventions focused on increasing individuals' physical activity engagement.


*Keywords*: Physical activity, morningness/eveningness, planning, motivation, habit

## Introduction

Physical activity is regarded as a complex behaviour consisting of many behavioural components and routines that need to be maintained long-term (Mullan & Novoradovskaya, 2018). Frequent physical activity is important for reducing poor health outcomes, such as cardiovascular disease and obesity (Hisler et al., 2017). Despite most people being aware of the positive health-related outcomes of physical activity, many people struggle to engage consistently (Wilson et al., 2012). For example, only 55% of Australian adults meet the recommended 150-300 minutes of moderate physical activity per day (Department of Health, 2021). Research has been conducted to understand the factors that prevent engagement, with a systematic review assessing the effectiveness of psychosocial factors in improving long-term engagement, finding that consistent physical activity engagement was associated with goal setting and feedback related to the behaviour (Tierney et al., 2012). However, studies such as these often exclude individual differences, such as preferred time-of-day (i.e., whether someone is more of a "morning person" or "evening person"; Hisler et al., 2017).

Morningness/eveningness is an individual's preferred time-of-day, based on their peak functionality and internal body "clock" (circadian rhythm; Adan et al., 2012). Therefore, this individual difference may impact individuals' external schedules, for example, when they prefer to engage in physical activity (Montaruli et al., 2021). Understanding the role of morningness/eveningness in a physical activity context appears to be an evolving field. Previous research has shown that time-of-day plays an important role in physical activity behaviour and training habituation (Blazer et al., 2020). Research investigating the effects of preferred and non-preferred training times on motivation, established it was higher at individuals' preferred time-of-day (Blazer et al., 2020). Additionally, a study looking at the effect of morningness/eveningness on physical activity exertion and performance, demonstrated that morning-oriented individuals exerted more effort in the afternoon session compared to the morning session, whereas the evening-type people showed the opposite (Mulè et al., 2020).

However, no difference was identified for both morning-types and evening-oriented individuals between morning and afternoon sessions (Mulè et al., 2020). Furthermore, Roveda et al. (2020) also determined, in an adolescent population, that morning-types performed better physically in the morning sessions, whereas evening-orientated individuals performed better in the evening. Most of the previous literature investigating morningness/eveningness in a physical activity context has been conducted in a controlled environment (e.g., participants performing a single activity during a specific time block). In order to advance this, the current research took a more naturalistic approach by exploring the role morningness/eveningness plays in individuals' normal physical activity routines. Furthermore, despite morningness/eveningness being shown to be important in behaviours such as physical activity, it is not often explored as a part of health psychology models. This lack of integration may suggest that when investigated congruently, morningness/eveningness could be more or less important than other established factors, such as planning. Two commonly applied theories to the study of physical activity are the health action process approach and self-determination theory.

The health action process approach provides a theoretical framework for improving and predicting health-related behaviours such as physical activity engagement (Maxwell-Smith et al., 2018). One component is self-efficacy, which refers to how confident a person is in their ability to perform a behaviour (Presseau et al., 2017). Previous literature suggests that individuals who have an intention and high self-efficacy are more likely to limit sedentary behaviour (Maher & Conroy, 2016). Previous literature has also explored how intention differs, based on an individual's age. Alley et al. (2018) found that inactive older adults were less likely to have an intention to increase their physical activity engagement, compared to inactive younger adults.

Another component is planning, which involves knowing when, where and how to perform the desired behaviour (Teleki et al., 2021). Planning has been suggested to directly predict engagement in physical activity, suggesting that the greater extent to which individuals plan, the more likely they are to engage

in their chosen physical activity (Teleki et al., 2021). This is because even though an individual might have an intention to perform a specific behaviour, they sometimes need goal-directed plans to actually execute that behaviour (Sheeran et al., 2005). Furthermore, planning has been found to be an important mediator, particularly in previous research that incorporates the health action process approach, as better planning helps individuals to translate their intentions into performing the behaviour (e.g., engaging in physical activity; Teleki et al., 2021).

Habit involves regular engagement in the same context for an association to develop between a cue and activity (Rhodes & Rebar, 2018). Habit consists of two components: automaticity and routine (Ersche et al., 2017). Automaticity occurs as individuals learn to associate specific environmental cues with the initiation of behaviour, resulting in behaviours occurring without deliberation (Rhodes & Rebar, 2018). Additionally, routine is the regular execution of specific actions for a desired outcome (Wyckmans et al., 2020). Due to the complexity of physical activity, there have been many research debates as to whether it can truly be habitual (Rhodes & Rebar, 2018). However, Phillips and Gardner (2016) suggested that physical activity could be initiated habitually, even though performing these activities may require deliberate input.

Self-determination theory has previously often been used as a theoretical framework to explain the motivators of physical activity engagement (e.g., Mullan et al., 2021). Motivation has been successfully in predicting physical activity engagement in many studies (Maher & Conroy, 2016; Mullan et al., 2021; Teleki et al., 2021), therefore, this study integrated motivation with the components from the health action process approach, to see if it explains any additional variance, above and beyond the health action process approach variables.

**The Current Study**

The aim of the current research is to apply constructs derived from the health action process approach, as well as the additional variables of motivation, habit and morningness/eveningness to predict engagement in physical activity.

Based on previous research, it is hypothesised:

(H1) Morningness/eveningness and self-efficacy will predict motivation to engage in physical activity.

(H2) Morningness/eveningness, motivation, planning and habit will predict engagement in physical activity.

(H3) According to Mulè et al. (2020), morning-oriented people show greater physical performance in the morning, compared to evening-type people. Therefore, we hypothesised that morningness/eveningness will moderate the relationship between motivation and engagement in physical activity, such that the association between motivation and engagement will be greater at high levels of morningness.

(H4) Based on previous research by Teleki et al. (2021), it is hypothesised that planning will mediate the relationship between motivation and physical activity engagement.

## Methods

### Participants

An *a* priori power analysis was conducted using G*Power (version 3.1.9.7) with a moderate effect size ($f^2$ = .30 - .40; Keatley et al., 2012, Maher & Conroy, 2016) and eight predictors. As a result, this study required at least 59 participants. However, to account for anticipated attrition (of approximately 30%) and to obtain the required sample to detect a mediated effect (Fritz & MacKinnon, 2007), we aimed to recruit 150 participants. To be eligible, participants were required to understand written English, and be over the age of 16 years.

## Measures

In this study, physical activity was defined as any vigorous or moderate activity that was completed for recreation or exercise, for at least 30 minutes (Craig et al., 2003). Activities associated with commuting, housework, gardening, or team sports were excluded. Individuals often do not have the autonomy to decide when, where and how to engage (e.g., training sessions and fixtures are decided by coaches, clubs, and sporting associations). Therefore, to gain a better understanding of the role that planning, and habit may play, activities associated with team sport were excluded.

### *Morningness/Eveningness*

Participants preferred time-of-day was measured using the Morningness-Eveningness Stability Scale (MESSi; Randler et al., 2016). This measure is divided into three subscales of five items: Morning Affect, Distinctness, and Eveningness. However, the current study only used the items related to Morning Affect (i.e., items 1-4 and 6) and Eveningness (i.e., items 5, 7 and 13-15). This decision was made as the focus of this study is not on the changes individuals' experience in their psychological state throughout the day, but rather on their time-of-day orientation. Morning Affect measures alertness and energy levels after waking (e.g., "Assuming normal circumstances, how easy do you find getting up in the morning?"). Whereas Eveningness measures affect and energy levels in the evening (e.g., "In general, how are your energy levels in the evening?"). All the items were measured on a five-point scale. Higher scores on Morning Affect indicates a preference for mornings (i.e., morningness), whereas higher scores on Eveningness shows an evening orientation (i.e., eveningness). The current study reported a Cronbach's alpha of .85 for the five-item Morning Affect subscale and .84 for the five-item Eveningness subscale.

### *Habit*

The Creature of Habit Scale (COHS) was used, as it has been designed to measure the variations in the way individuals form habits, therefore, focusing on trait-based habitual tendencies instead of

state-based ones (Ersche et al., 2017). This scale has been used in previous research exploring the association between a person's tendency to form habits and health-related behaviours, such as alcohol consumption (Piquet-Pessôa et al., 2019). In order to advance this, the current study used the Creature of Habit Scale to measure people's habitual tendencies in relation to being physically active. The COHS consists of 27-items, which are split into 16-items measuring "routine" (e.g., "I find comfort in regularity") and 11-items evaluating "automaticity" (e.g., "I often find myself eating without being aware of it"). The Cronbach's alpha in the current study was .85. Both subscales were measured using a five-point scale ranging from 1 (definitely disagree) to 5 (definitely agree). Higher scores indicate stronger habitual tendencies.

***Self-efficacy***

The Spinal Cord Injury Exercise Self-Efficacy Scale (ESES) was used to measure self-efficacy in this context (Kroll et al., 2007). It was not necessary to adapt this scale, as the items were not worded specifically to assess individuals with a spinal cord injury. It includes 10-items evaluating individuals' confidence in their ability to engage in physical activity (e.g., "I am confident that I can accomplish my physical activity goals that I set"). Items were answered using a four-point Likert-type scale, ranging from 1 (not at all true) to 4 (always true). The internal consistency of this measure in the current study was .84. Higher scores indicate greater self-efficacy (Newson & Kemps, 2007).

***Motivation***

Previous health action process approach literature has suggested that volition does not describe a person's intention to engage, as well as motivation (Conner, 2008). Therefore, the current study combated this, by substituting the 'volition' components of the health action process approach with motivation. Motivation was measured by the Participation Motivation Questionnaire (PMQ; Gill et al., 1983). The PMQ includes 21-items asking participants to rate how often these reasons motivate them to engage in physical activity (e.g., "I enjoy physical activity"; Gill et al., 1983). Each of the 21-items was

assessed using a five-point scale, from 1 (not at all) to 5 (always). The current study reported a great Cronbach's alpha of .81. Higher scores indicate higher levels of motivation (Gill et al., 1983).

***Planning***

Planning was assessed by the items used in Sniehotta et al's. (2005) research. Nine items assessed participants' plans for where, when, and how they might engage in physical activity (e.g., "I have made a detailed plan regarding when to exercise"), and how they might cope with foreseen barriers ("I have made a detailed plan regarding how to cope with possible setbacks"). Items were answered using a four-point scale ranging from 1 (completely disagree) to 4 (completely agree). Higher scores indicate better planning. The Cronbach's alpha in the current study was .91.

***Physical Activity Engagement***

Physical activity behaviour was evaluated at time one and time two using the shortened version of the International Physical Activity Questionnaire (IPAQ-S; Craig et al., 2003). In the original measure, six items explore a participant's physical activity over the past seven days (e.g., "During the last 7 days, on how many days did you do vigorous physical activities?"). However, in this study, we only used four items related to vigorous and moderate physical activity and removed two items related to walking as previous research has suggested that walking is a type of moderate physical activity (Hoeger et al., 2008). The greater the amount of time reported engaging in physical activity, the greater the engagement in physical activity over the previous week.

**Procedure**

The study was approved by the University's Human Research Ethics Committee (HRE2017-0730). A prospective cross-sectional design was used to collect data between May to September 2021. Eligible participants were asked to complete an online questionnaire shared on the University's participant pool and social media. An information sheet was provided, at both time points, and outlined the research and ethical considerations. Participants were required to provide consent, by checking a box, to

proceed. Next, the participants were asked to provide an email address where they could be reached to complete the second phase. The first questionnaire took approximately 15 minutes to complete.

Seven days after the completion of time one, participants received an email containing a link to another online questionnaire. This questionnaire took approximately 5 minutes to complete.

**Data Analysis**

Descriptive statistics and two hierarchical multiple regressions were conducted in IBM SPSS Statistics 27. Additionally, bivariate correlations were conducted using the unstandardised predictors. Due to multicollinearity, the hierarchical multiple regressions and mediation analysis were conducted using standardised predictors. A missing values analysis was run at the individual item level. Only one case had at least one missing value identified, making the extent of missingness 0.70%. Little's MCAR test was non-significant, $\chi^2$ (93, $N$ = 136) = 86.87, $p$ = .659, indicating that this data was missing completely at random and therefore was imputed using expectation maximisation (Tabachnick & Fidell, 2013). Initially, we planned to control for all the demographic variables; however, upon inspection of the correlations, only age significantly correlated with motivation. Therefore, age was the only covariate in regression one. Furthermore, none of the demographic variables correlated with engagement in physical activity (time two); therefore, there were no covariates in regression two. For the first regression, the covariate age was entered at step 1, all the variables were added in steps two to four (morningness, eveningness, self-efficacy). For the second regression, all the variables were entered in steps one to five (morningness, eveningness, motivation, planning, habit). At step six, the interactions (motivation x planning, motivation x morningness, motivation x eveningness) were entered.

Furthermore, a mediation analysis was conducted using PROCESS (version 4.0) extension of IBM SPSS Statistics 27. Mediation analyses are concerned with investigating the effect of a predictor (i.e., motivation) in terms of how it accounts for the variance in the outcome variable (i.e., physical activity engagement; Allen et al., 2019). However, this is done by considering a mediating variable (i.e.,

planning). In the current study, a mediation analysis will help to determine whether the effect of motivation on physical activity engagement is indirect (i.e., the effect on the outcome variable through the mediator. Paths a and b) or direct (i.e., the effect on the outcome variable without the mediator. Path c'; Hayes, 2018)(see Figure 1). A mediation analysis can result in a partial mediation, where the mediator only accounts for some of the variance between the predictor and the outcome variable, or a full mediation model, where the mediator explains all the variance between the predictor and the outcome variable (Hayes, 2018).

## Results

### Participants

A total of 248 participants completed time one, and 140 participants completed time two (attrition of 43.55%). Responses were excluded if they did not complete time two, did not meet eligibility criteria, failed two attention check questions and if more than 30% of the survey was not completed. The final sample size of 136 participants provided adequate power, ranging from .996 to .999, $F(11, 124) = 1.87$. Participants' age ranged from 16 to 64 years ($M = 34.71$, $SD = 13.68$), with 72.80% women ($n = 99$), 26.50% men ($n = 36$) and 0.70% identifying as non-binary ($n = 1$). Furthermore, 50% of participants reported they engaged in a mixture of cardio and weight/strength activity ($n = 68$), 39.70% engaged in only cardio-based physical activity ($n = 54$), 8.1% only engaged in weight/strength-based activity ($n = 11$), and 2.2% reported they engaged in neither ($n = 3$). The average amount of time spent per week engaging in physical activity was approximately 127 minutes at time one and 105 minutes at time two. Table 1 shows the means and standard deviations, and the correlations between the variables used in the analyses.

**Table 1**

*Descriptive Statistics and Correlations of Physical Activity Engagement, Morningness, Eveningness, Habit, Self-efficacy, Motivation, Planning and Age.*

| | | *M* | SD | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | PA Engagement (T1) | 127.71 | 107.59 | -.01 | .10 | .02 | .16 | .06 | .08 | .45*** | .10 |
| 2. | Morningness | 17.06 | 2.61 | - | -.45*** | -.02 | .24*** | .10 | .13 | .05 | .25*** |
| 3. | Eveningness | 14.03 | 4.23 | | - | .01 | -.17* | -.01 | -.07 | .02 | -.14 |
| 4. | Habit | 3.31 | .49 | | | - | -.31*** | .09 | .10 | -.13 | -.32*** |
| 5. | Self-Efficacy | 3.31 | .43 | | | | - | .29*** | .29*** | .28*** | .17* |
| 6. | Motivation | 3.84 | .43 | | | | | - | .31*** | .12 | -.18* |
| 7. | Planning | 2.65 | .64 | | | | | | - | .24*** | -.05 |
| 8. | PA Engagement (T2) | 105.68 | 78.88 | | | | | | | - | .11 |
| 9. | Age | 34.71 | 13.68 | | | | | | | | - |

*Note:* PA = physical activity (in minutes); T1 = time one; T2 = time two; 2 = morningness; 3 = eveningness; 4 = habit; 5 = self-efficacy; 6 = motivation; 7 = planning; 8 = engagement in PA; 9 = age.

