Understanding the Enactment of Behaviour Change Techniques in Physical Activity Among University Students with Physical Disabilities and Chronic Conditions: An Ecological Momentary Assessment Study

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List of Abbreviations

BCTs	Behaviour Change Techniques
COM-B	Capability, Opportunity, Motivation-Behaviour
GLMM	Generalized Linear Mixed Model
LTPA	Leisure Time Physical Activity
MVPA	Moderate to Vigorous Physical Activity

Abstract

Behaviour change techniques (BCTs) are strategies to support behaviour change in physical activity. While numerous physical activity interventions use BCTs, there needs to be more understanding of *how* they are used to support physical activity behaviour change, especially among students with physical disabilities and chronic conditions. Therefore, our study aimed to examine BCT usage in physical activity engagement among university students with physical disabilities and chronic conditions. We conducted an intensive longitudinal design employing ecological momentary assessment. Through convenience sampling, current university students (*N* = 53; *Mage* = 22; *SDage* = 3.93) from McGill University (*n* = 40) and Queen's University (*n* =13) with chronic conditions (*n* = 45), pain-related disabilities (*n* =12), and/or mobility/flexibility disabilities (*n* =10) participated. The daily online survey was delivered randomly to their smartphones for ten consecutive days. The daily self-reported questionnaire included a checklist of 28 BCTs created through a multi-step process, a modified 6-item self-reported Capability, Opportunity, and Motivation (COM) questionnaire, a validated adapted physical activity questionnaire, and social and environmental disruption questions. A descriptive analysis summarized physical activity levels, BCT usage, COM, and contextual factors. A decision tree analysis identified groups of BCTs that predicted moderate-to-vigorous physical activity (MVPA) engagement. A generalized linear mixed model examined the relationship between the demographic variables, capability, opportunity and motivation, and contextual factors on the usage of BCTs. On average, 11 BCTs were used daily (*SD* = 5.53, R = 1 to 27) and 22 distinct BCTs (*SD* = 5.14, R = 6 to 28) were used over the 10 days. The most frequently used BCTs included task crafting with *n* = 52 participants using on average *M* = 5.78 times over the 10 days, goal integration (*n* = 51, *M* = 5.56) and finding meaning in PA *(n* = 50, *M* = 5.08). The

least frequently used BCTs included obtaining information on how to perform physical activity (n = 23, M = 4.47), pros and cons (n = 26, M = 2.80), and self-monitoring (n = 33, M = 4.36). Participants appeared to report higher mean levels of daily capability (M = 6.42, SD = 2.23) and opportunity (M = 6.30, SD = 2.34) to use BCTs than motivation (M = 5.56, SD = 2.35). The most frequently reported contextual factors that impacted BCT usage were commitments (n = 34, M = 3.83) followed by flare-ups (n = 35, M = 3.31). Participants reported an average of 83.50 minutes (SD = 90.57) of MVPA daily. When self-talk was combined with behavioural self-praise and obtaining information about health consequences, participants reported the most minutes of MVPA on any given day (M = 188.07, SD = 134.79). Women were most likely to enact 13 BCTs than men (OR range = 3.97 to 15.84, $p < .05$), and students with physical disabilities were less likely to use two BCTs (OR = 0.30 to 0.35, $p < .05$) than students with chronic conditions. Motivation and opportunity predicted the usage of 15 to 25 BCTs (OR = 1.03 to 1.62, $p <.05$), while capability precited the usage of two BCTs (OR = 0.84 to 1.28, $p <.05$). Integrating a nuanced understanding of BCTs provides valuable context for BCT enactment in the behaviour change literature. Our study findings can improve the structure of PA behaviour change interventions, leading to better success in physical activity participation among university students with disabilities and chronic conditions in Canada.

Keywords: Behaviour Change Techniques (BCTs), BCT Enactment, Behaviour Change, Physical Activity Promotion, University Students with Disabilities, Theory, Ecological Momentary Assessment (EMA).

Resumé

Les techniques de changement de comportement (TCC) sont des stratégies qui soutiennent le changement de comportement en activité physique, surtout chez les individus avec un handicap. Même s'il y a de nombreuses interventions en activité physique qui utilisent des TCC, il est nécessaire de mieux comprendre comment les TCC sont utilisées pour soutenir le changement de comportement en activité physique. Donc, notre étude vise à examiner et à d'écrire l'utilisation et l'exécution des TCC dans l'activité physique chez les étudiants universitaires avec un handicap physique et/ou des conditions chronique. Nous avons suivi un plan longitudinal intensif, avec une évaluation écologique momentanée. À travers de l'échantillonnage de convenance, des étudiants universitaires (*N* = 53; *Mage* = 22; *SDage* = 3.93), de l'Université McGill (*n* =10) et de l'Université Queens (*n* = 13), avec des conditions chronique (*n* = 45), handicaps liés à la douleur (*n* = 12), et/ou liés à la flexibilité/mobilité (*n* = 10) ont participé à l'étude. L'enquête en ligne quotidienne a été livrée aléatoirement à leur téléphone intelligent pendant dix jours consécutifs. Le questionnaire quotidien auto-rapporté comprenait une liste de 28 TCC créée en plusieurs étapes, un questionnaire COM (Capacité, Opportunité et Motivation) modifié en 6 items, un questionnaire d'activité physique de loisir adapté, et des questions sur les interruptions environnementales. Une analyse descriptive a résumé les niveaux d'activité physique, l'utilisation des TCC, les facteurs COM et les interruptions environnementaux. Une analyse par arbre de décision a identifié des ensembles de TCC qui prédits l'activité physique d'intensité modérée à vigoureuse (APMV). Un modèle linéaire généralisé mixte a démontré la relation entre les variables démographiques, la capacité, l'opportunité et la motivation, ainsi que les facteurs environnementaux sur l'exécution des TCC. En moyenne, 11 TCC ont été utilisées quotidiennement (*SD* = 5.53, *R* = 1 à 27) et 22 TCC

distinctes (*SD* = 5.14, *R* = 6 à 28) ont été utilisées sur les 10 jours. Les TCC les plus fréquemment utilisées étaient la création de tâches avec *n* = 52 participants l'utilisant en moyenne M = 5.78 sur les 10 jours, l'intégration des objectifs (*n* = 51, *M* = 5.56) et trouver un sens dans l'activité physique (*n* = 50, *M* = 5.08). Les TCC les moins fréquemment utilisés comprenaient l'obtention d'information sur la façon de participer à l'activité physique (*n* = 23, *M* = 4.47), les avantages et inconvénients (n = 26, M = 2.80) et l'autosurveillance (*n* = 33, *M* = 4.36). Les participants ont rapporté un niveau plus élevé de capacité quotidienne (*M* = 6.42, *SD* = 2.23) et d'opportunité (M = 6.30, SD = 2.34) pour utiliser les TCC que de motivation (*M* = 5.56, *SD* = 2.35). Les facteurs environnementaux les plus fréquemment rapportés qui avaient un impact sur l'utilisation des TCC étaient des obligations personnelles *(n* = 34, *M* = 3.83), suivis des exacerbations (*n* = 35, *M* = 3.31). Les participants ont rapporté une moyenne de 83.50 minutes (*SD* = 90.57) d'APMV quotidienne. Dans l'analyse de l'arbre de décision, l'utilisation de l'auto-dialogue démontrait un engagement d'APMV plus élevé *(M* = 126.36, *SD* = 116.79) comparé à lorsqu'ils ne l'utilisaient pas (*M* = 53.98, *SD* = 69.79). Lorsque l'auto-dialogue était combiné avec l'auto-éloge comportemental et l'obtention d'information sur les conséquences pour la santé, l'engagement en APMV était encore plus élevé (*M* = 188.07, *SD* = 134.79). Les femmes étaient plus susceptibles d'utiliser 13 TCC que les hommes (OR = 3.97 à 15.84, $p < .05$), et les étudiants avec des handicaps physiques étaient moins susceptibles d'utiliser deux TCC (OR = 0.30 à 0.35, $p < .05$) que les étudiants avec des conditions chronique. La motivation et l'opportunité étaient des prédicteurs dans l'utilisation de 15 à 24 TCC (OR = 1.03 à 1.62, $p < .05$), tandis que la capacité prédisait l'utilisation de deux TCC (OR = 0.84 à 1,28, $p < .05$). L'intégration d'une compréhension nuancée des TCC fournit un contexte important pour la mise en œuvre des TCC dans la littérature sur le changement de comportement. Les résultats de notre

étude peuvent améliorer la structure des interventions de changement de comportement en matière d'activité physique. De plus, les résultats peuvent mener à une participation réussie de l'activité physique chez les étudiants universitaires avec un handicap physique et avec des conditions chroniques au Canada.

Mots clés : Techniques de Changement de Comportement (TCC), Exécution des TCC, Changement de Comportement, Promotion de l'Activité Physique, Étudiants Universitaires avec des Handicaps, Théorie, Évaluation Écologique Momentanée (EMA)

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Chapter I: Introduction

The International Classification of Functioning, Disability, and Health Disabilities views disabilities as part of the human experience, arising from interactions between one's health condition (i.e., disease, disorders, and injuries) and contextual factors (i.e., external environmental factors and internal personal factors) (Kostanjsek, 2011). Approximately 1.7 billion people worldwide live with disabilities, which includes eight million of the Canadian population (Hébert et al., 2024). In Canada, there are 10 distinct types of disabilities which are: mental health, developmental, memory-related, visual, hearing, learning, dexterity, pain-related conditions, flexibility, and mobility (Statistics Canada 2023). Among the diverse range of recognized disabilities in Canada, physical disabilities (i.e., pain related, flexibility and mobility) are reported to be one of the most prevalent types. Physical disabilities can manifest in different ways, including accidents, injuries, post-surgery, and heredity, and can limit the bodily function, coordination, and strength of one or more limbs within an individual (Government of Canada, 2022). Common types of physical disabilities can be pain-related disabilities (e.g., chronic pain), reported by 62% of Canadians; flexibility disabilities (e.g., Ehlers-Danlos), affecting 40% of Canadians; and mobility disabilities (e.g., amputation), affecting 30% of Canadians (Statistics of Canada, 2023). Individuals with physical disabilities sometimes require using devices and accommodations to help them perform daily activities, maintain independence, and improve their quality of life (Government of Canada, 2022). Chronic conditions also contribute largely to the report of disabilities among the Canadian population. Chronic conditions persist over a long period and require ongoing medical care, often need lifestyle modification and support to manage flare-ups and frequently require medical treatment. (Statistics Canada, 2023). Common types of chronic conditions include diabetes, asthma, endometriosis, and rheumatoid arthritis. In

Canada, 45% of individuals reported suffering from at least one chronic condition (Statistics Canada, 2023).

Most of the Canadian population (79%) have reported living with two or more types of disabilities (Statistics Canada, 2023). A sub-population of Canadians who requires particular attention are young adults, considering the increase rate in reporting disabilities from 13% in 2017 to 20% in 2022 and were 43% more likely to have two or three disability types than the working age (36%) (Statistics Canada, 2023). The rise in young adults reporting disabilities has become increasingly noticeable in Canadian universities, with 9% of first-year students reporting disabilities in 2013 to 40% of middle students in 2023 (Canadian University Survey Consortium 2013; 2023). One explanation for the surge in reporting disabilities among students in Canadian Universities could be due to the increased contextual barriers students face in accessing education and the lack of support services to help students succeed (Moriña & Orozco, 2021; Moriña & Perera, 2020). Examples of such challenges reported are mostly physical obstacles in the university environment such as inaccessible spaces in classrooms and corridors, along with negative attitudes and prejudice held by both faculty and peers without disabilities. Moriña and Orozco (2021) and Moriña and Perera (2020) assertions regarding the challenges faced by students with disabilities is well founded, as recent studies have consistently demonstrated similar findings in various aspect of life for individuals with disabilities, including health facilities (Bonnell et al., 2021; Martin Ginis et al., 2016). As the rate of reporting disabilities has increased over the last ten years, it becomes important to implement more research and health initiatives to better support university students with physical disabilities and chronic conditions.

Engaging in leisure time physical activity (LTPA) (e.g., sports, exercising, walking/wheeling) have contributed to favorable physical and psychological health outcomes for

individuals with disabilities, particularly students (Devine et al., 2016). Despite the benefits, studies have shown that most university students with disabilities use campus recreational activities less than five times per semester and are found to be less active than university students without disabilities (Yoh et al., 2008; Valis et al., 2017). Further, one study on physical activity participation among Spanish university students with disabilities reported that 72.2% did not achieve the physical activity guidelines (Úbeda-Colomer et al., 2019b). Úbeda-Colomer et al. (2019b) further reported that students with multiple disabilities, chronic conditions, and disabilities acquired over time were less active compared to their counterparts. These results are not surprising, as people with disabilities are 16-62% less likely to meet the physical activity guidelines than people without disabilities (Martin Ginis et al., 2021a), Specifically, compared to individuals without disabilities, individuals with physical disabilities are 31% less likely to achieve the physical activity guidelines, and individuals with chronic condition are 18% less likely to meeting the 24-hour movement guidelines (Porter et al., 2023). Therefore, these results demonstrate the need to support individuals with physical disabilities and chronic condition in adopting healthier behaviours.