*$p$<.05, ***$p$<.001

**Predicting Motivation to Engage in Physical Activity**

In step one, age was controlled for and accounted for a significant 3.10% of variance in motivation. At step two, morningness accounted for an additional non-significant 2.20%. In step three, eveningness accounted for an additional, non-significant 0.30% of variance. Self-efficacy was added in step four and accounted for an additional significant 8.9%. In combination, the four predictors explained 14.4% of variance in motivation $R^2$ = .14, $F(1, 131) = 5.51$, $p < .001$. However, age ($p$ = .004) and self-efficacy ($p < .001$) were the only significant predictors. According to Cohen's (1988) conventions, this is classified as a medium effect ($f^2$ = .18) (see Table 2).

**Table 2**

*Unstandardised (B) and Standardised (β) Coefficients, and Squared Semi-Partial Correlations ($sr^2$) for Each Predictor Variable Entered into a Regression Predicting Motivation to Engage in Physical Activity*

| | Variable | *B* [95% CI] | *β* | $sr^2$ | p value | $R^2$ | $\Delta R^2$ | *F* | $\Delta F$ [*df*1, *df*2] |
|---|---|---|---|---|---|---|---|---|---|
| Step 1* | | | | | .042 | .03 | .03 | 4.22 | 4.22 [1, 134] |
| | Age | -.08 [-.15, -.00]* | -.18 | .03 | .042 | | | | |
| Step 2* | | | | | .027 | .05 | .02 | 3.73 | 3.17 [1, 133] |
| | Age | -.09 [-.17, -.02]* | -.21 | .04 | .015 | | | | |
| | Morningness | .07 [-.01, .14] | .16 | .02 | .077 | | | | |
| Step 3 | | | | | .059 | .06 | .00 | 2.54 | .21 [1, 132] |
| | Age | -.09 [-.17, -.02]* | -.21 | .04 | .017 | | | | |
| | Morningness | .07 [-.01, .16] | .17 | .02 | .075 | | | | |
| | Eveningness | .02 [-.06, .10] | .04 | .00 | .650 | | | | |
| Step 4*** | | | | | <.001 | .15 | .09 | 5.65 | 14.21 [1, 131] |
| | Age | -.11 [-.18, -.04] | -.25 | .06 | .004 | | | | |
| | Morningness | .05 [-.03, .13] | .12 | .01 | .212 | | | | |
| | Eveningness | .03 [-.05, .11] | .07 | .00 | .465 | | | | |
| | Self-efficacy | .14 [.06, .21]*** | .32 | .09 | <.001 | | | | |

*Note: B* = unstandardised coefficient; CI = confidence interval; *β* = beta (standardised coefficient); $sr^2$ = squared semi-partial correlation coefficient.

*$p$<.05, ***$p$<.001

**Predicting Physical Activity Engagement**

At step one, morningness explained a non-significant 0.30% of variance. In step two, eveningness accounted for an additional non-significant 0.30%. At step three, motivation accounted for an additional non-significant 1.3% of variance. Planning was added in step four and accounted for an additional non-significant 4.7% of variance. At step five, habit accounted for a non-significant 2.2%. Lastly, in step six, the interactions accounted for a significant 2.7% of variance. In combination, the eight predictors explained 11.5% of variance, $R^2$ = .12, $F$(3, 127) = 2.06, $p$ = .044. However, planning ($p$ = .009)

was the only significant predictor of physical activity engagement. According to Cohen's (1988) conventions, this is classified as a small effect ($f^2$ = .13) (see Table 3).

**Table 3**

*Unstandardised (B) and Standardised (β) Coefficients and Squared Semi-Partial Correlations ($sr^2$) for Each Predictor Variable Entered into a Regression Predicting Physical Activity Engagement.*

| | Variable | *B* [95% CI] | *β* | $sr^2$ | p value | $R^2$ | $\Delta R^2$ | *F* | $\Delta F$ [*df*1, *df*2] |
|---|---|---|---|---|---|---|---|---|---|
| Step 1 | | | | | .577 | .00 | .00 | .31 | .31 [1, 134] |
| | Morningness | 3.81 [-9.65, 17.27] | .05 | .00 | .577 | | | | |
| Step 2 | | | | | .742 | .00 | .00 | .30 | .29 [1, 133] |
| | Morningness | 5.65 [-9.47, 20.76] | .07 | .00 | .461 | | | | |
| | Eveningness | 4.08 [-11.03, 19.20] | .05 | .00 | .594 | | | | |
| Step 3 | | | | | .505 | .02 | .01 | .78 | 1.75 [1, 132] |
| | Morningness | 4.52 [-10.64, 19.69] | .06 | .00 | .556 | | | | |
| | Eveningness | 3.62 [-11.47, 18.71] | .05 | .00 | .636 | | | | |
| | Motivation | 9.06 [-4.50, 22.60] | .12 | .01 | .188 | | | | |
| Step 4 | | | | | .069 | .06 | .05 | 2.23 | 6.48 [1, 131] |
| | Morningness | 3.01 [-11.90, 17.92] | .04 | .00 | .690 | | | | |
| | Eveningness | 4.14 [-10.65, 18.93] | .05 | .00 | .581 | | | | |
| | Motivation | 3.71 [-10.20, 17.62] | .05 | .00 | .599 | | | | |
| | Planning | 17.94 [4.00, 31.87]* | .23 | .05 | .012 | | | | |
| Step 5* | | | | | .033 | .09 | .02 | 2.52 | 3.49 [1, 130] |
| | Morningness | 2.50 [-12.28, 17.28] | .03 | .00 | .738 | | | | |
| | Eveningness | 4.14 [-10.52, 18.79] | .05 | .00 | .577 | | | | |
| | Motivation | 4.53 [-9.27, 18.34] | .06 | .00 | .517 | | | | |
| | Planning | 18.96 [5.11, 32.81]* | .24 | .05 | .008 | | | | |
| | Habit | -12.44 [-25.60, .73] | -.16 | .02 | .064 | | | | |
| Step 6* | | | | | .047 | .11 | .03 | 2.04 | 1.22 [3, 127] |
| | Morningness | -.09 [-15.09, 14.90] | -.00 | .00 | .990 | | | | |
| | Eveningness | 5.46 [-9.36, 20.27] | .07 | .00 | .467 | | | | |
| | Motivation | .29 [-14.30, 14.89] | .00 | .00 | .969 | | | | |
| | Planning | 19.26 [5.04, 33.49]* | .24 | .05 | .008 | | | | |
| | Habit | -13.68 [-27.03, -.34]* | -.17 | .03 | .045 | | | | |
| | Motivation×planning | -10.47 [-23.61, 2.22] | -.17 | .02 | .105 | | | | |
| | Motivation×morningness | -.09 [-12.52, 12.33] | -.00 | .00 | .988 | | | | |
| | Motivation×eveningness | 1.05 [-15.54, 17.65] | .01 | .00 | .900 | | | | |

*Note: B* = unstandardised coefficient; CI = confidence interval; *β* = beta (standardised coefficient); $sr^2$ = squared semi-partial correlation coefficient.

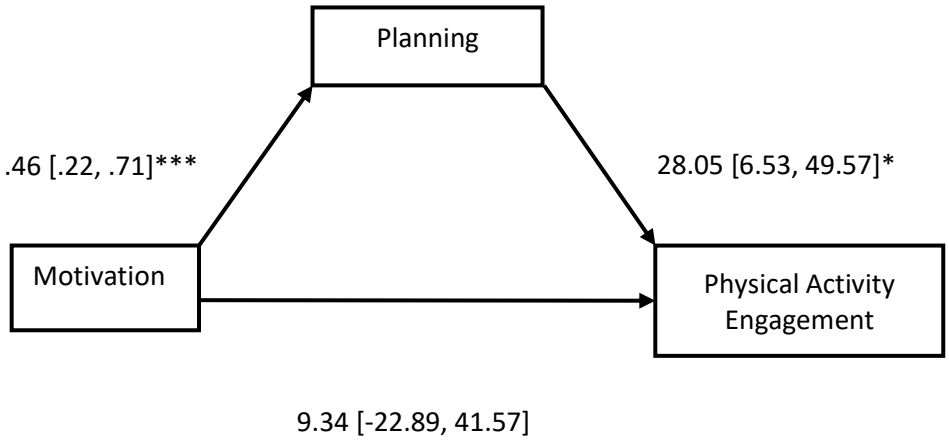
*$p$<.05

**Mediation Analysis**

To investigate whether the relationship between motivation and engagement in physical activity is indirect via planning, a mediation analysis was conducted. The mediation model explained a significant unique proportion of variance in engagement in physical activity $R^2 = .09$, $F(1, 134) = 13.91$, $p < .01$. According to Cohen (1988), this is a small effect ($f^2 = .10$). The direct effect of motivation did not significantly predict unique variance in engagement, $c' = 9.34$, 95% CI [22.89, 41.57], $p = .567$. The indirect effect of motivation via planning did significantly account for unique variance in engagement, $ab = 12.88$, BootLLCI/BootULCI [2.90, 27.25], $p < .05$. The results indicate full mediation (Figure 1) of the relationship between motivation and physical activity engagement by planning (see table 4). This suggests that individuals with better planning skills are more likely to translate their motivation to engage into performing their chosen physical activity.

**Figure 1**

*Full Mediation of the Relationship Between Motivation and Physical Activity Engagement via Planning.*




*$p$<.05, ***$p$<.001

**Table 4**

*Unstandardised (B) Regression Coefficients, 95% Confidence Intervals (CI), and R-Squared Coefficients for Motivation, Planning and Physical Activity Engagement.*

| Variable | *B* [LLCI, ULCI] | *SE* |
|---|---|---|
| DV = Plan ($R^2$ = .09)*** | | |
| Constant | .89 [-.48, 1.83] | .48 |
| Motivation | .46 [.22, .70] | .12 |
| DV = PA Engagement ($R^2$ = .06)* | | |
| Constant | -4.58 [-124.50, 115.35] | 60.63 |
| Motivation | 9.34 [-22.89, 41.57] | 16.29 |
| Planning | 28. 05 [6.53, 49.57] | 10.88 |

*Note:* PA = physical activity; *B* = unstandardised regression coefficients; LLCI = bootstrapped lower level confidence interval; ULCI = bootstrapped upper level confidence interval; *SE* = standard error estimates.

*$p$<.05, ***$p$<.001

## Discussion

The current study explored constructs derived from the health action process approach in combination with motivation, habit and morningness/eveningness, to investigate the predictors of physical activity engagement. The results showed self-efficacy and age were the only significant predictors of motivation to engage, whereas planning was the only significant predictor of physical activity engagement. Furthermore, planning mediated the relationship between motivation and engagement in physical activity.

### Predicting Motivation to Engage in Physical Activity

Our hypothesis that morningness/eveningness and self-efficacy would predict motivation to engage in physical activity when controlling for age, was partially supported as results showed that self-efficacy and age were the only significant predictors. This suggests that greater self-efficacy leads to increased motivation to engage in physical activity, in line with previous research (Tierney et al., 2012). Therefore, health professionals and personal trainers could look to increase self-efficacy by encouraging physical activity engagement with friends/family, as they provide support by conveying knowledge, and

facilitating safe activity (Steltenpohl et al., 2019). The current findings also provide further theoretical support for the importance of self-efficacy in understanding health behaviour.

The results showed younger adults were more motivated to engage in physical activity than older adults, suggesting that age is an important predictor of motivation. This is in line with previous literature showing inactive older adults to be less motivated to increase their physical activity than inactive younger adults (Alley et al., 2018). Literature in this area shows that social interaction can act as a motivator for older adults to engage (Kritz et al., 2021). Health professionals could therefore encourage older adults to engage in activities that promote social connection to improve their adherence to physical activity (Steltenpohl et al., 2019). Additionally, older adults may be less motivated to engage in physical activity as they may have physical injuries or degeneration that prevent them from being active (e.g., arthritis, poor mobility, weakened muscles). With this in mind, older people may also need the assistance of a walking frame or a wheelchair in order to move around. This is likely to decrease their motivation to be physically active as it limits the environments they can access and may mean they have to rely on others to help them move around. Therefore, health professionals, family members, or nurses could help older individuals set out times for when they can be physically active, so that they are able to help, as well as think about environments that are easily accessible (e.g., smooth paving in the neighbourhood, or an exercise pool; Costello et al., 2011).

**Predicting Physical Activity Engagement**

Our hypothesis that morningness/eveningness, habit, planning and motivation would predict physical activity engagement was partially supported. Results showed that planning was the only significant predictor of physical activity. This aligns with previous literature using the health action process approach, as it shows planning to be a strong predictor of individuals' engagement and maintenance of physical activity, despite potential barriers (Teleki et al., 2021). This provides further theoretical support for the importance of planning in behaviour change. Health professionals or

personal trainers could implement the 'action planning' behaviour change technique to increase physical activity engagement for clients who are inactive (Michie et al., 2013). This behaviour change technique can be implemented by developing actionable plans (i.e., when, where and how) that encourage engagement (Michie et al., 2013).

Additionally, the results showed that habit was not a significant predictor of physical activity engagement. Previous literature debates the true habitual nature of physical activity (Rhodes & Rebar, 2018), and our finding was not in line with more recent habit research which suggests that physical activity engagement can be initiated habitually (Phillips & Gardner, 2016). A potential explanation could be that the study was slightly underpowered. According to Cohen (1988), there was a small effect ($f^2$ = .13) between habit and physical activity engagement. Future research could explore the role of a person's tendency to habitually engage in physical activity by investigating whether routine is more important than automaticity. However, to investigate the role habit plays specifically in physical activity engagement, future research could also continue to use the more common Self-Report Habit Index (Verplanken & Orbell, 2003), as it measures habit strength by focusing on state-based automaticity (i.e., for a specific behaviour) rather trait-based.

Furthermore, results showed that motivation was not a significant predictor of physical activity engagement. This is not in line with the literature, as it has often been used to predict physical activity engagement (Deci & Ryan, 2000). Based on this, motivational approaches to behaviour change might not be suited to each individual or behaviour. The implementation of a multi-component approach to behaviour change might be more beneficial, as it would allow for an individualised action plan to be developed based on the person's goals, beliefs, and expectancies, rather than just on motivational factors (Lachman et al., 2018). An additional explanation could be that motivation is not the most important predictor of behavioural engagement. This is not uncommon, with previous research also finding other factors such as attitudes (Ogden et al., 2007) and cues to action (Liddelow et al., 2021b)

were more important predictors of health behaviour engagement, compared to motivation. Previous research has demonstrated that enjoyment plays an important role in individuals consistently engaging in physical activity (Carraro et al., 2014; Jekauc, 2015). Therefore, future research could explore enjoyment as part of health models, to see if it is a more proximal predictor of physical activity behaviour.

**Role of Morningness/Eveningness**

In contrast to our hypothesis, results showed that morningness/eveningness did not predict motivation to engage or engagement in physical activity. This suggests that engaging in physical activity during an individual's preferred time-of-day may not be important in this sample. The current results appear to contrast those of Blazer et al. (2020), who demonstrated that individuals had higher motivation to engage during their preferred time-of-day. Furthermore, Mulè et al. (2020) suggested that individuals performed physical activities better at their preferred time-of-day. Based on other previous research (Díaz-Morales & Randler, 2017), an explanation for our finding could be that during an individual's preferred time-of-day, they might engage in activities that require peak cognitive functioning (e.g., studying), rather than peak physical functioning. Future research should explore this by investigating whether cognitive load predicts if individuals engage in more physical or cognitive functioning activities during their preferred time-of-day. A further explanation might be that external events (e.g., taking care of children, shift work, seasonal changes) could inhibit people from engaging in physical activity (Sechrist et al., 1987). Future research could investigate whether this barrier prevents people from engaging in physical activity at their preferred time-of-day. This could be done by incorporating an open-ended question or conducting a qualitative study, exploring why individuals think they do not engage in physical activity at their preferred time-of-day.

Furthermore, our hypothesis that morningness/eveningness would moderate the relationship between motivation and physical activity engagement, was not supported. It appears that no other

previous research has explored this moderating effect. Additionally, the present study also established that planning does not significantly moderate the relationship between motivation and physical activity engagement. This is not in line with previous research showing the motivation-activity relationship was stronger when individuals plan to a greater extent (de Bruijn et al., 2012). These two results may suggest other variables moderate the motivation-engagement relationship. Based on this, future research could explore the effect other predictors, such as self-control, have on the motivation-engagement relationship.

**Planning Mediation**

Our results showed that planning significantly mediated the relationship between motivation and physical activity engagement, supporting previous literature that utilises the health action process approach (Scholz et al., 2008). This mediation suggests motivation to engage predicts the extent to which an individual plans their engagement, and subsequently, this predicts their engagement in physical activity. For instance, a highly motivated individual will plan to a greater extent and, therefore, engage in physical activity more consistently. Health professionals could help individuals improve the extent to which they plan, by implementing goal-setting theory into the planning of their engagement in physical activity (Swann et al., 2022). This can be done by assessing the individual's commitment, knowledge, facilities and ability to perform their desired physical activity (Swann et al., 2022). Based on this initial assessment specific plans can be created to achieve their physical activity goals (Swann et al., 2022).

**Strengths and Limitations**

Previous research investigating the role of morningness/eveningness in the context of physical activity has occurred in controlled environments, requiring participants arrive at specific times during the morning, afternoon and evening, to perform a specific exercise (e.g., bench press, fitness tests; Blazer et al., 2020; Mulè et al., 2020). In contrast, the current study has a more naturalistic design. This

is a strength, as it provides a truer representation of how important morningness/eveningness is in individuals engaging in physical activity. Overall, there is not a lot of research that explores this individual difference in the context of physical activity. Therefore, another strength of the current study is that it contributes to the growing body of research in this field. This is important as it can help health professionals and individuals see what could be inhibiting them from engaging in physical activity on a regular basis.

This study is not without its limitations. The current study measured physical activity subjectively with the shortened version of the International Physical Activity Questionnaire, which is a well-validated measure in physical activity research. However, we were unable to measure physical activity objectively. Only having self-report data could suggest the amount of physical activity that each participant reported is not an accurate reflection of their physical activity engagement. In order to reduce this potential inaccuracy, future research could look at collecting physical activity data via participants' own fitness watches. Participants sending screenshots of their physical activity from these devices could act as supporting evidence for any subjective data that might be collected. This could allow researchers to gather data that may be a better representation of an individual's engagement.

## Conclusion

The aim of this study was to apply constructs from the health action process approach and self-determination theory, with the additions of habit and morningness/eveningness, to predict physical activity engagement. The current study showed that self-efficacy and age are important predictors of motivation to engage in physical activity. Furthermore, physical activity engagement can be predicted by planning. Even though morningness/eveningness was not a significant predictor, these findings could guide behaviour change techniques focused on implementing actionable plans, the formation of physical activity routines and promoting social interaction. Furthermore, it could guide interventions aimed at facilitating an increase in physical activity engagement.

## Chapter 3: Combing Theoretical Approaches to Explore Individuals' Physical Activity Engagement

In the previous chapter, we identified that some of the variables that were derived from current health models were more important in physical activity engagement. These variables included self-efficacy and planning from the health action process approach (Schwarzer, 1992). However, the integration of the health action process approach and self-determination had low predictive utility of physical activity engagement. Therefore, this chapter extends the previous chapter as we wanted to determine the predictive utility of combining and integrating the theory of planned behaviour (Ajzen, 1991) and temporal self-regulation theory (Hall & Fong, 2007), in determining individuals'h physical activity engagement. Similar to the previous chapter, we incorporated morningness/eveningness to determine whether it plays a role in individuals being active. Additionally, we added the variable of enjoyment to understand if it is a more important predictor of future physical activity engagement than motivation (which was non-significant in the previous chapter).

**Abstract**

**Background:** Consistent physical activity is important for reducing poor physical and mental health outcomes. Despite most people being aware of the benefits of physical activity, many people struggle to engage regularly. Various strategies have been suggested to improve an individual's adherence to physical activity, for instance, time-of-day preference has been shown to play an important role in training habituation. In the current study, this preference will be referred to as morningness/eveningness.

**Aims:** The aim of the current study is to apply constructs from the theory of planned behaviour and temporal self-regulation theory to predict physical activity engagement, with the addition of enjoyment and morningness/eveningness

**Methods:** A prospective design was used to collect data from 228 participants, at two-time points, seven days apart, to investigate the predictors of physical activity engagement. Two hierarchical multiple regressions were used to examine the relationship between the predictor variables and physical activity engagement.

**Results** Individuals with greater perceived behavioural control had stronger intentions to be physically active, while past engagement in physical activity, environmental cues and habit (automaticity) directly predicted physical activity engagement. However, morningness/eveningness was not a significant predictor.

**Conclusion:** This study demonstrates that perceived behavioural control is an important predictor of intention to engage in physical activity. Furthermore, physical activity engagement can be predicted by past behaviour, environmental cues, and the automaticity component of habit. These findings could guide behaviour change strategies focused on implementing goal-priming and promoting implementation-intentions. Furthermore, it could guide interventions emphasising physical activity engagement.

## Introduction

Regular physical activity improves fitness, cardiovascular health, and mental well-being (Warburton et al., 2006). Individual differences are often not included in physical activity research, despite being important (Hisler et al., 2017). An example of these individual differences is morningness/eveningness, as described in Chapter 1. In order to continue to understand the role that morningness/eveningness plays in physical activity engagement, the current study has integrated it, along with enjoyment, into a dual-process model.

Enjoyment, in a physical activity context, has been defined as a positive response to exercise experiences, for example, feelings such as pleasure and fun (Carraro et al., 2014). People tend to approach pleasant events and avoid aversive ones (Jekauc, 2015). Furthermore, research suggested that people who enjoy physical activity are more likely to be consistent with their engagement compared to those who do not enjoy it (Carraro et al., 2014). The role of enjoyment, in the context of physical activity, has focussed on a variety of populations in a range of environments. Research exploring physical activity engagement in the school environment demonstrated that negative experiences in, and perceptions of, physical activity are an important factor in a decline in physical activity engagement (Cairney et al., 2012). Additionally, with regards to demographic differences, the more women report enjoying physical activity the more likely they are to engage consistently (Budd et al., 2018). Cairney et al. (2012), similarly established that an increase in enjoyment leads to more physical activity engagement among children and adolescents. Despite enjoyment being an important factor for behaviour (e.g., physical activity), it is not often integrated with health models.

The theory of planned behaviour is a model that is commonly used to understand the predictors of health behaviours (Kothe et al., 2015; Liddelow et al., 2021a), as well as in physical activity research (Allom et al., 2016; Mullan et al., 2016; Mullan et al., 2021). This model suggests that intention is a strong predictor of engagement in behaviour (Ajzen, 1991). According to the theory, a person's

intention to engage in a specific behaviour can be predicted by their attitude, subjective norm, and perceived behavioural control towards that behaviour (Ajzen, 1991). Attitude consists of how people feel about engaging in a particular behaviour (e.g., pleasant, or unpleasant; Ajzen, 1991). Subjective norm refers to a person's belief as to whether people important to them or people like them would approve or disapprove of them engaging in a specific behaviour (Ajzen, 1991). Whereas, perceived behavioural control encompasses how difficult a person thinks it would be to engage in a specific behaviour (Ajzen, 1991). However, a meta-analysis showed that while the theory of planned behaviour predicts 44% of intention to engage, it only predicts 19% of the variance in the performance of a specific behaviour (McEachan et al., 2011).

Temporal self-regulation theory is another model that is often used to attempt to close this intention behaviour gap (Hall & Fong, 2007). Intention, behavioural prepotency, and self-regulatory capacity are the main components of this model (Hall & Fong, 2007). In this case, intention refers to the activity that someone aims to perform. Additionally, behavioural prepotency refers to the likelihood that an individual will engage in a specific behaviour based on their past behaviour, how habitual their behaviour and how they respond to environmental triggers (Booker & Mullan, 2013; Hall & Fong, 2007; Liddelow et al., 2021b). In particular, temporal self-regulation theory directly influences behaviour as well as moderate the relationship between intention and engagement in health behaviours, such as physical activity (Evans et al., 2017; Hall, 2013). In previous health behaviour literature, the behavioural prepotency components of environmental cues and habit are most commonly assessed (Liddelow et al., 2021a; Liddelow et al., 2021b; McAlpine & Mullan, 2022). Environmental cues are aspects of the environment that trigger the automatic performance of a behaviour (Hall & Fong, 2007). For example, putting out running shoes and workout clothes the night before may trigger a person to put them on in the morning, and consequently lead them to be physically active (Rhodes & Rebar, 2018). Habit involves engaging in a particular behaviour on a regular basis so an association can develop between the cue and

the activity (Rhodes & Rebar, 2018). Habit consists of two components: automaticity and routine (Ersche et al., 2017). Automaticity occurs as individuals begin to link cues with the performance of a behaviour, leading to behaviours occurring without conscious thought (Rhodes & Rebar, 2018). Whereas, routine involves performing specific behaviours that result in the execution of the desired behaviour (Wyckmans et al., 2020).

Furthermore, self-regulatory capacity refers to a person's ability to control their thoughts, feelings and actions, which can impact their engagement in a behaviour, such as physical activity (Cameron & Webb, 2013; Hall & Fong, 2007). For example, the less control a person has over thoughts such as "it's too cold", or feelings such as "I'm too tired", the less likely they are to engage in physical activity (Hall & Fong, 2007). The extent to which a person can plan their physical activity has been linked with their self-regulatory capacity (Hall & Fong, 2007). For example, Cameron and Webb (2013) determined that the more a person plans, the greater their self-regulatory capacity.

**The Current Study**

The aim of the current study was to predict physical activity engagement using constructs from temporal self-regulation theory and the theory of planned behaviour, with the addition of enjoyment and morningness/eveningness (see Figure 2). However, previous literature shows a similarity between the pre-intention constructs of the theory of planned behaviour and temporal self-regulation theory (Ajzen, 2011; Hall & Fong, 2007). Combining the pre-intention variables of the theory of planned behaviour and the post-intention variables of temporal self-regulation theory has been successfully incorporated in previous health psychology research (Liddelow et al., 2021a). Therefore, the aim of this study was to determine whether this combination of models and additional variables could successfully predict physical activity engagement.

Based on the tenets of the theory of planned behaviour (Ajzen, 2011) and temporal self-regulation theory (Hall & Fong, 2007), and previous literature (Blazer et al., 2020; Cairney et al., 2012; Carraro et al., 2014; Hisler et al., 2017), it was hypothesised that:

H1: Attitude, subjective norm and perceived behavioural control will predict peoples' intention to engage in physical activity.

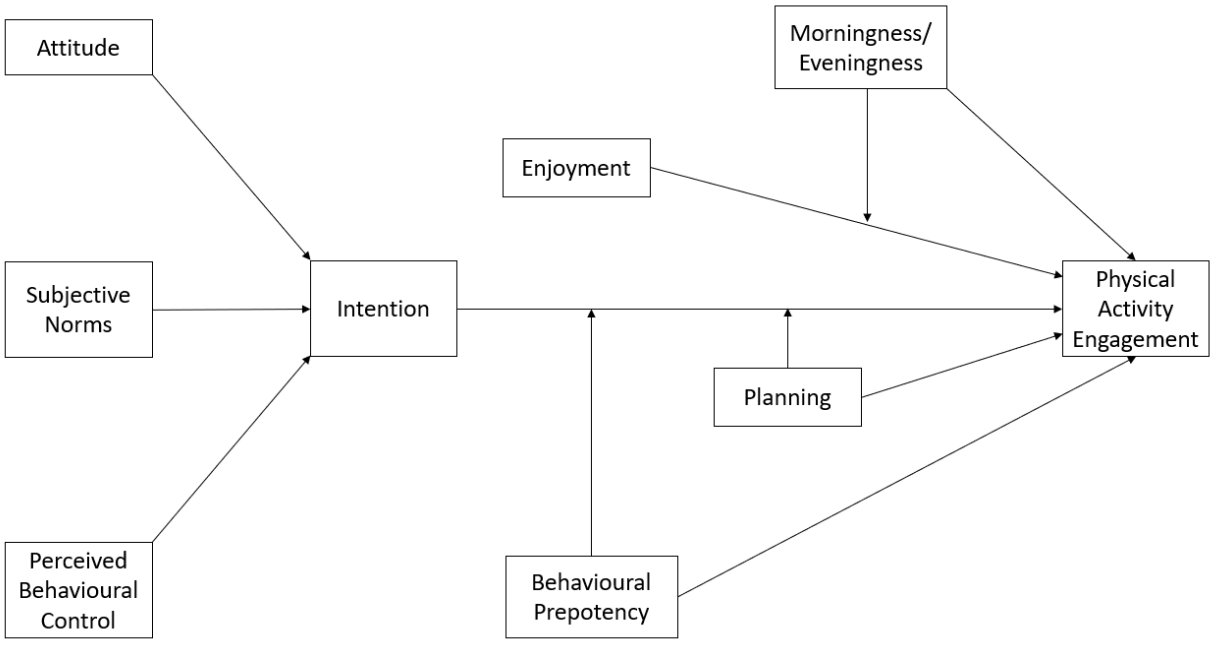
H2: Enjoyment, morningness/eveningness, intention, planning, habit, environmental cues, and past engagement in physical activity will directly predict engagement in physical activity.

H3: Planning, habit, past physical activity engagement and environmental cues will moderate the relationship between intention and physical activity engagement, such that individuals who plan to a greater extent, have stronger habits, and more environmental cues will have greater associations between intention and physical activity engagement.

H4: Morningness/Eveningness will moderate the relationship between enjoyment and physical activity engagement, such that the association between enjoyment and physical activity will be greater when individuals' engagement aligns with their morningness/eveningness preference.

**Figure 2**

*A Combined and Extended Theory of Planned Behaviour and Temporal Self-Regulatory Theory* (Ajzen, 2011; Hall & Fong, 2007).




## Method

### Research Design

A prospective cross-sectional design was used to collect data from participants at two time points, seven days apart, to investigate the predictors of physical activity engagement. At time one, participants completed measures of morningness/eveningness, the variables associated with the theory of planned behaviour and temporal self-regulation theory, physical activity, enjoyment and demographics (e.g., age, gender, type of physical activity). At time two, seven days later, physical activity behaviour was measured through self-report and objective methods. Additionally, participants were asked if they engaged in physical activity at their preferred time-of-day. Physical activity was defined as any vigorous or moderate activity that was completed for recreation or exercise (Craig et al., 2003). Activities associated with housework, gardening, or team sport were excluded.