There has been growing evidence of behaviour change interventions, particularly behaviour change techniques (BCTs) to encourage physical activity among this population (Ma & Martin Ginis., 2018). However, issues and ambiguity surrounding BCTs, and their effectiveness to promote behaviour change persist (Hankonen, 2021; Ma & Martin Ginis, 2018; Spring et al. 2021). Behaviour change techniques (BCTs) are recognized as strategies (e.g., goal setting) that support the behaviour change process (Michie et al., 2011). However, there is not enough substantial evidence to conclude the effectiveness of BCTs due to ambiguities in the types and frequency of BCT used within interventions (MA & Martin Ginis, 2018; Spring et al.,

2020). It has been suggested instead to directly test the impact of BCTs (Spring et al., 2020) and to shift our focus by investigating how participants understand and explicitly enact BCTs (Hankonen, 2021). Focusing on BCT enactment could provide a clearer understanding of BCT effectiveness, as BCT enactment considers how participants independently integrate BCTs to achieve behaviour change in real-life settings (Hankonen, 2021). Some studies have explored BCT enactment, finding that only 36% of participants consistently enacted 16 BCTs, and 40.5 % enacting all eight BCTs in physical activity (Hankonen et al., 2015). Therefore, these studies collectively indicate a dearth of knowledge regarding BCT enactment remains, especially surrounding the description of types, frequency, and consistency of BCT use in daily life. Only by understanding the specifics of BCT enactment and the underlying factors and mechanisms related to BCT enactment can we better promote behaviour change, particularly among university students with physical disabilities and chronic conditions.

Purpose and Research Questions

This study investigated and described the enactment of BCTs among physically active university students living with chronic conditions and physical disabilities. This study aimed to:

1. Understand and describe the frequency of enactment in physical activity BCTs among this student population.
2. Investigate the relationship between the person-level predictors such as capability, opportunity and motivation, contextual factors, and the enactment of BCTs.
3. Identify the most prevalent combinations of BCTs and which combination results in greater physical activity participation among physically active university students with chronic conditions and physical disabilities

Chapter II: Literature Review

Physical activity encompasses any bodily movements that engage skeletal muscles during transportation, work-related or leisure pursuits (World Health Organization, 2022). Among these various types of physical activity, leisure time physical activity gained popularity as individuals engage in an activity primarily for recreation, enjoyment, and personal well-being during their free time (Steinbach et al., 2008). These activities include gardening, home exercises, swimming, dancing, and bicycling, with walking being the most practiced activity among Canadian adults (Statistics Canada, 2017). Canadians who practice these activities were reported to be in good health, less likely to report high blood pressure and stress, and less likely to be overweight (Statistics Canada, 2017).

The benefits of participating in leisure time physical activity go beyond the general population. Leisure time physical activity contributes to favourable physical and psychological health outcomes and reduces the risk of secondary health conditions among individuals with disabilities (Martin Ginis et al., 2021a). For students with disabilities, participating in LTPA (e.g., sports, exercising, walking/wheeling) improves resilience, cognitive functions, and overall well-being and quality of life (Devine et al., 2016). Despite the benefits, studies have shown that most university students use campus recreational activities less than five times per semester and are found to be less active than university students without disabilities (Valis et al., 2017; Yoh et al., 2008). Further, one study on physical activity participation among Spanish university students with disabilities reported that 72.2% did not achieve the physical activity guidelines, with students who had chronic illness being the least active group and failed to meet the physical activity guidelines (Úeda-Colomer et al., 2019b). These results are not surprising as people with disabilities are 16-62% less likely to meet the physical activity guidelines than people without

disabilities (Martin Ginis et al., 2021a). Specifically, compared to individuals without disabilities, individuals with physical disabilities are 31% less likely to achieve the physical activity guidelines, and individuals with chronic condition are 18% less likely to meeting the 24-hour movement guidelines (Porter et al., 2023).

The World Health Organization took the initial steps in creating a physical activity guideline for adults with disabilities aged 16-65 years. The physical activity guideline recommends that adults with disabilities participate in at least 150 to 300 minutes of moderate-intensity aerobic physical activity per week or at least 75-150 minutes of vigorous-intensity aerobic physical activity (World Health Organization, 2022). Furthermore, these physical activity guidelines suggest that individuals with disabilities incorporate muscle-strength strengthening exercise that targets all major muscle groups at least two or more days per week (World Health Organization, 2022). These physical activity guidelines among people with disabilities have been questioned as the evidence supporting these guidelines consists mostly of individuals without disabilities (Martin Ginis et al., 2021b). Yet, the World Health Organization still recommends that individuals with disabilities follow the same physical activity guidelines developed for the general population, as they may receive similar health benefits (Carty et al., 2021). The standardization of the physical activity guidelines is concerning as it promotes a one-size-fits-all approach and does not consider the unique challenges and barriers experienced by individuals with disabilities while trying to engage in physical activity (Martin Ginis et al., 2021b). Physical activity guidelines for populations with specific types of disabilities, such as spinal cord injury (Martin Ginis et al., 2011) and multiple sclerosis (Latimer-Cheung et al., 2013) differ from the WHO guidelines. While the adapted physical activity guidelines are a promising

step, there is still a need to develop better strategies to ensure active and consistent engagement in physical activity.

There are also numerous factors that makes it difficult for individuals with disabilities to be physically active. Prevalent barriers to physical activity participation can be related to health-related symptoms such as pain, fatigue, and lack of energy (Jaarsma et al., 2014; Martin Ginis et al., 2016; Úbeda-Colomer et al., 2019b). Inadequate infrastructure (e.g., inaccessible facilities), community-related challenges (e.g., transportation), lack of knowledge in disability and physical activity (e.g., insufficient staff training), financial burdens (e.g. high cost of adaptive devices or specialized programs), and interpersonal barriers (e.g., lack of social support and discrimination) are also barriers that has limited physical activity -participation for- of individuals with disabilities (Bonnell et al., 2021; Martin Ginis et al., 2016). For individuals with disabilities not being able to participate in physical activity is alarming as it can increase the risk for secondary conditions such as cardiovascular disease, depression, and chronic pain (Martin Ginis et al., 2021a). Therefore, physical activity interventions programs are important to not only promote physical activity participation among people with physical disabilities but mitigate the risk of developing secondary health conditions.

Physical Activity Interventions and Behaviour Change Techniques

Rimmer et al. (2010) conducted the first scoping review of physical activity interventions among individuals with disabilities and demonstrated the research need for physical activity interventions for individuals with disabilities. Many physical activity interventions have been implemented over the last decade to promote physical activity participation, ranging from informational interventions that provide knowledge (Plow et al., 2014) to social and behavioural interventions that focus on interpersonal support (Chemtob et al., 2019). While these

interventions promote physical activity engagement, they often overlook the underlying behavioural factors influencing their participation.

Behaviour change interventions have targeted these behavioural factors and have successfully promoted physical activity among different populations, such as individuals with disabilities (Ma & Martin Ginis., 2018). Defined as "coordinated sets of activities designed to change specified behavioural patterns" (Michie et al., 2011), behaviour change interventions often rely on active components known as behaviour change techniques (BCTs). BCTs are "observable, replicable, and irreducible components of behaviour change interventions systematically designed to promote behaviour change actively" (Michie et al., 2013, p.82). Historically, BCTs were once poorly described in research protocols and published reports. It became challenging for researchers to establish a precise definition and labels around the different types of BCTs. Therefore, the BCT taxonomy v1 (BCTTv1) was developed, a hierarchically structured taxonomy of BCTs. The BCTTv1 was assumed to help provide clarity and guidance by creating a shared and precise language and method of BCT reporting in behaviour change interventions (Michie, 2013). Since the creation of the BCTTv1, the taxonomy has been reported in numerous interventions to help with promoting behaviour change (Michie et al., 2018). Despite such improvements, issues surrounding BCTs still persists today.

BCTs has been implemented in physical activity interventions to improve physical activity participation among different populations. For instance, a systematic literature review by McHale et al. (2021) identified the most effective peer-lead BCTs for promoting students' physical activity. The most frequently reported BCTs within interventions among students were social support, information about health consequences, and demonstration of the behaviour. Other commonly used BCTs were goal setting, problem-solving, behavioural rewards, self-

monitoring, and instruction on how to perform the behaviour. The authors further reported that interventions that employed more BCTs (9 to 13) tended to be more successful. However, Ma & Martin Ginis, (2018) claimed that previous studies reported that the number of BCTs implemented in interventions does not necessarily correlate with behaviour change outcomes, suggesting that "more is not necessarily better". In addition to students, BCTs have been implemented in physical activity behaviour change interventions among individuals with disabilities. For instance, studies by Ma & Martin Ginis (2018) and Tomasone et al. (2018) have shown that the most prevalent BCTs in physical activity interventions among individuals with disabilities are goal setting, problem-solving, self-monitoring, social support, instruction on performing a behaviour and graded tasks. Self-monitoring of behaviour and monitoring of the behaviour of others without feedback were found to be most effective with interventions that used self-monitoring and had a larger effect than interventions that did not use it (Ma & Martin Ginis, 2018). While interventions that used feedback on behaviour, instruction on how to perform the behaviour, and problem-solving showed larger effects than interventions that did not incorporate these techniques, the differences were not statistically significant (Ma & Martin Ginis, 2018). The lack of statistical significance suggests that there is not enough substantial evidence to conclude the effectiveness of the BCTs in interventions. As such, there is currently a lack of information concerning these techniques and the dearth of their frequency, intensity, and delivery of their effectiveness in implementation within physical activity interventions (Ma & Martin Ginis, 2018).

The need for a nuance understanding regarding BCTs is further echoed by Spring et al. (2021), who conducted a meta-review to examine interventions that promoted health behaviours with the usage of self-regulatory behaviour change techniques. Examples of self-regulatory

behaviour change techniques examined were goal setting, problem solving, action planning, and providing feedback. While the meta review reported improved outcomes in health behaviour of studies using self-regulatory BCTs, the overall findings on the effectiveness of these techniques remains unclear. An unexpected observation from these results was the absent of reports regarding the effectiveness of BCTs in promoting physical activity, despite many systematic reviews on physical activity BCTs. Moving forward, Spring et al. (2021) suggests for a nuanced examination of BCTs to address the ambiguity surrounding these techniques by directly testing the impact on different populations of individuals BCTs on health outcomes, particularly physical activity.

There is growing recognition that BCTs are more than just their delivery in behaviour change interventions. To truly understand the impact of BCT engagement, it is important to explore not only how they are delivered, but how they are understood and explicitly enacted by individuals. This exploration however requires two processes: BCT receipt and BCT enactment. BCT receipts refers to the participants ability to understand the BCTs taught to them (Hankonen, 2021; Palsola et al. 2020). However, the focus on BCT receipt has been overshadowed by putting focus to fidelity within behaviour change interventions, with only 19.6% of interventions address receipts (Rixon et al., 2014). A qualitative study by Miles et al. (2022) evaluated the receipt fidelity of a diabetes prevention program. The study conducted interviews to gain insights about how well participants understood and engage with self-regulatory BCTs. The study found there was an overall variation of understanding in BCTs among participants. Participants demonstrated ease in understanding self-monitoring, while struggling in understanding goal setting, and problem solving. As for action planning, most participants not only had a limited understanding but also found this BCT to be cognitively challenging, often comparing it to “homework”

task. Furthermore, Hoekstra et al. (2022) conducted a study to measure the delivery and receipt of BCTs in counselling sessions for people with physical disabilities. The authors emphasized that focusing on both delivery and receipt is important as it helps to identify which BCTs are comprehended, thereby improving intervention fidelity. However, both Hoekstra et al. (2022) and Miles et al. (2022) did not capture behaviour change enactment, a key aspect of behaviour changes interventions. Therefore, future research must delve into examining BCT enactment in a physical activity context (Hoekstra et al., 2022; Miles et al., 2022).

Hankonen (2021) highlighted that simply delivering BCTs by focusing on fidelity and receipt does not always guarantees that individuals will be able to apply the skills taught to them. Thus, the concept of BCT enactment was introduced, defined as how individuals independently apply BCTs in their daily routine beyond the controlled environment settings to achieve behaviour change (Hankonen, 2021; Palsola et al., 2020). Despite the importance of BCT enactment, there is still much to learn about how and to what extend individuals explicitly enact BCTs. In fact, several studies have demonstrated considerable differences and inconsistencies in BCT enactment. For example, Hankonen et al. (2015) examined the use of BCTs in participants with type 2 diabetes, targeting physical activity participation. The frequently used BCTs were goal setting, action planning, and self-monitoring. However, only 36% of participants reported using all 16 BCTs after the one-year follow-up. The low enactment rate post-intervention supports the idea that simply delivering BCTs does not guarantee enactment. Furthermore, Hankonen et al. (2017) explored BCT enactment among students to increase participation in physical activity. The study found that BCT enactment was moderate, with the intervention group showing higher use of BCTs than the control group. Motivational BCTs (e.g., thinking about the positive consequences of PA and one's motives) were more frequently reported in both

intervention groups. In contrast, self-regulatory BCTs (e.g., self-monitoring and coping planning) were less frequently enacted, particularly in the control group. The inconsistency in BCT enactment underscore the need for more research on this dimension of BCTs, as they appear to be more complex than initially understood. Further, French et al. (2021) qualitatively explored the enactment of self-regulatory BCTs within a physical activity intervention. Adults with chronic conditions were interviewed twice about their BCT enactment: immediately post intervention and three months later. The study found that while goal setting and self-monitoring was well received, participants experience challenges in enacting self-regulatory BCTs. Participants found self-regulatory BCTs complex and cognitively challenging to enact, highlight a need for simplification and additional support to enhance the engagement of BCTs. Lastly, Palsola et al. (2020) found that their intervention in promoting physical activity also encountered challenges in enacting self-regulatory BCTs such as action planning and self-monitoring. The participants generally understood the purpose of the intervention, and the BCT taught (i.e., receipt), but they struggled to apply the BCTs on their own, outside the controlled intervention setting (i.e., low BCT enactment). The participants even found while they understood the importance of action planning and self-monitoring, both BCT were burdensome and was not seen as suitable for their daily routines. Collectively, the interventions focusing on BCT receipt and enactment underscore the need for a better understanding of how BCTs are enacted, particularly in natural settings.