## Measures

### *Time One.*

#### Enjoyment.

Enjoyment was measured using the 12-item short version of the Physical Activity Enjoyment Scale (PACES; Kendzierski & DeCarlo, 1991). Based on previous research (Kendzierski & DeCarlo, 1991), the original 16-item scale was reduced to 12-items by removing the following 4 items (i.e., "I get something out of it", "It's very exciting", "It gives me a strong feeling of success" and "It makes me depressed"). The scale starts with the statement: "When I engage in physical activity…", with each item measured on a 5-point scale with 1 indicating "completely disagree" and 5 "completely agree". The score on both subscales ranged from 12 to 60 and is obtained by summing the ratings of the items. Higher scores indicated greater levels of enjoyment when physically active. The Cronbach's alpha in this study was excellent ($\alpha$ = .89).

#### Theory of Planned Behaviour variables.

The theory of planned behaviour questionnaire was created using the guidelines from Ajzen (2006). This questionnaire was used to measure the pre-intention variables (i.e., attitude, subjective norm, perceived behavioural control and intention) of the theory of planned behaviour. Some of the variables were measured using a single item. This is guided by previous research demonstrating that single-item measures are less ambiguous in the measurement of the associated construct (in this case, perceived behavioural control and intention; Allen et al., 2022).

#### *Attitude.*

Attitude was measured using two items that ask participants how they felt about engaging in physical activity. These items were prefaced by the statement, "I think engaging in physical activity is…". Participants were asked to respond either bad/good and unpleasant/pleasant. Items were summed, with higher total scores showing a more positive attitude towards physical activity engagement.

***Subjective norm.***

Two different aspects of subjective norm were measured using two items. One item was used to measure the descriptive aspect (“Most people who are like me engage in physical activity regularly”), and the other for the social aspect (“Most people who are like me think that I should engage in physical activity regularly”). Both items were answered on a 7-point Likert scale ranging from 1 “strongly disagree” to 7 “strongly agree”. Higher scores on the descriptive item the more important the perceptions of significant others’, on an individuals’ physical activity engagement. Additionally, higher scores on the social aspect, the more significant the opinions of important others’, on an individuals’ physical activity engagement.

***Perceived behavioural control***

Perceived behavioural control was measured using one question related to their level of confidence and control in physical activity engagement (e.g., “Engaging in physical activity is something that is up to me”). Participants answered on a 7-point Likert scale ranging from 1 “strongly disagree” to 7 “strongly agree”. Individual item scores were averaged, with higher scores indicating higher perceived behavioural control.

***Intention.***

Intention was measured using one item (e.g., “I intend to engage in physical activity over the next week”), with answers provided on a 7-point Likert scale ranging from 1 “strongly disagree” to 7 “strongly agree”. Higher scores on this item mean greater intention to engage in physical activity.

**Temporal Self-Regulation Theory variables.**

***Habit.***

Habit strength was measured using the Creature of Habit Scale (COHS; Ersche et al., 2017) and the Self-Report Habit Index (Verplanken & Orbell, 2003). The Creature of Habit Scale (COHS) consists of 27-items, with 11-items assessing "automaticity" and 16-items measuring "routine" (Ersche et al., 2017).

This questionnaire assesses an individual's habitual tendencies when engaging in a specific behaviour, as well as differences between the automaticity and routine aspects (Ersche et al., 2017). However, in this study, only the items related to the "routine" subscale were used (e.g., "I find comfort in regularity"; Ersche et al., 2017). This subscale was measured using a five-point scale ranging from 1 "definitely disagree" to 5 "definitely agree". Higher scores indicate stronger habits. The Cronbach's alpha in the current study was .75.

Seven items (items 2, 3, 5, 7, 8, 9, and 10) of the Self-Report Habit Index measure automaticity (Gardner et al., 2012). However, items 2, 3, 5 and 8 most consistently captured automaticity (Gardner et al., 2012). Therefore, these 4-items were used in this study to measure the automaticity component of habit (Gardner et al., 2012). Participants reported how much they agreed with the statements "Being physically active is something I do automatically, I do without thinking, I do without having to consciously remember, and I start doing before I realise, I'm doing it" on scales ranging from 1 "completely disagree" to 7 "completely agree". Overall scores came from calculating the mean of all four items, with higher scores indicating greater habit strength. The internal consistency for the scale was .92.

***Environmental cues.***

Environmental cues were measured using the Cues to Action Scale (Black et al., 2017; Booker & Mullan, 2013; McAlpine & Mullan, 2022). This scale uses five subscales to measure cues. Each subscale began with the question "Are there any physical/sensory/social/internal/ emotional things in the environment which trigger you to engage in physical activity." Answers of "no", were given a score of zero for that subscale. If answered "yes", they were asked about the frequency of the cue on a scale ranging from 0 "never" to 7 "a few times a day". Followed by how influential the cue was in initiating the behaviour on a scale ranging from 0 "not at all likely" to 6 "every time". Scores for subscales with an initial "yes" answer, were determined by multiplying the scores on the frequency questions with the

influence ones. The overall score was then the mean of all five subscales. Higher scores indicated the use of more types of cues and these cues having greater influence in being physically active.

***Physical activity.***

Participants' previous physical activity behaviour was determined using the shortened version of the International Physical Activity Questionnaire (IPAQ-S; Craig et al., 2003). The IPAQ-S has six items that explore a participant's physical activity over the past seven days (e.g., "During the last 7 days, on how many days did you do vigorous physical activities?"; Craig et al., 2003). These items are evenly split (i.e., two items each) into three subscales – vigorous-intensity physical activity, moderate-intensity physical activity and walking. The more days and time reported, the more physical activity the individual engaged in.

***Planning.***

Planning was measured using the planning subscale from the Self-Regulation Questionnaire (Brown et al., 1999). The subscale has nine items and uses a five-point Likert scale, ranging from 1 "strongly disagree" to 5 "strongly agree", to measure participants' ability to plan and set goals (e.g., "I have a hard time setting goals for myself"). The item scores were summed. Higher scores suggested a greater inclination to plan. This scale demonstrated excellent reliability with a Cronbach's alpha of .86.

**Morningness/Eveningness.**

Morningness/Eveningness was measured with the 5-item reduced version of the Morningness/Eveningness Questionnaire (rMEQ; Adan & Almirall, 1991). These five questions clearly distinguish different time-of-day orientations. The questions are related to the individual's preferred time to wake up and go to sleep, when they experience peak performance, alertness and self-assessment of morning/evening types. Scores ranged from 4 to 25, from which participants were categorised into 'evening-types' (scores of 4-11), 'neither-types' (scores of 12-17), and 'morning-types' (scores of 18-25). The Cronbach's alpha in this study was .78.

***Time Two.***

**Physical activity.**

Participants were asked to provide a screenshot of their weekly exercise summary from their fitness watch. Within each screenshot, participants were asked to include the time at which the activity took place, the type of activity that they engaged in, and the total time they performed that activity. In order to combat recall difficulties, this more objective data was used to support the self-report data, as participants were asked to use the recorded activity from their fitness watches as a guide to complete the timeline follow-back section of the survey.

Additionally, the Timeline Follow Back method (Sobell & Sobell, 1992) was used to measure physical activity subjectively after seven days. This method involves participants retrospectively reporting their physical activity over the previous seven days. However, if participants experienced any technical difficulties, this method also provided the opportunity for all physical activity to be reported. Participants were asked to report what time they were physically active, what type of physical activity they engaged in, as well as how much time (in minutes) they spent engaging in physical activity (i.e., 'active minutes' or 'workout minutes'), over the previous seven days.

Furthermore, participants were asked whether they engaged in physical activity at their preferred time of day. This was measured on a scale where 1 was "yes", and 2 was "no". Participants who answered "no", were then provided with a text-entry box where they could provide an explanation for why they thought they were not physically active at their preferred time of day.

**Procedure**

Prior to data collection, an *a*-priori power analysis was conducted using G*Power (version 3.1.9.7). A hierarchical multiple regression was run with a large effect size ($f^2$ = .9; Nicholson et al., 2022), error probability of .05, a power level of .80 and fifteen predictors. As a result, this study required a minimum of 36 participants. However, to account for the inclusion of interactions in the second

regression as a means of testing for moderating effects, Green (1991) suggests a minimum sample size of 119. Additionally, in consideration of anticipated attrition between the two-time points (of approximately 30%), we aimed to recruit a total sample size of 166.

Once ethics approval was provided by the University's Human Research Ethics Committee (HRE2022-0250). Participants were recruited via convenience sampling using social media networks (e.g., Facebook, Instagram, Twitter, and Reddit). Advertisements included the survey link where participant could access the online Qualtrics questionnaire. Social media was a feasible and timely way to recruit the required number of participants. The eligibility criteria, in this study, included participants tracking their physical activity with a fitness watch (including but not limited to Fitbit, Apple, Garmin, and Samsung), understanding written English, and being over the age of 16. Eligible participants were asked to complete an online questionnaire hosted on Qualtrics. An information sheet was provided, and informed consent was obtained from each participant. This first questionnaire took approximately 15 minutes to complete. Once the questionnaire had been completed, each participant was thanked for their time and asked to provide an email address where they could be reached to complete time two.

Seven days after the completion of time one, participants received an email with the link for time two as well as an individualised instruction booklet. Each booklet consisted of a step-by-step guide on how to access the data that needed to be captured in a screenshot. This questionnaire took approximately 5 minutes and asked participants to self-report various details that had been tracked with their fitness watches, as well as provide screenshots of the weekly summary screens for each day.

**Data Analysis**

The raw data was checked, and participants who did not complete both parts of this study were removed from all data analyses. Following this, any participants who did not complete the physical activity measures or where more than 30% of the questions were not answered, were deleted. Two attention-check questions were integrated into the survey. If these were not completed, the

participants' data was also removed. After the deletion of these cases, a missing values analysis was run at the individual item level. Ninety-eight cases had at least one missing value identified, making the extent of missingness 3.17%. Little's MCAR test was $\chi^2$ (63, $N$ = 228) = 72.08, $p$ = .203, therefore this data was missing completely at random, and was imputed using expectation maximisation (Tabachnick & Fidell, 2013).

Using IBM SPSS Statistics 27 (IBM Corp, 2020), assumption tests for normality, outliers, multicollinearity, and homoscedasticity were run, and assumed. Descriptive statistics and bivariate correlations were conducted using the unstandardised predictor and outcome variables.

Two hierarchical multiple regression analyses were run. The first was used to predict intention to engage in physical activity, with attitude, subjective norm and perceived behavioural control being entered at step one, as per the theory of planned behaviour.

The second regression was used to directly predict physical activity engagement. Based on the outcome of the bivariate correlation, age was the only demographic variable that significantly correlated with physical active engagement; therefore, it was entered at step one. Enjoyment at step two; morning/eveningness at step three; intention at step four; planning at step five; habit, environmental cues, past engagement in physical activity in step six; and the following interactions at step seven, intention×planning, intention×habit, intention×environmental cues, intention×past physical activity engagement and enjoyment×morningness/eveningness.

## Results

### Participants

A total of 482 participants completed time one, and 259 participants completed time two (attrition of 53.18%). After the removal of these participants, a total sample of 228 remained in the data analysis. Most participants resided in Australia (98.2%, $n$ = 224) and 4 participants lived overseas (e.g., South Africa, Saudi Arabia, Ireland, and the USA). Participants were between 19-78 years old ($M$ = 41.76,

*SD* = 14.48), with 85.5% identifying as female (*n* = 195), 14% male (*n* = 32) and 0.4% identified as non-binary (*n* = 1). The reported median time spent engaging in physical activity was approximately 410 minutes per week at time one and 305 minutes at time two. Related to this, 56.6% of participants engaged in a mixture of cardio and weight/strength-based activity (*n* = 129), 33.8% only engaged in cardio-based physical activity (*n* = 77), 6.5% only engaged in weight/strength-based activity (*n* = 15), and 3.1% reported that they did not engage in either of these (*n* = 7). These seven participants engaged in Pilates or yoga. A total of 12 different fitness watches were used. Garmin was used be 55.3% of participants (*n* = 126), 20.2% used Apple (*n* = 46), 15.4% used Fitbit (*n* = 35), 3.5% used Samsung (*n* = 8), and 13 participants had another type of fitness watch (e.g., Whoop Strap, Huawei, Polar).

With regards to morningness/eveningness, there were 32.9% morning-types (*n* = 75), 8.8% evening-types (*n* = 20), and 58.3% neither-types (*n* = 133). Despite, majority of the sample being categorised at neither-type, 186 (81.6%) individuals said that they did feel that they engaged in physical activity at their preferred time of day. The most common reasons for individuals not engaging at their preferred time of day was work and family commitments. Some other reasons included study commitments, wellbeing (e.g., not wanting to sacrifice sleep, being unwell), weather (e.g., being too dark and cold during winter), having been on holiday, or external factors (e.g., personal trainer availability, scheduling of events/races, wanting to align with partners schedule). However, some of these explanations were described as being short-term disruptions (e.g., short-term shift changes, being unwell, holiday, seasonal changes, university lecture timetable), whereas others appeared to be relatively rigid commitments (e.g., full-time work, looking after children, not wanting to sacrifice sleep).

**Relationships between Variables**

Pearson's Bivariate Correlation (*r*) was conducted on the unstandardised variables to determine the association between the predictor and outcome variables. Based on this correlation analysis, none of the demographic variables correlated with intention to engage in physical activity. However, it did

show a significant, small, positive relationship between physical activity engagement (time two) and age ($r$ = .167, $p$ = .012). It also highlighted significant, small, positive relationship between physical activity engagement (time two) and planning ($r$ =.136, $p$ =.040), enjoyment ($r$ =.181, $p$ = .006), attitude ($r$ =.175, $p$ = .008) and perceived behavioural control ($r$ =.167, $p$ = .012). The findings of the correlation analysis also demonstrated that there was a significant, small to moderate, positive relationship between physical activity engagement (time two) and habit (automaticity; $r$ =.380, $p$ < .001 and morningness/eveningness ($r$ =.214, $p$ = .001). Furthermore, there was also a significant, moderate, positive relationship between physical activity engagement (time two) and past behaviour ($r$ = .555, $p$ < .001). The strength of these relationships is in accordance with Cohen's (1988) conventions. Table 5 shows the means, standard deviations and correlations between the variables that were used in the analyses

**Table 5**

*Descriptive Statistics and Correlations of the Significant Predictors of Intention to Engage and Physical Activity Engagement*

| | *M* | *SD* | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age | 41.76 | 14.48 | -.15* | .00 | -.14* | .20** | .09 | .03 | .21** | -.18** | -.26** | .10 | -.05 | .21** | .17* |
| 2. Habit (routine) | 3.41 | .45 | - | .20** | .16* | -.03 | .05 | .12 | .09 | -.01 | .06 | .02 | .08 | .22** | .05 |
| 3. Habit (automaticity) | 4.67 | 1.53 | - | - | .66** | .17** | .50** | .35** | .28** | -.06 | .13 | .23** | .11 | .35** | .38** |
| 4. Environmental Cues | 14.72 | 5.71 | - | - | - | .20** | .61** | .46** | .32** | .13 | .19** | .31** | .28** | .28** | .23** |
| 5. Planning | 31.40 | 6.28 | - | - | - | - | .24** | .23** | .19** | -.04 | .01 | .14* | .04 | .31** | .14* |
| 6. Enjoyment | 51.14 | 5.97 | - | - | - | - | - | .24** | .52** | -.01 | .00 | .25** | .23** | .20** | .18** |
| 7. Past PA Engagement (min/week) | 475.04 | 418.50 | - | - | - | - | - | - | .10 | .03 | .01 | .14* | .10 | .14* | .56** |
| 8. Attitude | 1.98 | .08 | - | - | - | - | - | - | - | -.14* | -.09 | .25** | .16* | .16* | .18** |
| 9. Subjective norm (descriptive) | 1.98 | .15 | - | - | - | - | - | - | - | - | .03 | .05 | .08 | -.10 | -.01 |
| 10. Subjective norm (social) | 1.68 | .47 | - | - | - | - | - | - | - | - | - | -.01 | -.11 | -.06 | -.08 |
| 11. PBC | 6.68 | .81 | - | - | - | - | - | - | - | - | - | - | .32** | .05 | .17* |
| 12. Intention | 6.82 | .80 | - | - | - | - | - | - | - | - | - | - | - | .04 | .08 |
| 13. Morningness/Eveningness | 15.98 | 3.02 | - | - | - | - | - | - | - | - | - | - | - | - | .21** |
| 14. Physical activity (min/week) | 359.00 | 264.91 | - | - | - | - | - | - | - | - | - | - | - | - | - |

*Note:* PA = physical activity; PBC = perceived behavioural control; 2 = Habit (Routine); 3 = Habit (Automaticity); 4 = Environmental cues; 5 = Planning; 6 = Enjoyment; 7 = Past PA engagement; 8 = Attitude; 9 = Subjective norm (Descriptive); 10 = Subjective norm (Social); 11 = PBC; 12 = Intention; 13 = Morningness/Eveningness; 14 = Physical activity.

*$p$<.05, ***$p$<.001

**Predicting Intention to Engage in Physical Activity**

The first hierarchical multiple regression was conducted using standardised scores to investigate whether attitude, subjective norm and perceived behavioural control accounted for a significant proportion of variance in intention to engage in physical activity. Based on the results of the correlation analysis, no demographic variables were included as covariates. In step one, attitude, subjective norm and perceived behavioural control were entered. The model, as a whole, accounted for a significant 12.4% of the variance in intention, $R^2 = .12$, $F\ (4, 223) = 7.86$, $p < .001$. However, perceived behavioural control ($p < .001$) was the only significant predictor. According to Cohen's (1988) conventions, this is classified as a small-moderate effect ($f^2 = .14$). See Table 6 for the unstandardised and standardised coefficients and squared semi-partial correlations for each predictor variable.

**Table 6**

*Unstandardised (B) and Standardised (β) Coefficients, and Squared Semi-Partial Correlations ($sr^2$) for Each Predictor Variable Entered into a Regression Predicting Intention to Engage in Physical Activity*

| | Variable | *B* [95% CI] | *β* | $sr^2$ | p-value | $R^2$ | $\Delta R^2$ | *F* | $\Delta F$ [*df1, df2*] |
|---|---|---|---|---|---|---|---|---|---|
| Step 1*** | | | | | <.001 | .124 | .124 | 7.86 | 7.86 [*4, 223*] |
| | Attitude | .921 [-.38, 2.23] | .09 | .00 | .166 | | | | |
| | Subjective norm (descriptive) | .427 [-.26, 1.11] | .08 | .01 | .220 | | | | |
| | Subjective norm (social) | -.172 [-.35, .04] | -.10 | .01 | .113 | | | | |
| | PBC | .287 [.16, .42] | .29 | .08 | <.001 | | | | |

*Note:* PBC = perceived behavioural control; *B* = unstandardised coefficient; CI = confidence interval; *β* = beta (standardised coefficient); $sr^2$ = squared semi-partial correlation coefficient

****p*<.001

**Predicting Physical Activity Engagement**

The second hierarchical multiple regression was conducted using standardised scores to investigate whether enjoyment, morningness/eveningness, intention, planning, habit, environmental cues and past physical activity engagement account for a significant proportion of variance in physical activity engagement. Based on the results of the correlation analysis, in step one, age was controlled for and explained a significant 2.8% of variance, $R^2$ = .03, $F$ (1, 226) = 6.47, $p$ = .012. In step two, enjoyment and morningness/eveningness were entered and accounted for an additional significant 7.9% of variance $\Delta R^2$ = .05, $\Delta F$ (2, 224) = 6.27, $p$ = .002. Intention was added in step three and accounted for an additional non-significant 8.2% of variance, $\Delta R^2$ = .00, $\Delta F$ (1, 223) = .72, $p$ = .396. At step four, planning was entered and accounted for an additional non-significant 8.3% of variance, $\Delta R^2$ = .00, $\Delta F$ (1, 222) = .25, $p$ = .618. In step five, habit (routine and automaticity), environmental cues, and past physical activity engagement were entered and accounted for an additional significant 40.8% of variance, $\Delta R^2$ = .32, $\Delta F$ (4, 218) = 29.85, $p$ <.001. Lastly, in step six, the intention×planning, intention×habit (routine), intention×habit (automaticity), intention×environmental cues, intention×past physical activity engagement and enjoyment×morningness/eveningness interactions were added and additionally accounted for a non-significant 41.1% of variance, $\Delta R^2$ = .00, $\Delta F$ (6, 212) = .22, $p$ = .972. In combination, the 15 predictors explained 41.1% of variance, $R^2$ = .41, $F$ (6, 212) = 9.87, $p$ <.001. However, habit (automaticity; $p$ <.001), environmental cues ($p$ = .010) and past physical activity engagement ($p$ < .001) were the only significant predictors. According to Cohen's (1988) conventions, this is classified as a large effect ($f^2$ = .70). See Table 7 for the unstandardised and standardised coefficients and squared semi-partial correlations for each predictor variable.

**Table 7**

*Unstandardised (B) and Standardised (β) Coefficients and Squared Semi-Partial Correlations ($sr^2$) for Each Predictor Variable Entered into a Regression Predicting Physical Activity Engagement.*

| | Variable | *B* [95% CI] | *β* | $sr^2$ | *p*-value | $R^2$ | $\Delta R^2$ | *F* | $\Delta F$ [*df*1, *df*2] |
|---|---|---|---|---|---|---|---|---|---|
| Step 1* | | | | | .012 | .03 | .03 | 6.47 | 6.47 [*1, 226*] |
| | Age | 44.18 [9.95, 78.42] | .17 | .03 | .012 | | | | |
| Step 2* | | | | | .002 | .08 | .05 | 6.43 | 6.27 [*2, 224*] |
| | Age | 32.04 [-2.24, 66.31] | .12 | .01 | .067 | | | | |
| | Enjoyment | 36.36 [2.13, 70.58] | .14 | .02 | .037 | | | | |
| | Morningness/Eveningness | 42.56 [7.68, 77.43] | .16 | .02 | .017 | | | | |
| Step 3** | | | | | .396 | .08 | .00 | 5.00 | .72 [*1, 223*] |
| | Age | 33.10 [-1.29, 67.48] | .13 | .01 | .059 | | | | |
| | Enjoyment | 32.87 [-2.32, 68.05] | .12 | .01 | .067 | | | | |
| | Morningness/Eveningness | 42.48 [7.58, 77.38] | .16 | .02 | .017 | | | | |
| | Intention | 14.88 [-19.62, 49.38] | .06 | .00 | .396 | | | | |
| Step 4** | | | | | .618 | .08 | .00 | 4.04 | .25 [*1, 222*] |
| | Age | 31.91 [-2.85, 66.67] | .12 | .01 | .072 | | | | |
| | Enjoyment | 31.19 [-4.67, 67.05] | .12 | .01 | .088 | | | | |
| | Morningness/Eveningness | 40.22 [4.14, 76.30] | .15 | .02 | .029 | | | | |
| | Intention | 14.95 [-19.61, 49.51] | .06 | .00 | .395 | | | | |
| | Planning | 9.19 [-27.11, 45.47] | .04 | .00 | .618 | | | | |
| Step 5* | | | | | <.001 | .41 | .32 | 16.67 | 29.85 [*4, 218*] |
| | Age | 26.09 [-4.02, 56.20] | .10 | .01 | .089 | | | | |
| | Enjoyment | 1.98 [-34.24, 38.21] | .01 | .00 | .914 | | | | |
| | Morningness/Eveningness | 25.65 [-6.02, 57.33] | .10 | .01 | .112 | | | | |
| | Intention | 17.82 [-10.90, 46.54] | .07 | .00 | .223 | | | | |
| | Planning | -13.34 [-43.35, 16.67] | -.05 | .00 | .382 | | | | |
| | Habit (Routine) | -15.43 [-44.38, 13.52] | -.06 | .00 | .295 | | | | |
| | Habit (Automaticity) | 88.91 [50.60, 127.23] | .34 | .08 | <.001 | | | | |
| | Environmental Cues | -68.94 [-114.25, -23.62] | -.26 | .02 | .003 | | | | |
| | Past PA Engagement | 145.99 [114.57, 177.42] | .55 | .23 | <.001 | | | | |

| | Variable | *B* [95% CI] | *β* | $sr^2$ | *p*-value | $R^2$ | $\Delta R^2$ | *F* | $\Delta F$ [*df*1, *df*2] |
|---|---|---|---|---|---|---|---|---|---|
| Step 6** | | | | | .972 | .41 | .00 | 9.87 | .22 [*6, 212*] |
| | Age | 25.21 [-5.80, 56.22] | .10 | .01 | .111 | | | | |
| | Enjoyment | 4.03 [-33.51, 41.57] | .02 | .00 | .833 | | | | |
| | Morningness/Eveningness | 24.46 [-8.01, 56.92] | .09 | .01 | .139 | | | | |
| | Intention | -22.35 [-139.07, 94.37] | -.08 | .00 | .706 | | | | |
| | Planning | -13.09 [-44.31, 18.13] | -.05 | .00 | .409 | | | | |
| | Habit (Routine) | -11.67 [-41.86, 18.53] | -.04 | .00 | .447 | | | | |
| | Habit (Automaticity) | 86.21 [46.54, 125.88] | .33 | .05 | <.001 | | | | |
| | Environmental Cues | -63.21 [-110.91, -15.51] | -.24 | .02 | .010 | | | | |
| | Past PA Engagement | 147.07 [98.13, 196.02] | .56 | .10 | <.001 | | | | |
| | Intention×Planning | -8.56 [-61.26, 44.15] | -.03 | .00 | .749 | | | | |
| | Intention×Habit (Routine) | -26.32 [-78.14, 25.50] | -.08 | .00 | .318 | | | | |
| | Intention×Habit (Automaticity) | 1.34 [-53.49, 56.16] | .01 | .00 | .962 | | | | |
| | Intention×Environmental Cues | -22.08 [-91.61, 47.45] | -.11 | .00 | .532 | | | | |
| | Intention×Past PA Engagement | 1.01 [-174.71, 176.73] | .00 | .00 | .991 | | | | |
| | Enjoyment×Morningness/Eveningness | 1.62 [-26.51, 29.75] | .01 | .00 | .910 | | | | |

*Note:* PA = physical activity; *B* = unstandardised coefficient; CI = confidence interval; *β* = beta (standardised coefficient); $sr^2$ = squared semi-partial correlation coefficient.

*$p$<.05; **$p$<.001

**Comparing Attrition and Non-Attrition Groups**

A series of samples *t* tests were used to compare the participants who did not complete time two (Attrition group; *N* = 257) to those who did (*N* = 228) on a range of key demographic and psychological variables. There was only a statistically significant different between the mean age of participants who completed time two, and those who did not. Age of the 'Attrition' group (*M* = 45, *SD* = 15.18 years) was on average, 5 years older, 95% CI [.91, 6.22], than the 'Non-Attrition' group (*M* = 41.76, *SD* = 14.48), *t*(483) = 2.63, *p* = .009, two-tailed, *d* = 0.24. This means that younger people were more likely to complete time two. See Table 8 for the means and standard deviations for each of the variables.

**Table 8**

*Means and Standard Deviations for Each of the Variables in the Independent Samples t-Test*

| | Group | *M* | *SD* |
|---|---|---|---|
| Age* | Attrition | 45.32 | 15.18 |
| | Non-Attrition | 41.76 | 14.48 |
| Gender | Attrition | 1.81 | .45 |
| | Non-Attrition | 1.86 | .36 |
| Enjoyment | Attrition | 51.82 | 6.56 |
| | Non-Attrition | 51.14 | 6.00 |
| Past PA | Attrition | 491.55 | 357.73 |
| | Non-Attrition | 475.04 | 418.50 |
| Attitude | Attrition | 2.00 | .04 |
| | Non-Attrition | 1.98 | .08 |
| Subj. Norms (descriptive) | Attrition | 1.94 | .23 |
| | Non-Attrition | 1.98 | .15 |
| Subj. Norms (social) | Attrition | 1.66 | .48 |
| | Non-Attrition | 1.68 | .47 |
| PBC | Attrition | 6.63 | .95 |
| | Non-Attrition | 6.68 | .81 |

*Note:* PA = physical activity; Subj. Norms = subjective norms; PBC = perceived behavioural control

*$p < .05$

## Discussion

A combined and extended model of the theory of planned behaviour and temporal self-regulation theory with the addition of enjoyment and morningness/eveningness was used in the current

study to investigate the predictors of physical activity engagement. Perceived behavioural control was the only significant predictor of intention to engage in physical activity, and past behaviour, habit (automaticity) and environmental cues were the only significant predictors of physical activity engagement, with no significant interactions.

**Predicting Intention to Engage in Physical Activity**

Our hypothesis that attitude, subjective norm, and perceived behavioural control would predict intention to engage in physical activity, was only partially supported as perceived behavioural control was the only significant predictor. This means that the easier an individual thinks it is to be physically active, the more likely they are to engage in that activity. This is in line with previous research that also showed perceived behavioural control to be a significant predictor of physical activity (de Bruijn et al., 2012). The current study therefore provides further support for the importance of incorporating perceived behavioural control in dual-process health models. Darker et al. (2010) designed and implemented an intervention that increased participants perceived behavioural control, leading to an increase in physical activity. Health professionals could implement this intervention to help individuals decrease their sedentary behaviour.

Attitude and subjective norm did not significantly predict physical activity engagement which is not in line with previous research suggesting that they are two of the main predictors of intention to engage in physical activity (Ajzen, 1991; Barkoukis & Lazuras, 2020). An explanation for these non-significant results could be the importance of past behaviour in this sample. Previous literature has suggested that greater levels of past behaviour led to weaker associations between the pre-intention variables of the theory of planned behaviour (i.e., attitude and subjective norm) and intention to engage (Sommer, 2011). Therefore, health professionals may not need to focus on improving individuals' attitudes or change their beliefs regarding how others perceive them, as this is not necessary for all individuals to develop an intention to be physically active. Theoretically, these results suggest that there

might be more important predictors of intention, such as past behaviour. Future research could explore the importance of past behaviour in developing an intention.

**Predicting Physical Activity Engagement**

Our hypothesis that enjoyment, morningness/eveningness, intention, planning, habit, environmental cues, and past behaviour would predict physical activity engagement was partially supported. Habit (automaticity), environmental cues and past behaviour significantly predicted physical activity, suggesting that the more automatic the performance of physical activity the more likely individuals are to engage consistently. Previous literature has demonstrated that the initiation of physical activity can be habitual (Phillips & Gardner, 2016). The results of the current study are in line with this, as they show that the automaticity of physical activity is important and provides further support for the inclusion of habit in the behaviour prepotency component of temporal self-regulation theory. It further suggests that novice physical activity engagers may rely more on planning, however, as they increase their physical activity, the need to plan may decrease as associated habits strengthen. Previous literature supports this as it suggests that when a behaviour is automatically triggered by an environmental cue, there is need to consciously plan the engagement in that behaviour (Rhodes & Rebar, 2018). Health professionals could provide individuals with educational resources on the development of habits to help improve their physical activity engagement. Furthermore, they could help clients establish environmental cues, leading to the transition from needing to plan, to performing physical activity more automatically.