The lack of understanding regarding BCT enactment brings attention in Greaves (2015) idea by treating BCTs as independent behaviour targets rather than tools for change. Greave's (2015) paradigm shift towards understanding the mechanism behind BCTs could help fill the gap by offering a nuanced understanding of BCTs and addressing the ambiguity surrounding their

effectiveness, as suggested in the study conducted by Spring et al. (2021). Viewing BCTs as their own behaviours could help researchers examine and clearly understand the effectiveness of various BCTs in promoting behaviour change among individuals. Researchers have begun to treat BCTs as their own behaviour. For instance, Sweet et al. (2014) and Mistry et al. (2015a) investigated action planning as an independent behaviour. Sweet et al. (2014) explore various messaging strategies to promote action planning and found that providing instructions on creating a specific and detailed plan increases the quality of action planning. Similarly, Mistry et al. (2015a) also reported the impact of text messaging on action planning and the quality of the action plans. The authors reported that when text messages were absent, it led to a decline in the use of action planning and, in turn, impacted physical activity. Together, these studies illustrate and support Greaves' (2015) idea that treating BCTs (e.g., action planning) as their own behaviour can provide a nuanced understanding of the mechanics behind enacting BCTs, ultimately enhancing their impact on behaviour change.

Hankonen (2021) highlighted a need for more understanding and specific theoretical explanations about the enactment and frequency of behaviour change techniques as BCTs may have their own psychosocial predictors. For instance, Mistry et al. (2015b) and Michalovic et al. (2018) has examined the psychological process of action planning. Mistry et al. (2015b) examined whether the theory of planned behaviour could predict change in planning behaviour. The researchers found that while the theory of planned behaviour did not predict physical activity, they were effective in predicting action planning. While the study provided a preliminary investigation of the psychological process of BCTs, their findings suggest the possibility that traditional behavioural theories may not fully explain BCT enactment (Willmott et al., 2021). Furthermore, Michalovic et al. (2018) investigated the psychological process by

exanimating whether risk perception influenced action planning and if message elaboration on the creation and quality of physical activity planning influences the behaviour of action planning. One of their main results showed that emotional risk framing moderated the relationship between message framing and action planning, highlight the role of emotion in action planning. Moreover, Palsola et al. (2020) found that motivational factors (e.g., social support) were associated with the engagement of self-regulated BCTs. By having the opportunity to actively seek social support, it enhanced their motivation to commit to physical activity. However, BCT engagement in most participants varied, with some reported being highly motivated, and others showing little to no engagement, impacting the enactment of BCTs. Lastly, both Palsola et al. (2020) and Miles et al. (2022) reported that the participants often compared BCTs to homework. Consequently, it negatively impacted their motivation to engage in these BCTs consistently in their daily lives. Overall, these studies support Hankonen (2021) call that BCTs may have their own psychological process, and appropriate theoretical explanation is needed. The inconsistent enactment in BCTs highlight the need for more research to understand the psychological process underlying BCTs. By understanding what drives the use of BCTs within individuals, it can improve the structure of behaviour change interventions, leading to better success in BCT enactment.

Theory/COM-B

Many psychological theories have been used in behaviour change interventions among adults with physical disabilities. These include the Theory of Planned Behaviour, Social Cognitive Theory, the Transtheoretical Model, the Health Action Process Approach Model, the Relapse Prevention Model (Ma & Martin Ginis, 2018), and the Self-Determination Theory (Chemtob et al., 2019). While these psychological theories have been effective in promoting

physical activity participation, each has its limitation. A common issue among these theories is their inability to fully capture the full picture of behaviour change, as they primarily focus on the intra-individual factors, and overlook the broader social and environmental factors impacting behaviour change (Willmott et al., 2021). Therefore, Willmott et al. (2021) explored the capability, opportunity, and motivation (COM-B) model in health behaviours and found that the COM-B model was favourable to other social psychological theories (e.g., Theory of Planned Behaviour) when assessing behaviour change. Further, Willmott et al. (2021) reported that the COM-B model can explain between 23% to 31% of the variance in young adults' health behaviour, highlighting the model's ability to account for broader factors beyond intra-individual factors that impact behaviour change.

The COM-B model is a framework that is intended to capture the many facets of behaviour change (Coupe et al., 2019; Willmott et al., 2021). Derived from the Behaviour Change Wheel, the COM-B model is a theoretical framework that aims to understand behaviour change through essential components that influences behaviour (Michie et al., 2011). The model proposes that to influence behaviour (B) change, the individual must have the Capability (C), Opportunity (O) and Motivation (M). *Capability* is defined as having the physical and psychological capability physically to engage in a behaviour. Under the umbrella of capability, *physical capability* refers to having the knowledge and skills to do the behaviour, and psychological capability refers to engaging in the thought process to perform the behaviour. *Opportunity* refers to the physical and social factors that facilitate or hinder one in engaging in the behaviour. *Physical opportunity* refers to the physical environment providing the necessary opportunities and resources to engage in the behaviour. *Social opportunity* refers to social norms that can help or hinder behaviour. Lastly, *motivation* directs behaviour through a reflective and

automatic motivational process. *Reflective motivation* is a cognitive process involving conscious thought and intentional decision-making influenced by values and personal goals. Emotions and impulsive reactions without conscious consideration drive *automatic motivation*. Interestingly, while motivation can directly be associated with behaviour, it can also mediate the association between capability, opportunity, and behaviour (Michie et al., 2011).

COM-B has been a promising framework for understanding many health behaviours across different population. Regardless of the health behaviour, research has consistently demonstrated that COM-B can predict health behaviour, by accounting individuals' capability, opportunity, and motivation. For instance, Howlett et al. (2019) explored the construct and predictive validity of the COM-B model in physical activity for adults. The authors found that the COM-B model effectively predicted physical activity behaviour, with capability being the highest predictor, followed by motivation and opportunity. The results are consistent when studying physical activity behaviour among individuals with disabilities, with each component being crucial for physical activity engagement (Reicherzer et al., 2022).

Given that BCTs may be distinct health behaviours and have their own psychosocial processes (Hankonen, 2021), behavioural theories are also needed to further our understanding in their enactment. Mistry et al. (2015b) used the theory of planned behaviour variables to explain action planning. However, their findings suggest the possibility that traditional behavioural theories may not fully explain the complexities of BCT enactment. The COM-B model could therefore be a theoretical framework for understanding the nuances behind BCT enactment as they can understand why and how individuals enact BCTs in their daily lives by examining capability, opportunity, and motivation. For example, if BCTs are found to be complex and cognitively challenging (French et al., 2022), we need to examine whether individuals have the

knowledge, skills, and abilities to engage in BCTs. Moreover, if social support influences the motivation of BCT enactment (Palsola et al., 2020), using COM-B will allow us to examine whether individuals have opportunities to receive such social support. Additionally, if motivation is varied in BCT enactment (Palsola et al., 2020), the COM-B model can examine how variations in motivation impact BCTs enactment. Therefore, the COM-B model has great potential to provide novel insights into the psychological, social, and environmental processes of BCTs enactment.

Chapter III: Manuscript

The Enactment of Behaviour Change Techniques in Physical Activity Among University Students with Physical Disabilities and Chronic Conditions: An Ecological Momentary Assessment Study

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Introduction

In Canada, between 30% to 62% adults report living with a type of disability and 45% report having at least one chronic condition (Statistics of Canada, 2023). Physical disabilities (e.g., chronic pain, ehlers-danlos, and amputation) and chronic conditions (e.g., diabetes, asthma, and endometriosis) can limit bodily function, require continuous care, and can hinder the ability to adopt healthy behaviours (Statistics of Canada, 2023). Compared to individuals without disabilities, those with physical disabilities and chronic conditions are 18% to 31% less likely to enact healthy behaviours (Porter et al., 2023). These low rates are particularity evident in the university student population with disabilities, with Spanish students with disabilities failing to meet the physical activity guidelines, and students with chronic conditions being the least physically active group (Úbeda-Colomer et al., 2019b). As the number of university students reporting disabilities has increased from 9% of first-year students reporting disabilities in 2013, to 40% of middle students in 2023 (Canadian University Survey Consortium 2013; 2023), more research is clearly needed to understand how to best support physical activity among university students with physical disabilities and chronic conditions.

Engaging in leisure time physical activity (LTPA; e.g., sports, exercising, walking/wheeling) have contributed to favorable physical and psychological health outcomes for individuals with disabilities, particularly students (Devine et al., 2016). However, there is a rise in concern regarding their low levels of physical activity participation. (Úbeda-Colomer et al., 2019a; Valis et al., 2017). As a result, there has been growing evidence of behaviour change interventions, particularly behaviour change techniques (BCTs) to encourage physical activity among individuals with disabilities (Ma & Martin Ginis., 2018). Behaviour change techniques (BCTs) are recognized as strategies (e.g., goal setting) that support the behaviour change process

(Michie et al., 2011). However, there is not enough substantial evidence to conclude the effectiveness of BCTs due to ambiguities in the types and frequency of BCT used within interventions (Ma & Martin Ginis, 2018; Spring et al., 2020). Therefore, it has been suggested to shift our focus to understand how participants understand and explicitly enact BCTs, thus treating BCTs as behaviours (Hankonen, 2021). Focusing on BCT as behaviours could provide a clearer understanding of how participants independently integrate BCTs in real-life settings (Hankonen, 2021).

Some studies have explored BCT enactment, finding that only 36% of participants consistently enacted 16 BCTs, and 40.5 % enacting all eight BCTs in physical activity (Hankonen et al., 2015). Additionally, many struggled to apply BCTs on their own beyond interventions (French et al., 2021; Hankonen et al., 2017; Palsola et al., 2020). These studies collectively indicate a dearth of knowledge regarding BCT enactment remains, especially surrounding the description of types, frequency, and consistency of BCT use in daily life. Only by understanding the specifics of BCT enactment and the underlying factors and mechanisms related to BCT enactment can we better promote behaviour change, particularly among university students with physical disabilities and chronic conditions.

The COM-B model is a valuable framework for understanding the complexities of behaviour change (Coupe et al., 2019; Willmott et al., 2021). The model proposes that to influence behaviour (B), the individual must have the capability (C), opportunity (O) and motivation (M) (Michie et al., 2011). In the context of BCT enactment, capability involves having the physical and psychological skills to enact BCTs. Opportunity refers to the physical and social factors that can impact the enactment of BCTs. Motivation encompasses reflective and automatic processes of BCT enactment. Utilizing COM-B as the guided framework could

offer insight into the relationship between these three components and the enactment of BCTs given some qualitative studies hinted at COM factors being important for BCT enactment (e.g., if BCTs are found to be complex and cognitively challenging, we need to examine whether individuals have the knowledge, skills, and abilities to engage in BCTs; French et al., 2021). This theoretical approach will thereby enhance our understanding behind the mechanism of BCTs enactment among university students with physical disabilities and chronic conditions.

Taken together, this study provided insights around BCT enactment in a growing segment of the population, university students with disabilities and chronic conditions. Therefore, the purpose of this study was to (a) describe the frequency of enactment in physical activity BCTs, (b) examine the relationship between capability, opportunity and motivation, contextual factors, and the enactment of BCTs, and (c) identify prevalent combinations of BCTs and which combination results in greater physical activity participation among physically active university students with physical disabilities and chronic conditions.

Methods

Design

The study employed an intensive longitudinal design, using ecological momentary assessment (EMA) to investigate the enactment of behaviour change techniques in physical activity.

Fifty-three university students with physical disabilities and/or chronic conditions were recruited to participate in the EMA study. The sample size was selected based on previous EMA studies where studies with more than 15 participants enhanced the likelihood of finding significant results (Oleson et al., 2022). To be eligible to participate, students had to a) have physical disabilities and/or chronic conditions, b) be at least 18 years of age, c) be from McGill

(Montreal) or Queen's (Kingston) University, d) Speak English or French, e) have access to a smartphone device, and f) engage in moderate to vigorous physical activity at least twice per week for a minimum of 30 minutes in the last three months. Given the discrepancy in physical activity guidelines for people with disabilities (Martin Ginis et al., 2021b), the study followed an adapted version of the physical activity guidelines taken from (Hoekstra et al., 2020; Latimer-Cheung et al., 2013) to better align with the targeted population of our study. Students who identified having a mental health disorder, neurodevelopmental or sensory disabilities were excluded from the study. If students with physical disabilities and chronic conditions also identified having a mental health disorder meeting was arranged to discuss their eligibility status to ensure they met the eligibility criteria.

Procedures

Ethics approval was obtained for this study from McGill and Queen's University's Research Ethics Boards (REB # 22-06-095). A convenience sampling method was utilized to reach potential students. The McGill Students Accessibility & Achievement Services distributed hard copies of the study poster within their service centre, shared the recruitment poster on their social media platform, and emailed the study information to their respective email list. The research team also contacted respective McGill and Queen's University professors, requesting their collaboration in sharing the study recruitment with students on their online course platform.

Participants interested in the study followed a link or QR code to complete the screening questionnaire on the Lime-survey, an online survey platform hosted by McGill University. The link was available to students through the recruitment posters at the service centers, social media, their email, or their online course platform. The screening questionnaire collected pertinent information regarding the student's name, university email, and questions regarding the

eligibility criteria. Students who were not eligible after the screening questionnaire were notified at the end of the survey. Meanwhile, students who reported having physical disabilities and/or chronic conditions with a secondary health condition were deemed potentially eligible and needed further assessment. Eligible students received an email from the research team expressing their eligibility for participation and invited them to a pre-study meeting. After scheduling the pre-study meeting, the researchers provided each eligible student a unique ID code and a link to access the consent form and baseline questionnaire, via LimeSurvey. Eligible participants had the option to complete and sign the consent form and baseline questionnaire electronically on their own time before or during the meeting.

Pre-Study Meeting

During the pre-study meeting, the researcher verified that the consent form and baseline questionnaire were completed and answered questions about the study procedures. The researcher guided participants in setting up the Pathverse mobile application, the chosen EMA software for data collection. A screen recording on how to navigate the app and its features was presented during the pre-study meeting to familiarize participants with the mobile application. Once participants were comfortable navigating the app, they selected a start date for the study.

EMA Daily Survey Protocol

The daily questionnaires were delivered through the Pathverse mobile application. The Pathverse application prompted participation by releasing daily randomized single-pin notifications on their smartphones. Randomized pin notification was used to help reduce response biases and mitigate the chances of participants anticipating when the survey would be delivered. The time window of these randomized pin notifications was between 4:00 pm and

8:00 pm to ensure participants had the time to engage in physical activity. The notification window closed after 8:00 pm, and they had to complete the survey before 2:00 am.

The study duration of 10 days was chosen based on a systematic review of EMA studies, indicating that 7 days were standard in EMA studies (Hall et al., 2021). Extending the study to 10 days allowed some flexibility for participants to miss a few days of completing the daily survey without losing substantial data for the analysis. Participants were compensated 75$ for their time to complete the study. Five dollars was given for those who completed the consent form and baseline questionnaire, and seven dollars for those who completed the daily survey.

Measures

Demographic Information

Participants provided details of their demographic background in the baseline questionnaire only. Questions included a) date of birth (year and month), b) gender, c) ethnicity, d) university institution, e) school faculty, f) type of housing, g) time of commute to school, h) average work hours, i) type of physical disabilities and/or chronic condition, j) reliability to move around the community, and k) primary mode of mobility.

Leisure Time Physical Activity Questionnaire

The study used the leisure time physical activity questionnaire adapted for physical disabilities. The self-reported leisure time physical activity questionnaire aimed to assess the type of physical activity (i.e., aerobic activities and Strength Training) (Cummings et al., 2019; Martin Ginis et al., 2012). For each type of physical activity (i.e., aerobic and strength), participants were asked to estimate duration for each intensity (i.e., mild, moderate, and vigorous). In the baseline questionnaire, participants self-reported their physical activity in the

last seven days, while in the daily survey, they reported in the last 24 hours (See Appendix A). The overall scores of MVPA were calculated by summing the scores for vigorous and moderate.

Behaviour Change Techniques Questionnaire

The study used a modified version of a BCT questionnaire (Hankonen et al., 2017). Participants read an example of 28 BCTs. For example, participants read descriptions such as: (1) Task crafting, where individuals chooses a physical activity that matches their skills and abilities; (2) Goal integration, where individuals engage in physical activity at the same time as another personal interest; (3) Graded tasks, where individuals start with a simple physical activity and gradually makes it harder; (4) Self-monitoring, where individuals tracks their physical activity; and (5) Behavioural self-praise, where individuals verbally rewards themselves after doing physical activity.

For the baseline questionnaire, participants' enactment of 28 behaviour change technique was assessed on a 5-point Likert scale ranging from 0 (not even once) to 5 (daily) in the last two weeks. In the daily survey, participants responded yes or no to whether they used each of the 28 techniques in the last 24 hours.

Behaviour Change Technique Selection Process. The research team selected the behaviour change techniques through a four-step approach. Please refer to Appendix C for detailed steps.

Step One. The research team conducted a literature search using multiple databases, including PsycINFO, PubMed, and Medline of meta-analyses and reviews of physical activity interventions using the following search terms: Behaviour change techniques or behaviour change skills or BCT and Physical activity or PA and effectiveness or effective and disability or disabled and review and meta-analyses. Within 26 meta-analyses/reviews, the research team

identified 53 behaviour change techniques. Among these techniques, the research team examined their frequency and effectiveness across the 26 articles and identified a subset of eight techniques that were reported as being the most used or effective in physical activity interventions.

Step Two. Our team consulted the self-enactable compendium list (Knittle et al., 2020) to ensure participants' chosen techniques were relevant and adopted in their physical activity. Each of the five members of the team selected 10 self-enactable techniques from the list based on their knowledge from conducting physical activity interventions and empirical evidence from the literature among individuals with disabilities. The team shared their list and the team discussed similarities and differences among their list, resulting in a unified selection of 13 distinct techniques.

Step Three. Our team aligned the 13 selected behaviour change techniques with the theoretical domain framework (Cane et al., 2012) and the COM-B model from the BCW (Michie et al., 2011). This step ensured that our chosen BCTs covered theoretical construct for behaviour change. Since the initial 13 BCTs did not adequately cover all theoretical domains, we consulted Richardson et al. (2019), which maps BCTs to the theoretical domains and COM-B. Based on Richardson et al. (2019), we identified and selected 15 additional BCTs to cover the remaining theoretical domains.

Step Four. After selecting 28 behaviour change techniques, we wrote a simplified version of the behaviour change techniques' definitions. To ensure alignment of the simplified definition with the BCT, we asked one Ph.D. student, master's student, and undergraduate student- all unfamiliar with these techniques- to read the definition and associate each with the appropriate technique from the self-enactable list. The Ph.D. student correctly associated (21/28) of the BCTs, while the master student associated (22/28). After modifying the definitions of the BCTs,

an undergraduate student completed the task and correctly associated (24/28) with mistaking task crafting, obtaining practical help, observing the demonstration of the behaviour and focusing on enjoyment. After re-defining these definitions, the Ph.D. student revisited the task and correctly associated (27/28) of the BCTs with misidentifying goal integration. We were, therefore, confident that the simplified definition accurately represented the BCT while being sufficiently lay enough for student participants to understand the technique.

COM-B Questionnaire

The study used a modified COM-B questionnaire version from a generic 6-item self-evaluation COM questionnaire (Keyworth et al., 2020) to measure the student's capability, opportunity, and motivation to use behaviour change techniques in physical activity both at baseline and in the daily surveys. The COM-B questionnaire measured the subcomponents of COM-B, such as physical and psychological capability, physical and social opportunity, and automatic and reflective motivation. Each subcomponent was assessed on a 10-point Likert scale ranging from 0 (strongly disagree), to 10 (strongly agree). The baseline questionnaire aimed to measure the participants general perception of their capability, opportunity, and motivation of using behaviour change techniques in physical activity. In contrast, the daily surveys focus on capturing participants' capability, opportunity, and motivation on using behaviour change techniques in their physical activity within the past last 24 hours (See Appendix D). An example of a capability statement for the daily surveys includes "I was physically able to use behaviour change strategies in my physical activity today." An example of opportunity in the daily surveys is: "I had the social opportunity to use behaviour change strategies in my physical activity today." An example of motivation in the daily surveys is: "I was motivated to use behaviour change strategies in my physical activity today." The overall score for capability, opportunity

and motivation were created by calculating the mean of the two items for each respective subcomponent.

Situational Disruption Information

The assessment of situational disruption in the daily survey consisted of five items, prompting participants to indicate whether they had challenges in participating in physical activity (See Appendix E). Participants responded to either yes or no to factors such as exams or course assignments, illness, weather, flare-ups, other personal responsibilities, or commitments (Bonnell et al., 2021; Úbeda-Colomer et al., 2019b).

Data Analysis

Research Question 1: Descriptive Statistics of Behaviour Change Techniques

Descriptive statistics for the sociodemographic variables, LTPA, BCTs, COM-B and situational disruption information were calculated using SPSS© 29.0.0.0 (IBM Corp, 2019). To address outliers in LTPA, an iterative approach was employed where ten values exceeding the expected range were flagged and adjusted by increasing the value by one unit following the next highest data point. There were 83 (18.32%) missing values across the dataset for LTPA (i.e., those who missed a day of the survey). Missing data were addressed using the group mean imputation method. This method involved replacing the missing values with the overall mean of LTPA across all participants. To measure which BCTs were frequently used together, a co-occurrence and combination count analysis were employed using ChatGPT 4o (OpenAI, 2024). The questions prompted by the research team to ChatGPT 4o were 1) "Can you help me identify the unique combinations of behavior change techniques (BCTs) reported by participants over the 10-day period?" 2) "Please list all unique combinations of BCTs observed across the 53 participants" and 3) "Could you count how many times each unique combination of BCTs

appears among the participants? I'd like to know the frequency of occurrence for each unique combination of BCTs."

Research Question 2: Generalized Linear Mixed Models (GLMM) of Behaviour Change Techniques Enactment

A series of generalized linear mixed models (GLMM) was conducted for our study to account for the data's hierarchical structure of our data, and the binary nature of our outcome variables (BCT usage: yes/no) (Coxe et al., 2013). The analyses focused on person-level predictions. Our GLMMs were carried out in R 4.3.1 (R Core Team, 2024), using the *"Lme4"* package and the *"glmer"* and "*binomia*l" function (Bates et al., 2015), to examine the relationship between BCTs and our predictive variables. The GLMM model coefficients were expressed in log-odds, but then transformed into odd ratios using the "exp(fixef)" function (Bates et al., 2015) to better interpret how changes in our predictor variables affect the likelihood of using BCTs. For our continuous predictors (COM variables), the coefficients represent the change in odds of using BCTs by a one-unit increase in the predictor (Hosmer et al., 2013). For our binary predictors (contextual factors), the coefficient indicates the change in the odds of using BCTs when the predictor changes from 0 to 1 (Hosmer et al., 2013).

Research Question 3: Decision Tree Analysis of Behaviour Change Techniques and Physical Activity

Using SPSS© 29.0.0.0, 14 decision tree analyses were conducted to determine which series of BCTs predicted MVPA levels at the daily level. Given the high number of BCTs, we conducted a series of analyses of grouped BCTs, taken from within Michie et al.'s (2013) BCT Taxonomy (v1): 93 hierarchically- clustered techniques (see supplemental materials, Table S1) From the hierarchical BCT taxonomy, we identified 13 groups of BCTs for our analysis (e.g., social support (e.g., BCTs: emotional and practical) and goals and planning (e.g., BCTs: goal

setting and action planning)) (see supplemental materials, Table S2). A final decision tree analysis was then performed using the predictive BCTs in each category.

Results

Two hundred and twenty-seven students completed the screening questionnaire to participate in our study. One hundred and seventy-four students were not eligible for our study. One student was initially interested in participating in the study but was too busy to start the study. A total of 53 participants enrolled in the study. All participants completed at least 3 days, 86.8% provided at least 7 days of data, and 30.2% completed all 10 days.

The fifty-three participants (*Mage* = 22, *SDage* = 3.93) who completed the study were current students from McGill (75%) and Queens University (25%), most self-identified as a woman (68%), and reported having chronic conditions (85%), pain-related disabilities (23%), and/or mobility/flexibility disabilities (19%). Participants were physically active, spending a daily time of 119.76 minutes (*SD* = 116.18) in LTPA and 83.50 minutes (*SD* = 90.57) MVPA. Sociodemographic and LTPA/MVPA descriptive statistics are presented in Tables 1 and 2.

Research Question 1: Descriptive Statistics of Behaviour Change Techniques

On average, participants reported using 11 BCTs per day to support their daily physical activity (*SD* = 5.53, R = 1 - 27). Across the 10 days, participants, on average, used 22 of the 28 BCTs (*SD* = 5.14, R = 6 - 28). The most frequently used BCTs were task crafting with *n* = 52 participants using it for, on average, 6 days (R = 0 - 10) over the 10 days, followed by goal integration (*n* = 51, M_{days} = 5, R_{days} = 0 - 10) and finding meaning in physical activity (*n* = 50, M_{days} = 5, R_{days} = 0 -10). The least frequently used BCTs included obtaining information on how to perform physical activity (*n* = 23, M_{days} = 2, R_{days} = 0 - 10), pros and cons (*n* = 26, M_{days} = 1, R_{days} = 0 - 7), and self-monitoring (*n* =33, M_{days} = 3, R_{days} = 0 - 10) (Table 3).

The most common pairs of BCTs were (a) goal integration and task crafting (238 occurrences), (b) focus on enjoyment and task crafting (236 occurrences), (c) focus on enjoyment and goal integration (221 occurrences, Figure 1). The most frequent trios of BCTs used by participants day were (a) focused on enjoyment, goal integration, and task crafting (193 occurrences), (b) finding meaning in physical activity, focus on enjoyment, and task crafting (179 occurrences), (c) find meaning in physical activity, goal integration, and task crafting (178 occurrences, Figure 2).