Additionally, the more influential and frequent their environmental cues, the more likely individuals are to be physically active regularly. Previous research has established that the experience of environmental cues triggers an urge to engage in the related behaviour (Rhodes & Rebar, 2018). Similar to the practical implications of the habit (automaticity) finding, health professionals could work

collaboratively with clients to identify cues that could be used to trigger physical activity engagement. This could be done by building upon routines that may already be established.

Furthermore, the greater the amount of previous physical activity engagement, the more likely people are to be physically active long-term. A theoretical implication of this finding is that past behaviour could continue to be included in future research that integrates the theory of planned behaviour and temporal self-regulation theory. It also suggests that once the implementation of an activity becomes more consistent, the less impact it has on personal resources, such as deliberate thought and planning (Hall & Fong, 2015).

Enjoyment, intention, habit (routine) and planning were not significant predictors of physical activity engagement. It appears that the level of enjoyment may not be important in engaging in physical activity. This is not in line with previous research, as most previous research indicates that individuals are more likely to engage in physical activity if they enjoy it (Cairney et al., 2012; Carraro et al., 2014; Jekauc, 2015). There does not appear to be any previous research that could help explain this result. However, it could be explained by exercise identity. Previous research suggests that self-categorising oneself as a "regular exerciser" is a self-regulating mechanism of motivation to be physically active and is independent of other factors (e.g., enjoyment; Husband et al., 2019) and this needs to be explored further. Furthermore, whether the individual intends to engage may not be important in predicting future physical activity engagement. This is not in line with previous temporal self-regulation research which has demonstrated that intention does directly predict behaviour (e.g., physical activity; Allom et al., 2016; Hall, 2013; Hall & Fong, 2015). However, an explanation could be that past behaviour is a stronger predictor of future engagement compared to intention (Sommer, 2011). This could be true in the current study as past behaviour was significant. Therefore, health professionals could help individuals to consistently engage in physical activity by using cueing interventions (e.g., goal priming) and training interventions (e.g., implementation-intentions; Papies, 2017). These could be used to help

remind clients of the health benefits associated with being physically active, therefore, motivating them to continue to engage.

Moreover, the extent to which an individual plans their physical activity, may not be important for this sample to be physically active. This is not in line with previous research which demonstrated that planning is a significant predictor of physical activity engagement (de Bruijn et al., 2012). The participants in the present study appear to have engaged in enough previous physical activity, over an extended period, to allow for the development of habitual engagement. This may suggest they are more experienced exercisers and therefore, rely more on habits than consciously planning their activity. Future research could investigate at what point in behaviour change, the importance of planning and habit shift. Additionally, health professionals may need to consider at what stage in the behaviour change process individuals are in order to focus on developing planning skills or habit formation.

**Role of Morningness/Eveningness**

In contrast to our hypothesis, results showed that morningness/eveningness did not predict engagement in physical activity. This suggests that, in this sample, morningness/eveningness may not be an important factor in increasing individuals' engagement in physical activity. This result is not in line with Mulè et al. (2020), who suggest that individuals perform physical activity better at their preferred time of day. An explanation could be that external factors prevent individuals from engaging at their preferred time of day. The present study showed that work and family commitments are two of the biggest barriers, along with overall wellbeing, weather, and study commitments. Furthermore, the majority of the participants did not identify as morning or evening people. This could provide an explanation as more than half of the sample did not prefer either mornings or evenings. Therefore, the concept of preferred and non-preferred time of day may not have been considered.

**Strengths and Limitations**

The current study follows the example of Nicholson et al. (2022) and uses a more naturalistic design rather than a controlled environment like previous research (Blazer et al., 2020; Mulè et al., 2020) to investigate the role of morningness/eveningness. This is a strength, as it provides a more realistic representation of the importance of morningness/eveningness in individuals physical activity engagement. Another strength of the current study is that it contributes to the growing body of research in this field. This is important as it can guide health professionals and individuals in implementing strategies that can increase physical activity engagement

This study is not without its limitations. The current study measured physical activity subjectively with the shortened version of the International Physical Activity Questionnaire as well as a Timeline Follow-Back, which are well-validated measures in physical activity research. However, despite trying to use data screenshots from individuals' fitness watches, we were unable to measure physical activity objectively. This was due to technical difficulties (e.g., watch not syncing with the app), flat batteries resulting in the participant not wearing their watch that day, as well as participants including sport and activities less than 30 minutes, which is not in line with the definition of physical activity in this study. In order to improve this method of objectively measuring physical activity, future research could look at meeting with each participant and directing them through the screenshot process. This could allow researchers to mitigate any errors, resulting in data that better represents the individual's engagement in line with the studies definition of physical activity.

## Conclusion

The aim of this study was to incorporate the pre-intention variables of the theory of planned behaviour with the post-intention variables of temporal self-regulation theory, as well as, add the constructs of enjoyment and morningness/eveningness, to predict physical activity engagement. The present study showed that perceived behavioural control is an important predictor of intention to engage. Furthermore, physical activity engagement can be directly predicted by past behaviour,

environmental cues, and the automaticity component of habit. Despite morningness/eveningness not being a significant predictor, these findings could guide behaviour change techniques focused on implementing interventions based on the theory of planned behaviour, the formation of goals and promoting implementation-intentions. Furthermore, it could guide interventions aimed at improving individuals' physical activity engagement.

## Chapter 4: Individuals' Experiences of Preferred Time of Day in their Physical Activity Routines: A qualitative study

In the previous two chapters, we aimed to understand the role that morningness/eveningness plays in individuals' physical activity routines. However, in both studies, morningness/eveningness was a non-significant predictor of physical activity engagement. Therefore, in this chapter we wanted to explore if morningness/eveningness was a concept that individuals' thought of when considering their physical activity behaviour. We also endeavoured to understand the influence that preferred time of day had on their physical activity routines, by gaining in-depth knowledge of individuals' experiences.

**Abstract**

**Background:** Morningness/Eveningness refers to individual differences in functionality and alertness at different times of day. It has been explored in conjunction with a variety of behaviours with varying results. Therefore, the aim of this study is to gain a greater understanding of the individual meaning of morningness/eveningness and explore individuals' experiences of preferred time-of-day when engaging in physical activity.

**Methods:** Convenience sampling was used to recruit 13 individuals who intend to engage in physical activity regularly. A social-constructionist epistemological position was taken, and reflexive thematic analysis was used to analyse the data and develop themes to gain a better understanding of morningness/eveningness and the role it plays.

**Findings:** This study found that most people understand the meaning of morningness/eveningness, which linked to their experiences of it. Those with more autonomy due to flexible commitments could optimise they schedules to suit their preferred time of day. Additionally, a person's purpose for engaging in physical activity demonstrated differences in task prioritisation at their preferred time. Furthermore, disruptions can interrupt peoples' ideal routines. Short-term disruptions resulted in people returning to their ideal routine, whereas long-term changes led to people establishing new routines.

**Conclusion:** This study provides an in-depth understanding of the role that morningness/eveningness could play in individuals' physical activity engagement, depending on schedule autonomy, the purpose of being physically active and the impact of disruptions. These findings could guide tailored behaviour change interventions focused on considering when individuals are functioning optimally.

## Introduction

The influence of biological timing as well as societal and environmental factors results in a continuum of preferences for when people prefer to be active during the day (Hisler et al., 2017). This preference for time of activity is referred to as morningness/eveningness (Hisler et al., 2017). The role of morningness/eveningness has been explored across a variety of behaviours, including academic performance, medication adherence and alcohol use (Akram et al., 2018; Phillips et al., 2021; Urbán et al., 2011). However, the importance of morningness/eveningness varies in previous literature. The development of the Morningness/Eveningness Questionnaire (Horne & Östberg, 1976), as well as a variety of other scales measuring this concept (e.g., Morningness/Eveningness Stability Scale; Randler et al., 2016), has provided a way of quantitatively measuring individuals' preferred time of day to be active. Recently, research has focused on understanding whether morningness/eveningness affects physical performance (i.e., the role it plays in physical activity behaviour; Blazer et al., 2020; Hisler et al., 2017). This research has often been conducted in controlled environments with the performance of specific exercises (e.g., bench press; Blazer et al., 2020; Hisler et al., 2017). In Chapters 2 and 3, the role of morningness/eveningness in participants' natural environments was investigated, to determine whether it impacts individuals' engagement in physical activity and showed that morningness/eveningness was not a significant predictor of engagement.

Previous quantitative literature seems to limit the exploration of the role of morningness/eveningness as it does not incorporate other commitments that individuals may have throughout their day (e.g., childcare, work, study). Therefore, it appears that the importance of morningness/eveningness may be underestimated if it is not considered within each individual's context and other responsibilities. This can be done qualitatively. This research could help gain a better understanding of the true role of morningness/eveningness in a physical activity context. Many health psychology topics are suited to rich, in-depth exploration that can be achieved by using qualitative

methods (Lyons, 2011). Understanding what morningness/eveningness means to the general population, and the daily contextual factors which play a role in how morningness/eveningness is used, can assist health psychology practitioners in determining when morningness/eveningness is a useful factor to consider for physical activity. However, a literature review of morningness/eveningness research only produced studies that have been conducted using a quantitative design. Therefore, it appears that no research has explored individuals' experiences of morningness/eveningness with regards to their routine and engagement in physical activity.

Thus, the aim of the present study is to use a qualitative design to gain a greater understanding of the individual meaning of morningness/eveningness and to explore individuals' experiences of preferred time of day, when engaging in physical activity. The overarching research question is: How do individuals conceptualise morningness/eveningness and their experiences of preferred time of day in their physical activity routines?

## Methodology and Method

The current research is conducted from a social constructionist epistemological position. Through a social constructionist lens, an individual's trust and knowledge are believed to be influenced by the social and cultural context in which it occurs (Walsh et al., 2014). Therefore, to understand the role that morningness/eveningness might play in individuals' physical activity routines, the research must explore the complex context each individual experiences and the meaning that they attach to factors within this context (Burr, 2015). This philosophical position aligns with the aim of this research, as it focuses on each participant's context and the meaning that they give to physical activity and morningness/eveningness. Researchers bring their own experiences and knowledge to the study as well as their own biases. Engagement in physical activity is a big part of the researcher's lifestyle, and so they have their own perspective when it comes to purpose, priorities and motivation for being physically active. They have also read and conducted research on morningness/eveningness, through which they

have formed their own ideas of what role it plays in their life. Therefore, it is important to engage in strategies that will help ensure that they are not viewing the data through their personal lens or from their worldview.

**Participants**

Ethics approval was obtained from the University's Human Research Ethics Committee (HRE2022-0250). Participants were recruited using convenience sampling, from the University's undergraduate student participant pool and those who expressed interest as part of a related study (see Chapter 3). To be part of the study, participants were required to be English-speaking, aged 16 years or older and who engaged or intended to engage in physical activity and were willing to engage in an interview about their physical activity engagement and routines.

Fifty participants expressed interest and invitation emails were sent to all the individuals who expressed interest. Based on the suggestions of Braun and Clarke (2021), the research team made a decision about the final sample size based on information power. This decision was shaped by the richness and adequacy of the data in addressing the research question (Braun & Clarke, 2021). The final sample consisted of 13 participants ranging in age, gender, and ethnicity to ensure that this study explored a broad range of perspectives. Participants identified as male (*N* = 3), female (*N* = 9) and non-binary (*N* = 1) and ranged from 18 to 73 years old. Eight participants identified themselves as morning people and five as evening people. The participants had a range of commitments in their weekly routines. Most of the participants were undergraduate university students (1 part-time and 10 full-time students), and two participants were retirees. All the participants engaged in some form of physical activity (e.g., team sport, gym, Pilates) ranging from 1-5 times a week. None of the participants worked full-time.

**Data Collection**

A semi-structured interview schedule consisting of approximately 12 questions was developed specifically for this study (seeing Table 9). Open-ended questions were designed to explore individual's conceptualisation of morningness/eveningness as well as their experiences of it relevant to their physical activity engagement (e.g., "How would you describe morningness/eveningness", "How do you think morningness/eveningness has shaped your physical activity routine"). This interview schedule was adapted throughout the data collection process. These adaptations were discussed amongst the research team, to ensure that appropriate questions were added and questions that did not align with the overarching research question were removed. This ensured that rich and adequate data was being collected.

**Table 9**

*Semi-structured interview schedule*

| | |
|---|---|
| Main questions and prompts | 1. What prompted you to take part in this interview?<br>2. How would you describe an average week in your life?<br>• What does an ideal day look like?<br>3. How would you describe morningness/eveningness?<br>4. Before signing up to this study, had you thought about the role that morningness/eveningness may play?<br>5. Do you have a favourite time of day?<br>• Why is this your favourite time of day?<br>6. Is there a time of day when you feel most alert?<br>7. In terms of morningness/eveningness, how would you describe the type of person that you are?<br>8. What types of physical activity do you engage in?<br>9. Do you have a physical activity routine?<br>10. When thinking about engaging in physical activity, do you think morningness/eveningness plays a role?<br>11. How often do you think you engage in physical activity at your preferred time of day?<br>• What prevents you from engaging in physical activity at this time?<br>12. How do you think morningness/eveningness has shaped your physical activity routine? |

**Procedure**

Prospective participants provided their email addresses, and an email was then sent introducing the research, detailing what the study entailed and explaining what would be required of them if they chose to participate. A link to an online Qualtrics survey was also included in this email which contained the information sheet, informed consent, and a few demographic questions. Participants who resided in the same Australian state as the researchers were provided with the option of a face-to-face or virtual (via Cisco Webex) interview. Once this information was obtained from the participant, they were sent an email with a link to an online poll with a range of timeslots for when the interview could occur. Participants were requested to select the most convenient times for an interview. After a response was received, a confirmation email was sent, and the interview was confirmed.

All interviews were conducted during September and October 2022 via Cisco Webex (virtual online meeting platform), with the exception of one face-to-face interview. This interview took place at a mutual, accessible public location. All the interviews were conducted by the researcher who has experience on the topic of morningness/eveningness and physical activity. This in-depth knowledge helped maintain the rigour of the research, as the researcher could facilitate a rich dialogue with the participants.

Each interview was audio-recorded using the online platform Otter.ai. The interviews ranged from 28 to 53 minutes in length. Participants who were recruited from the University's participant pool were awarded research participation points, whereas those participants who were recruited from the public were thanked with a $15 voucher. Data collection and analysis occurred concurrently in order to allow data collection to stop once adequately rich data has been collected.

**Data Analysis**

All the audio recordings were transcribed using the Otter.ai platform. The researcher then checked each transcript for mistakes and ensured that they were all de-identified. A reflexive thematic

analysis approach was used to interpret the collected data (Braun & Clarke, 2019). The analysis of the data was conducted in line with an inductive approach where semantic codes were used to generate patterns of meaning from the collected data (Braun & Clarke, 2019). This process was guided by Braun and Clarke's (2019) six phases of analysis: (1) data familiarisation, (2) coding, (3) generating initial themes, (4) developing and reviewing themes, (5) refining, defining and naming themes, and (6) writing up. Reflexive thematic analysis is a recursive process requiring the research team to move back and forth between the different phases in order to develop patterns of shared meaning that capture the narrative of the dataset (Braun & Clarke, 2019). It also requires continual questioning and querying of the assumptions that are being made in the interpretation and coding of the data (Braun & Clarke, 2019). The researchers took steps throughout the research process to ensure the quality of the interviews and analysis were upheld. A reflexive journal was maintained during each phase of the study, to allow the lead researcher to document the knowledge they brought to the research and the influence they might have on the interpretation of data (Maxwell, 1996). Keeping a reflexive journal also allows a balance between being systematic and flexible throughout the research process (Willig, 2013). Upon reflection, using this method, was when the researcher had the realisation that not all individuals valued performance when engaging in physical activity. This realisation led to the identification of the second theme (i.e., Performance versus Movement: The purpose of being physically active), which suggests how different purposes lead to different experiences.