Research Question 2: Generalized Linear Mixed Models (GLMM) of Behaviour Change Techniques Enactment

Intraclass Correlation Coefficient was .271 indicating that 72.9% of the variability in BCT use was within-person, while 27.1% was between-person variability. Therefore, multilevel modeling was warranted as most of the variability in BCTs usage is within individuals.

Pertaining to demographic variables, gender, ethnicity/race, and chronic condition/disability were found to predict some BCT enactment (Table 4). Specifically, participants who self-identified as woman were more likely to report using 13 BCTs (e.g., obtaining information about health consequences, and prompt and cues) compared to participants who self-identified as man (OR range = 3.97 - 15.84, $p < .05$). Participants who identified as racialized individuals were more likely to use 4 BCTs (e.g., obtaining information about health consequences, and behavioural self-praise) compared to individuals who self-identified as white (OR range = 0.11 - 0.25). Participants who reported having physical disabilities were less likely to use two BCTs, restructuring of social environment (OR = 0.35, $p < .05$) and prompt and cues (OR = 0.30, $p < .05$) compared to participants who reported having chronic conditions.

Regarding contextual factors that may impact their physical activity on a given day, participants reported, on average, at least one contextual factor per day (*M (SD)* = 1 (0.53), range = 0 - 4) and a total of 4 distinct factors (*SD* = 3.62, R_{days} = 1-5) across the 10 days. The most frequently reported contextual factors was encountering commitments with 34 participants reporting it, on average, three of the 10 days (R_{days} = 0 - 8), followed by flare-ups at (*n* = 35, M_{days} = 2, R_{days} = 0 - 10). Other reported contextual factors were exams (*n* = 33, M_{days} = 2.39), weather (*n* = 32, *M* = 2.12), illness (*n* = 24, M_{days} = 2.24). Participants who reported in having commitments were less likely to use 15 BCTs (e.g., behavioural goals, task crafting and self-talk) compared to those who did not report having commitments (OR range = 0.34 - 0.56). Participants who reported having flare-ups were less likely to use 9 BCTs (e.g., task crafting, problem solving, and prompt and cues) compared to those who did not report having flare-ups (OR range = 0.36 -0.58). Participants who reported having an illness were most likely to use task crafting (OR = 1.95), and less likely to use finding meaning in their physical activity (OR = 0.32). Both exams and weather did not show any significant relationship with any of the 28 BCTs. See Table 5 for details.

As it pertains to daily capability, opportunity, and motivation in using BCTs for their physical activity, participants appeared to report higher mean levels of daily capability (M_{days}= 6.42, *SD* = 2.23) and opportunity (M_{days} = 6.30, *SD* = 2.34) to use BCTs than motivation (M_{days} = 5.56, *SD* = 2.35). After controlling for significant demographic and contextual factors, all BCTs, except for pros and cons, were predicted by motivation, opportunity, or capability. Motivation and opportunity predicted the same 13 BCTs while no BCTs were predicted by all three constructs. Motivation was a significant predictor of 25 BCTs and was positively associated with a 16.6% to 62.2% increase odds of using those BCTs. There were five BCTs that had at least a

40% increase chance of being used due to motivation: self-talk (OR = 1.62, SE = 0.10), graded tasks (OR = 1.57, SE = 0.09), obtaining information about health consequences (OR = 1.58, SE = 0.10), reflection on the need to perform physical activity (OR = 1.47, SE = 0.09), finding meaning in physical activity (OR = 1.44, SE = 0.09), and self-monitoring (OR = 1.43, SE = 0.11). Opportunity was also a significant predictor of 15 BCTs, with 20% to 54.65% increased odds in using those BCT. There were four BCTs that had at least a 40% increase chance of being used due to opportunity such as emotional support (OR = 1.55, SE = 0.10), restructuring the social environment (OR = 1.47, SE = 0.09), practical social support (OR = 1.36, SE = 0.11), and self-monitoring (OR = 1.41, SE = 0.12). Capability was significantly and positively associated two BCTs: behavioural goals and problem solving. None of the two BCTs had at least 40% increase chance of being used due to capability. See Table 6 for details.

Research Question 3: Decision Tree Analysis of Behaviour Change Techniques and Physical Activity

In separate analysis based on BCT categories, 23 of 28 BCTs were found to be predictive of MVPA (see supplementary material, Table S2). In the final analysis, 5 of the 23 BCTs were found to be the most predictive of MVPA, namely self-talk, restructuring the physical environment, behavioural self-praise, task crafting, obtaining information about health consequences. On a single day, using self-talk predicted higher MVPA engagement (*M* = 126.36, *SD* =116.79) than when not using self-talk (*M* = 53.98, *SD* = 69.79). When combining self-talk and behavioural self-praise (*M* = 151.62, *SD* = 128.85), MVPA engagement was higher than without using these two BCTs (*M* = 92.02, *SD* = 87.78). The highest MVPA engagement was observed when self-talk was combined with behavioural self-praise and obtaining information about health consequences (*M* = 188.07, *SD* = 134.79). When not using self-talk, restructuring

the physical environment and task crafting, participants reported the least MVPA engagement (*M* = 19.59, *SD* = 38.35). See Figure 3 for details of the final decision tree analysis.

Discussion

Our study aimed to describe the enactment of BCTs and investigate their key predictors among physically active university students living with physical disabilities and chronic over 10 days. By examining daily BCT enactment, our study identified which BCTs were used more frequently and the demographic and contextual variables, such as women and flare-ups, tend to predict enactment of specific BCTs. Further, motivation and opportunity were found to be a more common predictor of BCT enactment. These findings provide critical insights to the behaviour change literature, given the general lack of knowledge of BCTs enactment, especially among individuals with physical disabilities/chronic conditions. Ultimately, our findings can provide key considerations for selecting and integrating BCTs in physical activity interventions for university students with physical disabilities and chronic conditions.

Our study demonstrated that participants used an average of 11 BCTs daily and enacted 22 distinct BCTs over 10 days. Hankonen et al. (2015), who retrospectively assessed BCT enactment one year-post intervention among adults with type 2 diabetes found that participants who used six to seven BCTs increased their physical activity levels. Hankonen et al. (2015) claimed that while using more BCTs might lead to higher physical activity levels compared to groups who use less, simply increasing the number of BCTs does not guarantee behaviour change outcomes. However, our study findings suggest that "more is likely happening" for students with physical disabilities and chronic conditions. It is possible that these students require more BCTs in light of the additional social and environmental barriers of living with a disability. Firm conclusions remain difficult as we did not compare students with and without

disability/chronic condition. Therefore, more research is needed before fully concluding the ideal number of BCTs, and how to facilitate the daily integration of multiple BCTs to promote behaviour change outside of controlled environments.

The most frequently reported BCTs enacted by students with physical disabilities and chronic conditions included task crafting, goal integration, and finding meaning in physical activity. BCTs such as obtaining information on how to perform physical activity, pros and cons, and self-monitoring were the least frequently used. Interestingly, it appears that the more frequently used BCTs were motivational in nature while the less common BCTs were self-regulatory types of BCTs. This preference for motivational BCTs (e.g., thinking about one's motives and values) over self-regulatory BCTs (e.g., self-monitoring) were also identified in other studies, potentially because they are easier to adopt and enact (French et al., 2021; Hankonen et al., 2017; Miles et al., 2021). In fact, French et al. (2021) and Palsola et al. (2021) found that their participants reported that self-regulatory BCTs challenging to enact. Therefore, physically active students with physical disabilities and chronic conditions may prefer to enact motivational BCTs because they are less demanding to stay physically active. While motivational BCTs may be easier, they may not be sufficient alone in supporting behaviour change (Hankonen et al., 2017), highlighting that "ease ≠ change". Future interventions should be designed to accommodate the cognitive demands of self-regulatory BCTs by providing clear and explicit guidance. Additionally, interventions should recognize the co-occurrence of motivational and self-regulatory BCTs and understand that both types of BCTs may have a synergetic effect that could optimize behaviour change while playing different roles at various stages of behaviour change.

In the behaviour change literature, it is unclear how different demographic groups use BCTs. Our study explores these nuances, specifically looking at gender and disability differences in

BCT enactment. Our findings show that women are more likely than men to enact 13 different BCTs, all were self-regulatory BCTs (e.g., self-monitoring and problem solving). This difference could be related to emotional intelligence as women generally have higher emotional intelligence (i.e., the ability to be more self-aware of their needs, and self-regulate their behaviour) than men (Cabello et al., 2016). Consequently, women may find it easier to navigate and manage the complexity of self-regulatory BCTs in their daily life. If emotional intelligence does indeed play a role in enacting BCTs, and there are differences in BCT enactment across genders, future research could explore this relationship.

Furthermore, our study found that the types of BCTs used by students with physical disabilities and those with chronic conditions were generally similar, with differences on only two of the BCTs. It appears logical to research these two groups together when examining BCT enactment for physical activity participation. Although the population does not differ in BCT usage, students with physical disabilities and chronic conditions may have unique contextual barriers and underlying psychological processes that may impact BCT enactment in physical activity. In fact, our individual level analysis reported that when commitments (e.g., health appointments) and flareups (e.g., health-related symptoms) are present, the likelihood of using some BCTs decreases. Then, when controlling for these contextual factors, motivation and opportunity remained positively associated with the enactment of 15 to 25 BCTs. Our research therefore adds evidence to the need to treat BCTs as their own behaviour and recognize that gender differences, individual environmental, psychological, and emotional factors, may all impact BCT enactment.

Given the ambiguity surrounding BCTs in promoting physical activity participation, we conducted a decision tree analysis aimed at identifying which set of BCTs work together to

predict higher levels of MVPA. As per the analysis, combining three BCTs - self-talk, behavioural self-praise, and obtaining information about health consequences - resulted in greater MVPA participation than when these BCTs were not used. Behavioural self-talk and self-praise are types of BCTs that involve internal dialogue, where individuals argue against self-doubt or give themselves verbal rewards when trying to achieve behaviour change (Knittle et al., 2020). Spring et al. (2020) suggested the benefits of using self-talk in behaviour change might be more complex than initially understood. This complexity is highlighted in our study. Despite engaging in self-talk increased MVPA engagement, self-talk was not a frequently enacted BCT. It remains unclear if this low reported use is due to a lack of conscious awareness of their internal dialogue (Gibson & Foster, 2012) or a BCT that is underutilized despites its benefits. More research is needed on the use of self-talk, self-praise and other BCTs related to internal dialogue in the physical activity context to better inform their use in future interventions.

Obtaining information about health consequences (i.e., learning about the effect of a behaviour on one's health, Knittle et al., 2020) predicted MVPA alongside behavioural self-talk and self-praise. This BCT has been reported as the most prominent BCT in improving physical activity engagement (Knittle et al., 2018), especially in students (McHale et al., 2021). Similar to our findings, McHale et al. (2021) reported that when obtaining information about health consequences combined with two other BCTs students reported increased physical activity levels. Our study's findings suggest that when students with disabilities and chronic conditions combine behavioural self-talk, self-praise and obtaining information about health consequences, it may create a synergetic effect that results in more MVPA engagement. Our results suggest that clusters of BCT may indeed be more effective than individual BCTs (McEwan et al., 2019), especially given that students with disabilities and chronic conditions reported enacting

approximately 11 BCTs daily. Given the infancy of the BCT enactment field in physical activity promotion, more research on the combined use of BCTs and its synergetic effect is needed before firm conclusions can be made.

Limitation and Future Research

A limitation of our study is our sample, considering that eligible participants were mostly white and female. However, our sample appeared to align with the demographic of the broader Canadian University population: 66% female, and 42% self-identified as a racialized person (CUSC 2023;2022). Employing a more inclusive recruitment sampling strategy such as including students across different Canadian universities could achieve a balanced representation of in future research on university students. Furthermore, our study did not differentiate between students with congenital disabilities/chronic conditions (i.e., disabilities present from birth), and those with acquired disabilities/chronic conditions (i.e., occurring later in life). Understanding the differences is important considering that individuals with acquired disabilities have shown to engage less in physical activity and adapt differently compared to those with congenital disabilities (Úbeda-Colomer et al., 2019a). Future research and interventions should account for these differences to better understand and improve BCT enactment among students with disabilities and chronic conditions.

We applied some strategies to encourage participation rates as we understood that daily surveys are burdensome for participants and missed days are likely. We provided daily compensation, conducted pilot testing with university students with disabilities, and drew on past research to ensure that the notifications were timed appropriately for students with disabilities. Despite these efforts, 86.8% of participants engaged for at least 7 days of study. The shorter duration may have led to missing important variations, and not fully capture students experience

in BCT enactment. While our study meets the 7-day mark recommendations for EMA studies (Hall et al., 2021) emerging strategies such as barrier reduction, and follow-up tracing (Teague et al., 2018) is needed for future research conducing EMA to improve participant engagement.

We also acknowledge limitations regarding our approach to studying BCT enactment. First, the BCT questions may have resulted in participants reporting the use for implicit enactment instead of explicit enactment. Since our questionnaire had definitions and examples of BCTs (e.g., I kept track of my physical activity (e.g., I wrote down my physical activities in a diary) for self-monitoring), participants may have been prompted to try a different technique on a future day. Furthermore, we selected 28 of the possible 120 self-enactable BCTs for our study using a stepped approach based on literature and theory. We acknowledge that our findings may not capture the full spectrum of BCT enactment but provide an excellent first step in advancing our understanding of BCT enactment. Additionally, BCT enactment was measured with a dichotomous response option (i.e., BCT usage; Yes/No). Exploring different ways of understanding enactment with different measures of BCT enactment or by using qualitative methods such as French et al (2021), could provide greater depth of the participant's experience of enacting BCT. Further our study focused on describing BCT enactment by treating BCTs as its primary outcome. As such, future research should examine the potential mediational pathways between theoretical variables, BCT enactment, and physical activity. Lastly, we understand that we conducted a conducting multiple analyses increases the chance to find statistically significant results. Despite the increased risk, the result of our study is valuable as it provides a necessary preliminary step to understand BCT enactment.