The researcher became familiar with the content of the dataset, documenting initial observations and insights in relation to the verbatim transcripts. From this, codes were generated that captured important aspects of the data that were deemed relevant in relation to addressing the research question. Multiple rounds of coding and discussions occurred to develop broader patterns of meaning (i.e., themes). Initial themes were reviewed regularly to ensure they accurately portrayed the dataset and addressed the research questions. Once the themes were generated, the research team

refined and defined them to determine the scope and focus of each theme. This involved creating a narrative for each theme. These narratives were then written up so that they were contextualised in relation to existing literature. To ensure reflexivity and the consideration of different interpretations, the research team met on a regular basis. Ongoing discussions amongst the research team occurred where the supervisors acted as "critical friends" for the researcher. This assisted in maintaining the quality of the research as codes and themes were challenged, and the researcher was encouraged to reflect on their interpretations to ensure that alternative explanations were explored (Smith & McGannon, 2018).

## Findings

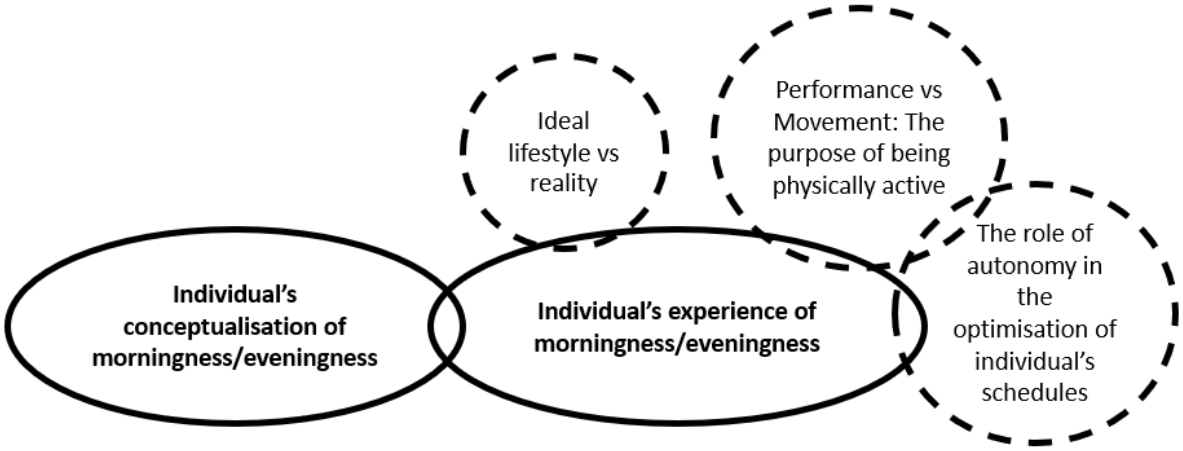
The overarching research question was how individuals conceptualise morningness/eveningness and their experiences of preferred time of day in their physical activity routines. Most participants had formed an idea of morningness/eveningness as they were familiar with the concept and were able to identify as either morning or evening people. However, some of the participants had new realisations during the interview, suggesting that not all the participants had a fully formed idea.

When exploring the participants' experiences of morningness/eveningness, three themes were identified. These themes encapsulated how participants who have the autonomy to optimise their schedules, described experiencing more benefits when engaging in physical activity at their preferred time of day. Participants also had differing experiences depending on whether they engage in physical activity for the purpose of moving their bodies or for improving their performance. The disruptions that occurred in the participants' lives led to a difference in experiences, as participants described having to make long-term adaptions or short-term changes. This meant that they had to engage in physical activity at their non-preferred time of day, or not at all, until they could return to their ideal routine.

The thematic map (see Figure 3) provides a visual depiction of the identified themes and the links between them. The associations between these themes create an understanding of a participant's experiences of morningness/eveningness in their physical activity routines.

**Figure 3**

*Thematic Map of Interview Findings*




*Note:* The two components of the overall research question are represented with solid lines. Broad key themes are represented with dashed lines. The overlapping rings show links between the components of the research.

**Individual's Conceptualisation of Morningness/Eveningness**

Participants conceptualised morningness/eveningness as a preference for the morning or the evening. This prior knowledge had come from the concept being discussed amongst friends and family, which was explained by participant 9, "…I have thought about it [morningness/eveningness] and had conversations with my friends about it [morningness/eveningness] …". Participants appeared to be familiar with the terms 'morning people' and 'evening people', or 'early birds' and 'night owls', rather than the term morningness/eveningness. Participant 3 demonstrated, "Yep, yep, I've heard of those terms [morning people, evening people, early birds, night owls]". Based on these conversations and

knowledge, some participants described having developed an awareness of how different times of day make them feel. Participant 7 described how understanding the idea of morningness/eveningness "…encouraged me to do my physical activity when I [felt] at my best, like physically and mentally", or how they performed particular tasks at their preferred and non-preferred times of day, one evening-type participant explained, "(Participant 7) Sometimes I'm trying to do lectures [at non-preferred time of day], but …I don't remember much which is really bad", and in the context of being physically active "(Participant 9)…I feel…like restricted in the morning…compared to at night". Through the development of this awareness, some participants started to think about the role that morningness/eveningness might play in their lives. However, for other participants, the questions that were asked in the interview encouraged further realisations of how certain aspects of their life could be easier if it was done at their preferred time of day. This suggests that not every participant had a fully formed idea of this concept or how it might relate to their lives.

**Individual's Experiences of Morningness/Eveningness**

***The role of autonomy in the optimisation of individuals' schedules***

This theme encapsulates how people who have autonomy over the commitments within their schedule also have control over when they engage in physical activity. Some participants had realised the importance of optimising their schedule to suit their preferred time of day through 'trial-and-error'.

> Participant 4 described this when they said, "…trying things different ways like in high school you don't have a choice. You got to get up early and get to school…when it comes…to uni, like if you sign up for that class, and then you quickly find out within a couple of weeks you start skipping that class because you don't want to get up early".

Participants described scheduling their physical activity to fit in with their commitments. Some participants also described how they would optimise their schedule so that they engage in physical activity based on how their body feels at certain times of the day. Participant 1 explained, "…I used to do

more afternoon sessions…but this year, I'm a bit more, maybe listening to myself…" and "…trying to squeeze it in before I leave [for work in the morning]."

All participants identified themselves as either a morning or evening person. Through this identification, most of the participants had set up routines in order to ensure that they were physically active and completed cognitive tasks at their preferred time of day. Participant 14 described, "…then you can start to realise…I can do a lot more activity in the afternoon/night [preferred time of day]"

Despite all the participants having a relatively high autonomy over their schedules, not all of them had successfully organised it in order to benefit them. Participant 6 described this to be due to the "knock-on effect" of changes in circumstances. This meant that as circumstances changed, for instance, a change in work shift or university lectures, so did their scheduled physical activity. Participants described how these changes required adaptation. Participant 5 described how a change in their part-time shifts resulted in a change in their schedule – "…it was all at night-time, and it wasn't working for me…so…I went from night-time to mornings", this led to "…I changed everything…". This change in work shift meant that this participant went from engaging in physical activity in the morning before work to being physically active mid-morning straight after their shift was finished.

The importance of autonomy is highlighted by participant 6, who reflected on their experiences from when they worked full-time. They described how the long commute to and from work, in combination with working full days, prevented them from engaging in physical activity at their preferred time of day. Due to the nature of their job, they did not have control over the hours or days that they worked, and so to be physically active, they had to engage in their activities during their lunch break (i.e., their non-preferred time of day).

> Participant 4 described, "…it took me an hour to get to work and an hour to get home, so I was leaving home at half past six and getting home at 5 o'clock. So, unless I did something in my

lunch hour [non-preferred time of day], I didn't do any exercise at all…So it's really one of those timely things."

This theme highlights how participants who optimised their schedules to engage in physical activity at their preferred time of day led them to be physically active more regularly, as they were able to schedule it around their other commitments. This was further emphasised by those participants who had not optimised their schedules as they struggled to engage in regular physical activity. Participants also appeared to experience more benefits when they engaged in physical activity at their preferred time of day.

***Performance versus Movement: The Purpose of Being Physically Active***

This theme portrays that the difference in the purpose of a participant's engagement in physical activity leads to a difference in participants' experiences of morningness/eveningness. People who engage in physical activity for the purpose of moving their bodies or "to start the day off well" are less concerned about how well they perform that activity. However, people who engage in physical activity in order to reach personal goals or improve their ability to play a particular sport, place greater importance on how well they perform their activities. This leads to differences in their experiences of morningness/eveningness in their physical activity routines. Participant 6, who engages in physical activity for the purpose of movement, described how "…either way…it's just my body moving, which is a nice feeling regardless [of the time of day] …". On the other hand, participants who place more value on the performance of their physical activity expressed how important it was for them to be physically active at their preferred time of day. Participant 10 explained how their activity was "pretty demanding some of the…movements…but…I do it in the morning when I'm fresh"**.** Those participants who engaged in physical activity for the purpose of improving performance also described their experiences of where morningness/eveningness impacted how they felt mentally. Participant 7 described how being physically active at their preferred time of day led to them being in a more positive mindset, "…I'd say

[morningness/eveningness] definitely impacts your motivation and your…mentality towards physical activity."

The purpose of physical activity also appeared to be linked to autonomy in the optimisation of participants' schedules. Participants who described having autonomy and valued performance when being physically active tried to organise their schedules to ensure they are physically active at their preferred time of day so that they are functioning optimally and feeling at their best. When speaking about being physically active at their preferred time of day, participant 5 described how they "…felt more energised…" which led them to be physically active at their preferred time of day. However, some participants optimised their schedules to suit other tasks that they value their performance in. Participant 9 explained how their "…body actually works better…getting…more…uni-related stuff done in the morning [preferred time of day]."

Another aspect of this theme is how participants combat disruptions to their routines based on the value they place in the performance of their physical activity. Participants who prioritised their physical activity described engaging in physical activity, even if it was at their non-preferred time of day. Participant 14, who described themselves as being a morning person, explained how if they are not able to engage in physical activity in the morning, then they would do so in the evening after work - "…still trying to run the same day…I'm just, I guess, motivated to stay active and stay healthy." However, those who described engaging in physical activity to move their bodies were more likely to skip their scheduled physical activity if they were not able to engage at their preferred time of day. Participant 5 explained how if they were unable to engage in physical activity at their preferred time of day, then they did not have a plan to do it later on the same day – "…the next day just because I just get too tired, and I just don't feel motivated."

***Ideal Lifestyle versus Reality***

This theme explores how the difference between participants' ideal lifestyle and reality can impact their experiences of the role of morningness/eveningness. The participants were asked to describe an ideal outlook of their schedules and outline when they would prefer to engage in their various commitments. However, they also all described how external factors sometimes disrupted their ideal routine. It appeared that these disruptions could contribute to long-term adaptions or short-term changes in participants' routines. Student participants described how assignment deadlines would lead to a short-term change in their schedule where they would find themselves engaging in tasks at their non-preferred time of day. Participant 5 explained, "…if I have something…like an assignment that's due soon. I have to kind of change my whole routine…". This highlights this short-term change in routine when university commitments are prioritised. Participant 5 also described, "…I can get more done at night [non-preferred time of day] if I have an assignment and [I'm] rushing…". Furthermore, some participants spoke about how family commitments can interrupt their routines. Participant 10 explained, "I've got the grandchildren, so a couple of days this week…I won't be doing [physical activity like] I normally do." Similarly, participant 11 explained that they do not engage in physical activity "…if my family wants me to go anywhere…"

On the other hand, great changes in circumstances can lead to long-term changes in routine and even in the way a participant may describe the type of person they are. This generally occurred in the lives of the participants who had experienced job-related changes.

> Participant 6 described, "…I used to work at a fast food place where I'd have to work until like 4 am…I thought I was naturally a night-time person, like a night owl…But since I…left there…I've changed my body clock around to be more of a morning person." They described how this change was "…a consequence of living circumstances…".

Similarly, participant 9 said, “I think what triggered the change [in the type of person], was that I started doing morning shifts at work, instead of late night shifts, so my body clock started like waking up early…”. This information emphasises how participants’ experiences of the role of morningness/eveningness in their physical activity routines, change depending on the differences between their ideal lifestyle and reality.

## Discussion

The aim of this study was to collect rich, in-depth information about the meaning that individuals give to morningness/eveningness and physical activity. This was achieved through gaining an understanding of how individuals conceptualise morningness/eveningness as well as their experiences of preferred time of day in their physical activity routines. Findings are nuanced compared to previous literature investigating the role of morningness/eveningness in a physical activity context. It appears that all previous research on this topic has been quantitative, with a range of results. Lab-based research found that morningness/eveningness is important in engagement in physical activity (Blazer et al., 2020; Mulè et al., 2020; Roveda et al., 2020). However, more naturalistic studies like that conducted in Chapters 2 (Nicholson et al., 2022) and 3 of this thesis, showed that morningness/eveningness was not an important predictor of physical activity engagement. Therefore, in gaining a qualitative perspective, a deeper understanding of the true role of morningness/eveningness was gained.

All the participants were able to self-identify whether they were morning or evening people. They gained this awareness and knowledge from information in the community as well as discussions with friends and family. However, the extent to which individuals had formed ideas of morningness/eveningness or considered the role it might play, differed. Some participants had benefitted from doing certain tasks at particular times of day (e.g., study, work, or physical activity), whereas others had not fully realised the role that it could play in their lives. Therefore, individuals may have different experiences depending on where the participant is in the process of forming an idea

about morningness/eveningness. Three themes were identified when exploring individuals' experiences of morningness/eveningness in their physical activity routines.

The role of autonomy in the optimisation of individuals' schedules suggests that individuals' experiences of morningness/eveningness in a physical activity context may need to be considered. Individuals with more flexible schedules have more control over when they are physically active compared to those with more rigid schedules. Findings showed that there was a difference in the extent to which individuals optimise their schedules to suit their preferred time of day, maybe individuals who had realisations of the benefits that could come from being physically active at their preferred time of day may not have considered planning their physical activity and other commitments at times when they could perform them optimally. Previous literature using health models such as the health action process approach has established that planning is an important predictor of physical activity engagement (Maher & Conroy, 2016; Maxwell-Smith et al., 2018; Nicholson et al., 2022). This theme is in line with these findings as it highlights that planning to be physically active at an individual's preferred time of day is important. Improving individuals' planning ability has been suggested in previous research as a strategy to increase engagement in various health behaviours (Nicholson et al., 2022; Samdal et al., 2017; Teleki et al., 2021). The findings of the current study suggest that within this strategy, health professionals could place emphasis on building a schedule that optimises when individuals perform certain tasks best. This may require improving their awareness of their functioning and performance levels at different times of day. Increasing individuals' awareness could be done through educational sessions on the role of biological timing and circadian rhythms and the impact they have on cognitive and physical performance. These sessions could be aimed at young adults, as they could provide an opportunity for them to build routines around physical activity engagement. This could lead to adherence to physical activity routines as their commitments and responsibilities change (e.g., start full-time work, have children), and their schedules become more rigid.

Individuals' experience of preferred time of day depends on whether they are physically active for the purpose of moving their bodies or because they value the performance of that activity. This could further be linked to the extent to which the individual prioritises their engagement in physical activity. Therefore, individuals may optimise their schedule to suit those commitments to which they prioritise their performance in more. For example, an evening person who prioritises their performance in the gym may optimise their schedule to engage in physical activity at 5 pm. However, another person who identifies as a morning person, but prioritises their study-related tasks could optimise their schedule to attend lectures or complete assignments at 8 am and therefore engage in physical activity at their non-preferred time of day. This could suggest that interventions aim to increase the importance of physical activity in an individual's life and therefore change their idea of physical activity, making it more of a priority. However, there is a lot of research emphasising the importance of physical activity in improving individual mental health (Warburton et al., 2006) as well as reducing the risk of chronic diseases (Department of Health, 2021). Therefore, more research needs to be done to explore the effectiveness of educational initiatives to determine whether they are sufficiently fostering the importance of physical activity. A further explanation that may come from this theme is the importance of motivation in physical activity engagement. Often previous literature has determined that motivation is a significant predictor of health behaviours (Mullan et al., 2021), including physical activity (Wilson et al., 2012). Therefore, when individuals are physically inactivity previous health and exercise psychology research recommends improving the individual's motivation to engage (Brand & Cheval, 2019). However, based on the findings in this study, individuals could, instead, be encouraged to prioritise engaging in physical activity at their preferred time of day, therefore potentially decreasing the importance on their motivation levels. Future research would, however, need to be conducted to determine if this is the case.

One group of people who value their performance in sport and physical activity is elite athletes. The findings of the current research could appeal to coaches as well as strength and conditioning trainers employed by professional sport organisations and athletes. Individual training and fitness sessions could be scheduled at the athlete's preferred time of day so that the athlete has the best chance of performing optimally. Future research could explore the role that morningness/eveningness might play in optimising the athlete's performance in elite or professional sport.

Individuals' experiences of morningness/eveningness are different depending on the changes that may occur in their lives. Small changes in their schedules, such as a change in work shift, or a deadline that needs to be met, appear to cause less disruption in the individual's ideal routine. However, long-term changes, for example, retiring from full-time work, could result in a greater disruption to an individual's ideal routine, which may lead to the individual adapting to a new routine. Changes in everyday life can be the reality of many individuals' lives. Coping planning has been shown to play an important role in long-term change (Sniehotta et al., 2005), therefore health professionals could use this to help mitigate a decrease in physical activity as a result of long-term change.

**Strengths and Limitations**

A strength of this research is it allowed the collection of rich, nuanced data allowing an in-depth understanding of individuals' experiences of morningness/eveningness in their physical activity routines. However, despite trying to stratify the sample and recruiting participants with a diverse range of experiences, the sample of this study ended up being individuals with flexible schedules. In order to combat this limitation, future research could look at recruiting individuals who are employed full-time (i.e., work approximately 40 hours per week). These individuals may have more rigid schedules and, therefore, could have different experiences of preferred time of day and the role it may play in their physical activity routines.

## Conclusion

The aim of this study was to have a distinct understanding of the role of morningness/eveningness by exploring the meaning that individuals give to it as well as their experiences of preferred time of day in their daily life. The current study showed that morningness/eveningness could play a role in individuals' physical activity engagement, through schedule optimization, considering the purpose of being physically active and being aware of the differences between ideal routines and reality. These findings could guide behaviour change techniques focused on implementing actionable plans, coping strategies, and the formation of physical activity routines. Furthermore, morningness/eveningness could be incorporated to guide tailored interventions aimed at facilitating an increase in physical activity engagement.

# Chapter 5: General Discussion

## Overview

In this thesis the role of morningness/eveningness in a physical activity context with a mixed methods approach was explored. The studies in Chapters 2 and 3 both combined and extended health models as well as integrated the additional variables of morningness/eveningness, and enjoyment to determine whether they provide additional predictive validity to physical activity engagement in addition to more established variables. However, this was not the case, as only planning, past behaviour, environmental cues and habit (automaticity) were important.

Individual's preferred time of day is determined by circadian rhythms as well as social and environmental factors that influence both cognitive and physical performance (Montaruli et al., 2021). We combined this knowledge with the results of the first two studies to design a qualitative study (Chapter 4) to gain a better understanding of the meaning that individuals give to morningness/eveningness and physical activity, as well as their experiences of preferred time of day in their physical activity routines. The findings in Chapter 4 suggested that morningness/eveningness did play a role in individuals who had autonomy over their schedules due to flexible commitments. Overall, the studies in this thesis are equivocal in determining the importance of morningness/eveningness in physical activity engagement. Nonetheless, the overall aim of gaining a better understanding of the factors that may be inhibiting individuals from engaging in physical activity has been achieved.

## Theoretical and Practical Implications

The variables that could improve an individual's level of physical activity have been highlighted in this thesis. The findings from the two predictive studies (Chapter 2 and 3) suggest that planning, environmental cues, past behaviour, and habit (automaticity) are the most important predictors for individuals engaging in physical activity, thus suggesting their utility in intervention design. The combined and extended models were only partially supported. The theory of planned behaviour and

self-determination theory are two of the most common models that have been used to explain the factors that promote physical activity engagement (Ntoumanis et al., 2018). Therefore, future research could move away from the use of these theories and instead consider using temporal self-regulation theory and the health action process approach, or others. Furthermore, future research could use structural equation modelling to determine the relationships between the variables that were shown to be important in this thesis. This could include self-efficacy from the health action process approach, the pre-intention variables integrated with, behaviour prepotency (i.e., past behaviour, habit, and environmental cues) from temporal self-regulation theory as well as coping and action planning from the health action process approach (instead of self-regulatory capacity from temporal self-regulation theory). Combining these models in this way, could contribute to the development of a new model for use in physical activity research that could guide health professionals in supporting individuals in changing their sedentary behaviour to meet physical activity guidelines (Department of Health, 2021).

Previous research exploring morningness/eveningness in a physical activity context has varied. Numerous studies show that morningness/eveningness is a significant predictor of physical activity (Kaushal & Rhodes, 2015; Przepiórka et al., 2019; Schumacher et al., 2019). Whereas, others, including the two predictive studies in this thesis (Chapters 2 and 3), have shown that physical activity levels do not differ based on preferred and non-preferred time of day (Brooker et al., in press.; Mulè et al., 2020; Nicholson et al., 2022). Based on this, in conjunction with, the results of the qualitative study (Chapter 4) that was conducted as part of this thesis, more qualitative research could be done to truly understand the role that morningness/eveningness may play. Exploring external factors, individuals' priorities, as well as their motivations behind engaging or not engaging in physical activity, may suggest ways to use an individual's preferred time of day to increase their engagement levels. Individuals with varying schedules (i.e., flexible vs. rigid), at different stages in the lifespan (i.e., school students, university students, full-time employees, and retirees), could be incorporated into the development of future

physical activity interventions. Such interventions could help develop skills (e.g., planning and habit formation) and integrate morningness/eveningness, so that individuals are engaging at a time when they are functioning optimally. This intervention could be evaluated to determine if morningness/eveningness plays a different role in the long-term maintenance of physical activity engagement.

**Measuring Physical Activity**

Previous research has measured physical activity both through self-report (e.g., the International Physical Activity Questionnaire) and objective measures (e.g., accelerometers, Fitbit watches). In study 1 (Chapter 2), physical activity data was only collected subjectively using the International Physical Activity Questionnaire (a self-report measure). The limitation of only using this method of data collection was that it was difficult to understand the true nature of individuals' physical activity routines (e.g., it could not be determined whether individuals were physically active for the same amount of time each day, or if it varied from 30 minutes one day to 60 minutes on another). In order to combat this limitation in study 2 (Chapter 3), subjective physical activity data was also collected using a timeline follow-back method. This study also aimed to collect data objectively via participants own fitness watches, as it appeared that no research had attempted to collect data in this way. However, it was unsuccessful as the objective data was unreliable. For example, technological difficulties in the syncing process between participants' watches and the related apps, or participants not recording their data on certain days due to the watch battery being flat. This consequently prevented participants from providing the data that was required in this study (i.e., time of day, total time spent being physically active, type of physical activity that the participant engaged in). Despite providing participants with detailed instruction booklets (tailored to the brand of fitness watch each participant used), participants still provided screenshots that did not contain all the required data. To combat the limitations of using this method of data collection, researchers could organise data collection sessions,

where they can step each participant through the screenshot process, ensuring all relevant data is obtained. At these sessions any problems (e.g., technical issues, barriers, etc.) can also be addressed. These sessions could be held online via videoconferencing platforms (e.g., Zoom or Webex) for online studies or to facilitate those participants who live in different regions to the researchers. However, until enough research has been done to limit the data collection errors that may occur, self-report data could still be used to counteract any potential issues.

**Strengths and Limitations**

A strength of this thesis is the naturalistic approach that was taken in the predictive studies (Chapter 2 and 3) as well as the conversations that were had with participants (Chapter 4) in order to determine the true role of morningness/eveningness. It appears that no previous research has been conducted using a qualitative design, and that most previous quantitative literature has been conducted in controlled environments with participants often only performing one type of physical activity (Blazer et al., 2020; Hisler et al., 2017; Mulè et al., 2020). However, this thesis is not without its limitations. Both the predictive studies only consisted of two time points that were seven days apart. This meant that the physical activity data that was collected could have been limited due to illness, holidays, or an abnormal week. In order to combat this, future research could use a longitudinal design to gather physical activity data that truly presents the participants levels of engagement.

Another strength of this thesis is that it highlights how morningness/eveningness may play a different role in an individual's physical activity depending on what stage they are in their life. The sample of study 3 (Chapter 4) had a median age of 21 (age range = 18-73). Individuals typically have different commitments at different stages of their life, and this study highlighted that these commitments were more flexible for young and older adults. This gave them autonomy over when they preferred to engage in physical activity. Furthermore, the samples of studies 1 and 2 (Chapters 2 and 3) included participants from a range of age groups. Study 1 included participants ranging from 16-64 years

of age (median age = 31 years), while study 2 consisted of participants from 19-78 years of age (median = 40 years). However, another limitation of this thesis, is that it only captures a greater understanding of the role of morningness/eveningness in individuals with more flexible commitments, as the two predictive studies did not provide in-depth data of the role morningness/eveningness played within the context of their other commitments. The open-ended question in study 2 (Chapter 3), appears to suggest that middle-aged individuals may have differing experiences of morningness/eveningness due to the rigid-nature of their schedules (e.g., full-time employment, childcare responsibilities). Therefore, future research could further explore the role of morningness/eveningness in physical activity engagement within the context of individuals' other commitments.

**Recommended Future Directions**

Based on the findings and limitations of this thesis, several future research directions can be suggested. Firstly, future research should consider a mixed methods approach to continue to gain a true understanding of the role morningness/eveningness plays in individuals' physical activity routines. The quantitative component of this research could involve collecting physical activity data objectively using participants own fitness watches. Data collection sessions could take place before the initiation, and then be organised every seven days. Furthermore, demographic and health model-related data would potentially only need to be collected prior to the commencement of the study. Similarly, morningness/eveningness data (using the Morningness/Eveningness Questionnaire; Horne & Östberg, 1976) could be collected initially, as well as every seven days to determine whether individuals think they are engaging in physical activity at their preferred time of day. Based on the results of the quantitative study, a qualitative study could then be designed to unpack the reasons that people are or are not physically active at their preferred time of day, as well as asking other questions related to their responsibilities, priorities, and the tasks that they may prefer to do when they are functioning optimally. A study like this could provide researchers the opportunity to collect objective physical activity data in a

way that has been recommended by previous research (Laranjo et al., 2021; Xie et al., 2018). As well as gain further insight into the meaning that individuals give to morningness/eveningness and how it could be tailored to fit into each individual's lifestyle in order to change their behaviour.

Secondly, the results from the open-ended question in study 2 and the findings of study 3 suggest that at different stages of individuals' lives and differences in the flexibility of their schedules, individuals have varied experiences of the role of morningness/eveningness. As a result, future research could focus on designing and evaluating an intervention that can be tailored to individuals, based on the stage of life they are in. For young adults who generally have more autonomy over their schedules, this tailored intervention could provide education modules that outline the importance of regular physical activity on their health and wellbeing as they get older. These modules could also involve teaching young adults planning skills as well as how to develop good habits. For example, these planning skills could involve action planning, meaning that young people are taught to plan when, where and how they are going to engage in physical activity, rather than just when. An example of helping young adults develop habits could consist of teaching them to develop cues before their engage, such as laying out their workout clothes. It could be important to develop these skills at a young age so that when their commitments become more rigid, they have the skills to combat any disruptions and continue to prioritise physical activity. These skills could also incorporate developing an awareness for their preferred time of day, and then planning in order to engage in physical activity when they are functioning optimally. Understanding the benefits that may come from being physically active at their preferred time of day, may help them to plan to fit it in at this time. For middle-aged adults, who typically have more rigid schedules, this intervention may focus more on helping the individual to understand their priorities. At this stage of life, family and full-time work commitments may take priority, therefore more emphasis may be placed on developing coping planning skills rather than developing routines. These skills could be important as they may need to plan on a more regular basis

and be able to manage any disruptions that may occur. For example, they could be provided with resources of shorter, more accessible exercises that could be done instead of long workouts that require having to, for instance, travel to a gym. Education modules could still also be used to remind middle-aged individuals of the health-related benefits of regular physical activity. It may also be important to consider the purpose of each individuals' physical activity engagement. This may influence the role of morningness/eveningness, as individuals' may not need to try and fit in their physical activity at their preferred time of day if they do not place too much importance on the performance of their chosen activity. For older adults, the focus of the intervention could be placed on morningness/eveningness. Morningness/Eveningness may play more of a role in this life stage than in middle-aged adults, as it may be more important for older adults to engage in physical activity when they are physically functioning optimally. Encouraging older adults to be physically active at their preferred time of day may combat barriers such as fatigue. This could be done by providing educational sessions on building routines, which will help older adults to get into the habit of being physically active at the same time every day. For example, this could mean providing older adults resources of appropriate exercise classes that align with their preferred time of day. In doing this, it may lead to them being physically active on a regular basis. Furthermore, this intervention should incorporate teaching all individuals how to perform certain exercises. This could help improve individuals' self-efficacy, which is important in all individuals' physical activity engagement. By developing individuals' knowledge and skills, it may lead to long-term behaviour change. In order to evaluate this tailored intervention, a longitudinal experimental study could be used with a sample that is representative of the three life stages mentioned in this discussion. A longitudinal study will allow researchers to track the effects of the intervention on individuals' adherence to physical activity, while the experimental nature of it will allow these effects of the intervention group to be compared to that of the control group. Researchers may also be able to explore the effects of the intervention as individuals move from one life stage to another (e.g., middle-aged to older adults).

## Conclusion

The aim of this thesis was to apply different components from a variety of health models, with the additions of habit, enjoyment and morningness/eveningness. It also aimed to provide a more in-depth understanding of the role of morningness/eveningness by exploring how it is conceptualised as well as individuals' experiences of it in their complex lifestyles.

This thesis showed that self-efficacy and age predicted motivation, while perceived behavioural control predicted intention to engage in physical activity. Additionally, planning, habit (automaticity), past behaviour, and environmental cues directly predicted physical activity engagement. However, even though the predictive studies suggested that morningness/eveningness is not important in individuals being physically active, interviews with participants indicated that it could play a role. This was demonstrated through schedule optimization, individuals' purpose for being physically active and the differences between ideal routines and reality. Together, these findings could guide behaviour change techniques that emphasise the implementation of actionable plans, as well as the formation of routines and goals. Furthermore, the findings in this thesis could guide interventions aimed at facilitating an increase in physical activity engagement.

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