Conclusion

Our study provides a novel and insightful understanding of BCT enactment among physically active university students with physical disabilities and chronic conditions. By examining daily BCT enactment, our study highlighted the types of BCTs, frequency, and co-occurrence of current BCT enactment. Furthermore, the difference in BCT usage between genders and individual-level factors, such as students' psychological processes and contextual factors, offer future interventions guidance on how to approach BCTs as their own behaviour. By considering these factors in future interventions that integrate BCTs, students with physical disabilities and chronic conditions will be well-placed to enact BCTs and increase physical activity participation.

References

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, *67*(1), 1–48. https://doi.org/10.18637/jss.v067.i01

Bonnell, K., Michalovic, E., Koch, J., Pagé, V., Ramsay, J., Gainforth, H. L., Lamontagne, M. E., & Sweet, S. N. (2021). Physical activity for individuals living with a physical disability in Quebec: issues and opportunities of access. *Disability and Health Journal*, *14*(3), 101089. https://doi.org/10.1016/j.dhjo.2021.101089

Canadian University Survey Consortium. (2022). 2022 first year students survey master report. https://cusc-ccreu.ca/?page_id=32&lang=en

Canadian University Survey Consortium. (2020). 2020 middle-years students survey master report. https://cusc-ccreu.ca/?page_id=32&lang=en

Cane, J., O'Connor, D. & Michie, S. (2021). Validation of the theoretical domains framework for use in behaviour change and implementation research. *Implementation Science*, *7*(1), 37. https://doi.org/10.1186/1748-5908-7-37

Chemtob, K., Rocchi, M., Arbour-Nicitopoulos, K., Kairy, D., Fillion, B., & Sweet, S. N. (2019). Using tele-health to enhance motivation, leisure time physical activity, and quality of life in adults with spinal cord injury: a self-determination theory-based pilot randomized control trial. *Psychology of Sport and Exercise*, *43*(12), 243–252. https://doi.org/10.1016/j.psychsport.2019.03.008

Cabello, R., Sorrel, M. A., Fernández-Pinto, I., Extremera, N., & Fernández-Berrocal, P. (2016). Age and gender differences in ability emotional intelligence in adults: A cross-sectional study. *Developmental Psychology*, *52*(9), 1486. https://doi.org/10.1037/dev0000191

Carty, C., van der Ploeg, H. P., Biddle, S. J. H., Bull, F., Willumsen, J., Lee, L., Kamenov, K., & Milton, K. (2021). The first global physical activity and sedentary behavior guidelines for people living with disability. *Journal of Physical Activity and Health*, *18*(1), 86–93. https://doi.org/10.1123/jpah.2020-0629

Coupe, N., Peters, S., Rhodes, S., & Cotterill, S. (2019). The effect of commitment-making on weight loss and behaviour change in adults with obesity/overweight; a systematic review. *BMC Public Health*, *19*(1), 816. https://doi.org/10.1186/s12889-019-7185-3

Coxe, S., West, S. G., & Aiken, L. S. (2013). *Generalized linear models.* The Oxford Handbook of Quantitative Methods, *2*, 26-51.

Cummings, I., Lamontagne, M. E., Sweet, S. N., Spivock, M., & Batcho, C. S. (2019). Canadian-french adaptation and test-retest reliability of the leisure time physical activity questionnaire for people with disabilities. *Annals of Physical and Rehabilitation Medicine*, *62*(3), 161–167. https://doi.org/10.1016/j.rehab.2018.12.002

Devine, M. A. (2016). Leisure-time physical activity: experiences of college students with disabilities. *Adapted Physical Activity Quarterly*, *33*(2), 176–194. https://doi.org/10.1123/APAQ.2014-0241

French, D. P., Banafa, R., Williams, S., Taylor, C., & Brown, L. J. E. (2021). How does the understanding, experience, and enactment of self-regulation behaviour change techniques vary with age? a thematic analysis. *Applied Psychology in Health and Well-Being*, *13*(1), 239–260. https://doi.org/10.1111/aphw.12243

Greaves C. J. (2015). Uptake of behavior change techniques - a key focus for process analysis and for intervention delivery: a comment on Hankonen et al. *Annals of Behavioral Medicine*, *49*(1), 1– 2. https://doi.org/10.1007/s12160-014-9630-y

Government of Canada. (2022). *Understanding disabilities*. Government of Canada. https://www.canada.ca/en/employment-social-development/programs/accessible-canada-regulations-guidance/consultation/key-concepts.html#h2.5

Hall, M., Scherner, P. V., Kreidel, Y., & Rubel, J. A. (2021). A systematic review of momentary assessment designs for mood and anxiety symptoms. *Frontiers in Psychology, 12*, 642044. https://doi.org/10.3389/fpsyg.2021.642044

Hall, P. A., Zehr, C., Paulitzki, J., & Rhodes, R. (2014). Implementation intentions for physical activity behavior in older adult women: An examination of executive function as a moderator of treatment effects. *Annals of Behavioral Medicine*, *48*(1), 130-136. https://doi.org/10.1007/s12160-013-9582-7

Hanna, M., & Strober, L. B. (2020). Anxiety and depression in Multiple Sclerosis (MS): Antecedents, consequences, and differential impact on well-being and quality of life. *Multiple Sclerosis and Related Disorders*, *44*(10), 102261. https://doi.org/10.1016/j.msard.2020.102261

Hankonen, N. (2021). Participants' enactment of behavior change techniques: a call for increased focus on what people do to manage their motivation and behavior. *Health Psychology Review*, *15*(2), 185–194. https://doi.org/10.1080/17437199.2020.1814836

Hankonen, N., Heino, M. T. J., Hynynen, S.-T., Laine, H., Araújo-Soares, V., Sniehotta, F. F., Vasankari, T., Sund, R., & Haukkala, A. (2017). Randomised controlled feasibility study of a school-based multi-level intervention to increase physical activity and decrease sedentary behaviour among vocational school students. *International Journal of Behavioral Nutrition and Physical Activity*, *14*(37), 1–14. https://doi.org/10.1186/s12966-017-0484-0

Hankonen, N., Sutton, S., Prevost, A. T., Simmons, R. K., Griffin, S. J., Kinmonth, A. L., & Hardeman, W. (2015). Which behavior change techniques are associated with changes in physical activity, diet and body mass index in people with recently diagnosed diabetes? *Annals of Behavioral Medicine*, *49*(1), 7–17. https://doi.org/10.1007/s12160-014-9624-9

Hébert, B-P., Kevins. C., Mofidi. A., Morris, S. Simionescu.D., & Ticke. M., (2024). *A demographic, employment and income profile of Canadians with disabilities aged 15 years and over, 2017.* https://www150.statcan.gc.ca/n1/pub/89-654-x/89-654-x2024001-eng.htm

Hoekstra, F., Collins, D., Dinwoodie, M., Ma, J. K., & Martin Ginis, K. A. (2022). Measuring behavior change technique delivery and receipt in physical activity behavioral interventions. *Rehabilitation Psychology*, *67*(2), 128–138. https://doi.org/10.1037/rep0000440

Hoekstra, F., McBride, C. B., Borisoff, J., Fetterly, M. J., Ginis, S., Latimer-Cheung, A. E., Ma, J. K., Maffin, J., Mah, L., West, C. R., Willms, R., & Martin Ginis, K. A. (2020). Translating the international scientific spinal cord injury exercise guidelines into community and clinical practice guidelines: a Canadian evidence-informed resource. *Spinal Cord*, *58*(6), 647–657. https://doi.org/10.1038/s41393-019-0410-1

Howlett, N., Schulz, J., Trivedi, D., Troop, N., & Chater, A. (2019). A prospective study exploring the construct and predictive validity of the COM-B model for physical activity. *Journal of Health Psychology*, *24*(10), 1378–1391 https://doi.org/10.1177/1359105317739098

Hosmer Jr, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied Logistic Regression*. John Wiley & Sons.

Hox, J. J., Moerbeek, M., & Van de Schoot, R. (2017). *Multilevel Analysis: Techniques and Applications* (3rd ed.). Routledge. https://doi.org/10.4324/9781315650982

IBM Corp. *IBM SPSS Statistics for Windows*; Version 27.0; [SPSS]; IBM Corp: Armonk, NY, USA, 2019.

Keyworth, C., Epton, T., Goldthorpe, J., Calam, R., & Armitage, C. J. (2020). Acceptability, reliability, and validity of a brief measure of capabilities, opportunities, and motivations ("COM-B"). *British Journal of Health Psychology*, *25*(3), 474 – 501. https://doi.org/10.1111/bjhp.12417

Knittle, K., Heino, M., Marques, M. M., Stenius, M., Beattie, M., Ehbrecht, F., Hagger, M. S., Hardeman, W., & Hankonen, N. (2020). The compendium of self-enactable techniques to change and self-manage motivation and behaviour v.1.0. *Nature Human Behaviour*, *4*(2), 215–223. https://doi.org/10.1038/s41562-019-0798-9

Kostanjsek N. (2011). Use of the international classification of functioning, disability and health (ICF) as a conceptual framework and common language for disability statistics and health information systems. *BMC Public Health, 11*(4), S3. https://doi.org/10.1186/1471-2458-11-S4-S3

Latimer-Cheung, A. E., Martin Ginis, K. A., Hicks, A. L., Motl, R. W., Pilutti, L. A., Duggan, M., Wheeler, G., Persad, R., & Smith, K. M. (2013). Development of evidence-informed physical activity guidelines for adults with multiple sclerosis. *Archives of Physical Medicine and Rehabilitation, 94*(9), 1829–1836. https://doi.org/10.1016/j.apmr.2013.05.015

Loo, M. van der, & Jonge, E. de. (2018). *Statistical Data Cleaning with Applications in R*. John Wiley & Sons.

Ma, J. K., & Martin Ginis, K. A. M. (2018). A meta-analysis of physical activity interventions in people with physical disabilities: content, characteristics, and effects on behaviour.

Psychology of Sport and Exercise, *37*, 262–273. https://doi.org/10.1016/j.psychsport.2018.01.006

Martin Ginis, K. A., Hicks, A. L., Latimer, A. E., Warburton, D. E., Bourne, C., Ditor, D. S., Goodwin, D. L., Hayes, K. C., McCartney, N., McIlraith, A., Pomerleau, P., Smith, K., Stone, J. A., & Wolfe, D. L. (2011). The development of evidence-informed physical activity guidelines for adults with spinal cord injury. *Spinal Cord*, *49*(11), 1088–1096. https://doi.org/10.1038/sc.2011.63

Martin Ginis, K. A., Ma, J. K., Latimer-Cheung, A. E., & Rimmer, J. H. (2016). A systematic review of review articles addressing factors related to physical activity participation among children and adults with physical disabilities. *Health Psychology Review*, *10*(4), 478–494. https://doi.org/10.1080/17437199.2016.1198240

Martin Ginis, K. A. M., Phang, S. H., Latimer, A. E., & Arbour-Nicitopoulos, K. P. (2012). Reliability and validity tests of the leisure time physical activity questionnaire for people with spinal cord injury. *Archives of Physical Medicine and Rehabilitation*, *93*(4), 677–682. https://doi.org/10.1016/j.apmr.2011.11.005

Martin Ginis, K. A., van der Ploeg, H. P., Foster, C., Lai, B., McBride, C. B., Ng, K., Pratt, M., Shirazipour, C. H., Smith, B., Vásquez, P. M., & Heath, G. W. (2021a). Participation of people living with disabilities in physical activity: a global perspective. *Lancet*, *398*(10298), 443–455. https://doi.org/10.1016/S0140-6736(21)01164-8

Martin Ginis, K. A., Latimer-Cheung, A. E., & West, C. R. (2021b). Commentary on "The First Global Physical Activity and Sedentary Behavior Guidelines for People Living with Disability". *Journal of Physical Activity and Health*, *18*(4), 348–349. https://doi.org/10.1123/jpah.2020-0871

McHale, F., Ng, K., Taylor, S., Bengoechea, E., Norton, C., O'Shea, D., & Woods, C. (2022). A systematic literature review of peer-led strategies for promoting physical activity levels of adolescents. *Health Education and Behaviour*, *49*(1), 41–53. https://doi.org/10.1177/10901981211044988

Mistry, C. D., Sweet, S. N., Rhodes, R. E., & Latimer-Cheung, A. E. (2015a). Text2Plan: Exploring changes in the quantity and quality of action plans and physical activity in a text messaging intervention. *Psychology and Health*, *30*(7), 839–856. https://doi.org/10.1080/08870446.2014.997731

Mistry, C. D., Sweet, S. N., Latimer-Cheung, A. E., & Rhodes, R. E. (2015b). Predicting changes in planning behaviour and physical activity among adults. *Psychology of Sport and Exercise*, *17*, 1–6. https://doi.org/10.1016/j.psychsport.2014.10.002

Michalovic, E., Hall, S., Duncan, L. R., Bassett-Gunter, R., & Sweet, S. N. (2018). Understanding the Effects of Message Framing on Physical Activity Action Planning: the role of risk perception and elaboration. *International Journal of Behavioral Medicine*, *25*(6), 626–636. https://doi.org/10.1007/s12529-018-9746-8

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., ... & Wood, C. E. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine*, *46*(1), 81–95. https://doi.org/10.1007/s12160-013-9486-6

Michie, S., Van Stralen, M. M., & West, R. (2011). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science*, 6(1), 1–12. https://doi.org/10.1186/1748-5908-6-42

Michie, S., West, R., Sheals, K., & Godinho, C. A. (2018). Evaluating the effectiveness of behavior change techniques in health-related behavior: a scoping review of methods used. *Translational Behavioral Medicine*, *8*(2), 212–224. https://doi.org/10.1093/tbm/ibx019

Miles, L. M., Hawkes, R. E., & French, D. P. (2022). How is the Behavior Change Technique Content of the NHS Diabetes Prevention Program understood by participants? a qualitative study of fidelity, with a focus on receipt. *Annals of Behavioral Medicine*, *56*(7), 749–759. https://doi.org/10.1093/abm/kaab093

Mitchell, R. J., Ryder, T., Matar, K., Lystad, R. P., Clay-Williams, R., & Braithwaite, J. (2022). An overview of systematic reviews to determine the impact of socio-environmental factors on health outcomes of people with disabilities. *Health and Social Care in the Community*, *30*(4), 1254–1274. https://doi.org/10.1111/hsc.13665

Moriña, A., & Perera, V. H. (2020). Inclusive higher education in Spain: students with disabilities speak out. *Journal of Hispanic Higher Education*, *19*(3), 215–231. https://doi.org/10.1177/1538192718777360

Moriña, A., & Orozco, I. (2021). Spanish faculty members speak out: Barriers and aids for students with disabilities at university. *Disability and Society*, *36*(2), 159–178. https://doi.org/10.1080/09687599.2020.1723495

Oleson, J. J., Jones, M. A., Jorgensen, E. J., & Wu, Y. H. (2022). Statistical Considerations for Analyzing Ecological Momentary Assessment Data. *Journal of Speech, Language, and Hearing Research*, *65*(1), 344–360. https://doi.org/10.1044/2021_JSLHR-21-00081

OpenAI. (2023). *ChatGPT (GPT-4)* (May 21, 2024 version) [Large language model]. OpenAI. https://www.openai.com/chatgpt

Palsola, M., Renko, E., Kostamo, K., Lorencatto, F., & Hankonen, N. (2020). Thematic analysis of acceptability and fidelity of engagement for behaviour change interventions: the let's move it intervention interview study. *British Journal of Health Psychology*, *25*(3), 772-789. https://doi.org/10.1111/bjhp.12433

Plotnikoff, R. C., Costigan, S. A., Karunamuni, N., & Lubans, D. R. (2013). Social cognitive theories used to explain physical activity behavior in adolescents: a systematic review and meta-analysis. *Preventive Medicine*, *56*(5), 245–253. https://doi.org/10.1016/j.ypmed.2013.01.013

Plow, M., Bethoux, F., Mai, K., & Marcus, B. (2014). A formative evaluation of customized pamphlets to promote physical activity and symptom self-management in women with multiple sclerosis. *Health Education Research*, *29*(5), 883–896. doi: 10.1093/her/cyu034

R Core Team. (2021). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.r-project.org/

Porter, C. D., McPhee, P. G., Kwan, M. Y., Timmons, B. W., & Brown, D. M. Y. (2023). 24-hour movement guideline adherence and mental health: A cross-sectional study of emerging adults with chronic health conditions and disabilities. *Disability and health journal*, *16*(3), 101476. https://doi.org/10.1016/j.dhjo.2023.101476

Richardson, M., Khouja, C. L., Sutcliffe, K., & Thomas, J. Using the theoretical domains framework and the behavioural change wheel in an overarching synthesis of systematic reviews. *BMJ Open.* 2019; *9*(6), e024950. https://doi.org/10.1136/bmjopen-2018-024950

Rimmer, J. H., Chen, M.-D., McCubbin, J. A., Drum, C., & Peterson, J. (2010). Exercise intervention research on persons with disabilities: what we know and where we need to go.

American Journal of Physical Medicine and Rehabilitation, *89*(3), 249–263. https://doi.org/10.1097/PHM.0b013e3181c9fa9d

Rixon, L., Baron, J., McGale, N., Lorencatto, F., Francis, J., & Davies, A. (2016). Methods used to address fidelity of receipt in health intervention research: a citation analysis and systematic review. *BMC Health Services Research*, *16*(1), 663. https://doi.org/10.1186/s12913-016-1904-6

Rusby, J. C., Westling, E., Crowley, R., & Light, J. M. (2014). Psychosocial correlates of physical and sedentary activities of early adolescent youth. *Health Education and Behavior 41*(1), 42–51. https://doi-org.proxy3.library.mcgill.ca/10.1177/1090198113485753

San Román-Mata, S., Puertas-Molero, P., Ubago-Jiménez, J. L., & González-Valero, G. (2020). Benefits of physical activity and its associations with resilience, emotional intelligence, and psychological distress in university students from southern Spain. *International Journal of Environmental Research and Public Health*, *17*(12), 4474. https://doi.org/10.3390/ijerph17124474

Shields, N., van den Bos, R., Buhlert-Smith, K., Prendergast, L., & Taylor, N. (2019). A community-based exercise program to increase participation in physical activities among youth with disability: a feasibility study. *Disability and Rehabilitation*, *41*(10), 1152–1159. https://doi.org/10.1080/09638288.2017.1422034

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual review of clinical psychology*, *4*(1), 1–32. https://doi.org/10.1146/annurev.clinpsy.3.022806.091415

Spook, J. E., Paulussen, T., Kok, G., & Van Empelen, P. (2013). Monitoring dietary intake and physical activity electronically: feasibility, usability, and ecological validity of a mobile-based

Ecological Momentary Assessment tool. *Journal of Medical Internet research*, *15*(9), e214. https://doi-org.proxy3.library.mcgill.ca/10.2196/jmir.2617

Spring, B., Champion, K. E., Acabchuk, R., & Hennessy, E. A. (2021). Self-regulatory behaviour change techniques in interventions to promote healthy eating, physical activity, or weight loss: A meta-review. *Health Psychology Review*, *15*(4) 1–32. https://doi.org/10.1080/17437199.2020.1721310

Statistics Canada. (2023). Canadian Survey on Disability, 2017 to 2022. *The Daily*. https://www150.statcan.gc.ca/n1/daily-quotidien/231201/dq231201b-eng.htm

Statistics of Canada. (2017). Leisure-time physical activity. *Healthy People, Healthy Places.* https://www150.statcan.gc.ca/n1/pub/82-229-x/2009001/deter/lpa-eng.htm#n5

Steinbach, D., Graf, C. (2008). Leisure Time Physical Activity and Sedentariness. *Encyclopedia of Public Health,* 849-851. https://doi.org/10.1007/978-1-4020-5614-7_1968

Sweet, S. N., Brawley, L. R., Hatchell, A., Gainforth, H. L., & Latimer-Cheung, A. E. (2014). Can persuasive messages encourage individuals to create action plans for physical activity? *Journal of Sport and Exercise Psychology*, *36*(4), 413–23. https://doi.org/10.1123/jsep.2013-0218

Tomasone, J. R., Flood, S. M., Ma, J. K., Scime, N. V., Burke, S. M., Sleeth, L., Marrocco, S., & SCIRE Research Team. (2018). Physical activity self-management interventions for adults with spinal cord injury: Part 1–A systematic review of the use and effectiveness of behavior change techniques. *Psychology of Sport and Exercise, 37,* 274–285. https://doi.org/10.1016/j.psychsport.2018.01.012

Úbeda-Colomer, J., Monforte, J., & Devís-Devís, J. (2019b). Physical activity of university students with disabilities: Accomplishment of recommendations and differences by age, sex, disability, and weight status. *Public Health*, *166*, 69–78. https://doi.org/10.1016/j.puhe.2018.10.006

Úbeda-Colomer, J., Devís-Devís, J., & Sit, C. H. (2019a). Barriers to physical activity in university students with disabilities: Differences by sociodemographic variables. *Disability and Health Journal*, *12*(2), 278–286. https://doi.org/10.1016/j.dhjo.2018.11.005

Valis, J., & Gonzalez, M. (2017). Physical activity differences for college students with disabilities. *Disability and Health Journal*, *10*(1), 87–92. https://doi.org/10.1016/j.dhjo.2016.09.003

Vader, K., Doulas, T., Patel, R., & Miller, J. (2021). Experiences, barriers, and facilitators to participating in physical activity and exercise in adults living with chronic pain: a qualitative study. *Disability and Rehabilitation*, *43*(13), 1829-1837. https://doi.org/10.1080/09638288.2019.1676834

Willmott, T. J., Pang, B., & Rundle-Thiele, S. (2021). Capability, opportunity, and motivation: an across contexts empirical examination of the COM-B model. *BMC Public Health*, *21*(1), 1014. https://doi.org/10.1186/s12889-021-11019-w

World Health Organization (2022) Noncommunicable diseases. *World Health Organization.* https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases

Table 1

Sociodemographic Characteristics of Participants at Baseline

Baseline characteristic	n (%)	M (SD)
Gender		
Man	14 (26%)	
Non-binary	1 (2%)	
Transgender/Intersex	2 (4%)	
Woman	36 (68%)	
Age		22 (3.93)
Ethnicity		
Arab	4 (8%)	
Black	4 (8%)	
Chinese	7 (13%)	
First Nations	1 (2%)	
Latin American	5 (9%)	
South Asian	7 (13%)	
West Asian	1 (2%)	
White	30 (57%)	
Disability		
Chronic Conditions	45 (85%)	.23 (.42)
Mobility/Flexibility	10 (19%)	.19 (.39)
Pain-Related	12 (23%)	.85 (.36)
Transportation Aid		
No assistance	47 (89%)	
Personal Assistance	6 (11%)	
University		
McGill	40 (75%)	
Queen's	13 (25%)	
University Level		
Professional / Graduate	11(21%)	
Undergraduate	42 (79%)	
Faculty		
Arts and Humanities	18 (34%)	
STEM	14 (26%)	
Education and Health/Social Sciences	21 (40%)	
Commute		
0-30 minutes	39(73%)	
31-60 minutes	8 (15%)	
Over 60 minutes	5 (9%)	

N/A	1 (2%)	
Work hours		
Less than 15 hours per week	42 (81%)	3.96 (4.91)
Less than 35 hours per week	5 (9%)	22 (7.49)
More than 35 hours per week	6 (11%)	44 (9.17)

Note. $N = 53$

Table 2

Descriptive Statistics of Leisure Time Physical Activity (LTPA)

Variable	M (SD)
LTPA Total	119.76 (116.18)
MVPA Total	83.50 (90.57)
LTPA Aerobic Total	90.63 (87.48)
LTPA Strength Total	44.96 (58.16)

Note. MVPA = Moderate to Vigorous Physical Activity. LTPA means, and SD were calculated by an averaged across days (n = 534).

Table 3

BCT Frequency and Percentage among Participants Over 10 Days

BCTs	Count	Participants using BCT (%)	Average BCT Frequency of Participants
Task Crafting	301	52 (98%)	6 (R =1 -10)
Goal Integration	284	51 (96%)	5 (R = 0 -10)
Finding Meaning in Physical Activity	254	50 (94%)	5 (R = 0 -10)
Positive Reframing	251	49 (92%)	5 (R = 0 -10)
Restructuring the Social Environment	203	49 (92%)	4 (R = 0 - 9)
Focus on Enjoyment	276	48(91%)	5 (R = 0 -10)
Normalizing Difficulty	210	48 (91%)	4 (R = 0 -10)
Behavioural Goals	228	47 (89%)	4 (R = 0 - 9)
Graded Task	192	46 (87%)	4 (R = 0 -9)
Self-Kindness	194	45 (85%)	4 (R = 0 - 9)
Outcome Goals	188	44 (83%)	3 (R = 0 - 9)
Restructuring the Physical Environment	196	42 (79%)	4 (R = 0 - 9)
Self-Talk	184	42 (79%)	3 (R = 0 -10)
Reflection on the Need to Perform Physical Activity	179	42 (79%)	3 (R = 0 - 9)
Emotional Support	167	42 (79%)	3 (R = 0 - 9)
Problem Solving	164	42 (79%)	3 (R = 0 - 9)
Focus on Past Success	160	42 (79%)	3 (R = 0 -10)
Behavioural Self-Reward	160	42 (79%)	3 (R = 0 - 9)
Prompt and Cues	143	41 (77%)	3 (R = 0 - 9)
Observe Demonstration of Physical Activity	141	40 (75%)	3 (R = 0 - 8)
Action Planning	134	39 (74%)	2 (R = 0 - 10)
Behavioural Self-Praise	145	36 (69%)	3 (R = 0 -10)
Obtaining Information about Antecedents	116	36 (68%)	2 (R = 0 - 9)
Obtaining Information about Health Consequences	106	35 (66%)	2 (R = 0 - 8)
Practical Social Support	102	34 (64%)	2 (R = 0 - 8)
Self-Monitoring	144	33 (62%)	3 (R = 0 -10)
Pros and Cons	73	26 (49%)	1 (R = 0 - 7)
Obtaining Information on How to Perform Physical Activity	103	23 (43%)	2 (R = 0 -10)

Note: BCTs = Behaviour Change Techniques. n = 530. Missing values=79 (15%). R = range

Table 4

Odds Ratios and Percentage Changes for Socio-Demographic Predictors in Behaviour Change Techniques from GLMM

Model	Predictors	Estimate (Log-Odds)	Std. Error	Z value	Odd ratios
Self-Monitoring	(Intercept)	-2.39	0.75	-3.19**	0.09
	Gender	2.76	1.00	2.77**	15.84
	Ethnicity	-2.22	0.88	0.18*	0.11
	Disability	0.14	0.80	0.86	1.15
Obtaining Information about Health Consequences	(Intercept)	-2.52	0.56	-4.48***	0.08
	Gender	2.40	0.74	3.24**	11.00
	Ethnicity	-1.91	0.65	-2.95**	0.15
	Disability	0.27	0.58	0.46	1.31
Antecedents	(Intercept)	-1.77	0.54	-3.28**	0.17
	Gender	1.48	0.75	1.98*	4.38
	Ethnicity	-1.16	0.68	-1.72	0.31
	Disability	-0.34	0.62	-0.56	0.71
Task Crafting	(Intercept)	0.76	0.36	2.11*	2.15
	Gender	0.36	0.52	0.69	1.43
	Ethnicity	-0.15	0.48	-0.32	0.86
	Disability	-0.06	0.45	-0.14	0.94
Practical Social Support	(Intercept)	-2.51	0.54	-4.61***	0.08
	Gender	1.42	0.72	1.97*	4.16
	Ethnicity	-0.01	0.63	-0.01	0.99
	Disability	-0.36	0.59	-0.61	0.70
Obtaining Information on How to Perform Physical Activity	(Intercept)	-1.86	0.58	-3.18**	0.16
	Gender	0.26	0.81	0.32	1.30
	Ethnicity	-0.27	0.72	-0.38	0.76
	Disability	0.36	0.65	0.56	1.44
Restructuring the Social Environment	(Intercept)	-0.53	0.38	-1.39	0.59
	Gender	1.38	0.55	2.51*	3.97
	Ethnicity	-0.38	0.50	-0.76	0.69
	Disability	-1.05	0.47	-2.22*	0.35

Restructuring the Physical Environment	(Intercept)	-1.05	0.47	-2.21*	0.35
	Gender	2.01	0.67	3.01**	7.46
	Ethnicity	-0.82	0.60	-1.37	0.44
	Disability	-0.64	0.56	-1.15	0.52
Prompt and Cues	(Intercept)	1.85	0.43	-4.36***	0.16
	Gender	1.84	0.57	3.23**	6.31
	Ethnicity	0.16	0.49	0.33	1.18
	Disability	-1.20	0.47	-2.53*	0.30
Behavioural Goals	(Intercept)	-0.17	0.38	-0.43	0.85
	Gender	0.25	0.55	0.46	1.29
	Ethnicity	0.28	0.50	-0.55	0.76
	Disability	0.48	0.46	1.03	1.61
Outcome Goals	(Intercept)	-0.46	0.46	-1.01	0.63
	Gender	0.04	0.66	0.06	1.04
	Ethnicity	-0.63	0.60	-1.05	0.53
	Disability	0.80	0.55	1.45	2.23
Goal Integration	(Intercept)	0.57	0.45	1.27	1.77
	Gender	0.60	0.65	0.93	1.83
	Ethnicity	-0.30	0.59	-0.52	0.74
	Disability	-0.21	0.55	-0.37	0.81
Positive Reframing	(Intercept)	0.26	0.52	-0.50	0.77
	Gender	1.54	0.75	2.06*	4.67
	Ethnicity	-0.45	0.68	-0.66	0.64
	Disability	-0.52	0.63	-0.84	0.59
Pros and Cons	(Intercept)	-3.10	0.74	-4.18	0.05
	Gender	1.54	0.97	1.59	4.67
	Ethnicity	-1.22	0.88	-1.39	0.30
	Disability	0.00	0.82	0.00	1.00
Reflection on the Need to Perform Physical Activity	(Intercept)	-0.69	0.52	-1.32	0.50
	Gender	0.67	0.75	0.89	1.96
	Ethnicity	-1.01	0.70	-1.45	0.36
	Disability	0.34	0.65	0.52	1.40
Finding Meaning in Physical Activity	(Intercept)	0.09	0.52	0.17	1.09
	Gender	0.86	0.75	1.14	2.35
	Ethnicity	-0.84	0.69	-1.22	0.43

	Disability	0.32	0.63	0.50	1.37
Self-Talk	(Intercept)	-1.03	0.54	-1.91	0.36
	Gender	2.10	0.79	2.65**	8.18
	Ethnicity	-1.06	0.70	-1.51	0.35
	Disability	-1.12	0.65	-1.73	0.33
Behavioural Self-Praise	(Intercept)	-1.56	0.60	-2.58**	0.21
	Gender	2.03	0.85	2.40*	7.65
	Ethnicity	-1.76	0.77	-2.27*	0.17
	Disability	-0.59	0.71	-0.83	0.56
Behavioural Self-Reward	(Intercept)	-1.63	0.52	-3.14**	0.20
	Gender	1.75	0.72	2.43*	5.76
	Ethnicity	-0.63	0.63	-0.99	0.53
	Disability	-0.33	0.58	-0.57	0.72
Normalizing Difficulty	(Intercept)	-0.09	0.43	-0.21	0.91
	Gender	0.51	0.61	0.84	1.67
	Ethnicity	-0.89	0.57	-1.57	0.41
	Disability	0.09	0.52	0.18	1.10
Focus on Enjoyment	(Intercept)	-0.01	0.37	-0.03	0.99
	Gender	1.05	0.54	1.94	2.85
	Ethnicity	0.18	0.50	0.37	1.20
	Disability	-0.47	0.47	-1.00	0.63
Self-Kindness	(Intercept)	-0.99	0.40	-2.51*	0.37
	Gender	0.84	0.55	1.53	2.32
	Ethnicity	-0.27	0.50	-0.54	0.76
	Disability	0.31	0.46	0.67	1.36
Graded Task	(Intercept)	-0.99	0.40	-2.51*	0.37
	Gender	0.84	0.55	1.53	2.32
	Ethnicity	-0.27	0.50	-0.54	0.76
	Disability	0.31	0.46	0.67	1.36
Action Planning	(Intercept)	-1.50	0.50	0.56**	0.22
	Gender	1.24	0.69	1.81	3.45
	Ethnicity	-1.37	0.62	-2.22*	0.25
	Disability	0.49	0.56	0.87	1.63
Emotional Support	(Intercept)	-1.67	0.54	-3.09**	0.19
	Gender	1.73	0.75	2.30*	5.65
	Ethnicity	-0.57	0.67	-0.85	0.56
	Disability	-0.24	0.63	-0.37	0.79
Problem Solving	(Intercept)	-1.43	0.47	-3.05**	0.24

	Gender	1.60	0.65	2.45*	4.93
	Ethnicity	-0.51	0.58	-0.88	0.60
	Disability	-0.43	0.54	-0.81	0.65
Focus on Past Success	(Intercept)	-1.13	0.51	-2.20*	0.32
	Gender	1.10	0.72	1.53	3.02
	Ethnicity	-1.12	0.66	-1.70	0.33
	Disability	0.25	0.60	0.42	1.29
Observe Demonstration of Physical Activity	(Intercept)	-1.21	0.43	-2.85**	0.30
	Gender	0.97	0.60	1.61	2.63
	Ethnicity	-0.35	0.55	-0.64	0.70
	Disability	-0.77	0.51	-1.50	0.46

Note. % Change is calculated from the odds ratio. Odds > 1 = (odds ratio 1*100). Odds < 1 = (1-odds ratio *100), * = p <0.05, ** = p < 0.01, *** = p < 0.001.

Table 5

Odds Ratios and Percentage Changes for Contextual Factors Predictors in BCTs from GLMM

Model	Predictors	Estimate (Log-Odds)	Std. Error	Z value	Odd ratios
Self-Monitoring	(Intercept)	-1.00	0.43	-2.31*	0.37
	Weather	-0.26	0.46	-0.57	0.77
	Illness	-0.07	0.51	-0.14	0.93
	Flareup	-0.82	0.43	-1.89	0.44
	Commitments	-1.00	0.36	-2.76**	0.37
	Exams	0.09	0.41	0.22	1.09
Obtaining Information about Health Consequences	(Intercept)	-1.57	0.33	-4.71*	0.79
	Weather	0.41	0.41	1.00	0.50
	Illness	-0.03	0.49	-0.06	0.03
	Flareup	0.60	0.39	-1.53	0.45
	Commitments	0.01	0.32	0.05	0.01
	Exams	-0.41	0.42	-0.99	0.34
Antecedents	(Intercept)	-1.29	0.34	-3.84***	0.28
	Weather	-0.21	0.42	-0.49	0.81
	Illness	-0.25	0.49	-0.52	0.78
	Flareup	-0.40	0.38	-1.04	0.67
	Commitments	-0.28	0.32	-0.89	0.75
	Exams	-0.39	0.41	-0.95	0.68
Practical Support	(Intercept)	-1.57	0.33	-4.79***	-2.57
	Weather	-0.28	0.42	-0.67	1.28
	Illness	0.12	0.39	0.32	0.92
	Flareup	-0.13	0.37	-0.36	0.13
	Commitments	-0.13	0.32	-0.42	1.13
	Exams	-0.49	0.42	-1.15	1.49
Task Crafting	(Intercept)	1.69	0.27	6.26***	5.42
	Weather	-0.33	0.37	-0.90	0.72
	Illness	0.12	0.39	0.32	1.13
	Flareup	-1.07	0.32	-3.35***	0.34
	Commitments	-1.07	0.28	-3.78***	0.34
	Exams	-0.31	0.33	-0.95	0.73
Obtaining Information on How to Perform Physical Activity	(Intercept)	-1.07	0.35	-3.11**	0.34
	Weather	-0.92	0.50	-1.84	0.40

	Illness	-0.94	0.59	-1.61	0.39
	Flareup	-0.78	0.43	-1.80	0.46
	Commitments	-1.03	0.37	-2.80**	0.36
	Exams	-0.06	0.44	-0.12	0.95
Restructuring the Social Environment	(Intercept)	0.13	0.25	0.53	1.14
	Weather	-0.09	0.35	-0.25	0.92
	Illness	-0.02	0.38	-0.05	0.98
	Flareup	-0.67	0.31	-2.18*	0.51
	Commitments	-0.38	0.27	-1.44	0.68
	Exams	-0.23	0.33	-0.72	0.79
Restructuring the Physical Environment	(Intercept)	0.13	0.31	0.43	1.14
	Weather	0.29	0.38	0.76	1.34
	Illness	-0.15	0.42	-0.37	0.86
	Flareup	-0.54	0.34	-1.60	0.58
	Commitments	-0.87	0.29	-3.02**	0.42
	Exams	-0.53	0.35	-1.50	0.59
Prompt and Cues	(Intercept)	-0.28	0.29	-0.98	0.75
	Weather	-0.75	0.43	-1.74	0.47
	Illness	-0.78	0.47	-1.65	0.46
	Flareup	-1.03	0.37	-2.78**	0.36
	Commitments	-1.01	0.32	-3.20**	0.36
	Exams	0.19	0.36	0.53	1.21
Behavioural Goals	(Intercept)	0.65	0.24	2.65**	1.91
	Weather	-0.33	0.36	-0.92	0.72
	Illness	0.05	0.39	0.12	1.05
	Flareup	-0.54	0.30	-1.77	0.58
	Commitments	-1.05	0.27	3.85***	0.35
	Exams	-0.38	0.33	-1.17	0.68
Outcome Goals	(Intercept)	-0.03	0.27	-0.13	0.97
	Weather	-0.07	0.37	-0.18	0.94
	Illness	-0.75	0.42	-1.80	0.47
	Flareup	-0.41	0.32	-1.26	0.66
	Commitments	-0.47	0.28	-1.71	0.62
	Exams	-0.38	0.35	-1.11	0.68
Goal Integration	(Intercept)	1.16	0.27	4.28***	3.20
	Weather	0.08	0.37	0.22	1.08

	Illness	-0.42	0.39	-1.07	0.66
	Flareup	-0.45	0.31	-1.44	0.64
	Commitments	-0.58	0.27	-2.11*	0.56
	Exams	-0.43	0.33	-1.29	0.65
Positive Reframing	(Intercept)	0.74	0.33	2.29*	2.10
	Weather	-0.70	0.39	-1.80	0.50
	Illness	0.55	0.42	1.31	1.73
	Flareup	-0.69	0.34	-2.05*	0.50
	Commitments	-0.25	0.29	-0.86	0.78
	Exams	-0.22	0.36	-0.61	0.80
Pros and Cons	(Intercept)	-2.81	0.47	-5.99***	0.06
	Weather	0.26	0.45	0.57	1.30
	Illness	-0.82	0.59	-1.40	0.44
	Flareup	0.64	0.41	1.56	1.89
	Commitments	0.34	0.36	0.95	1.40
	Exams	-0.49	0.48	-1.02	0.61
Reflection on the Need to Perform Physical Activity	(Intercept)	-0.34	0.30	-1.11	0.71
	Weather	-0.06	0.39	-0.17	0.94
	Illness	0.16	0.42	0.38	1.17
	Flareup	-0.24	0.34	-0.72	0.78
	Commitments	-0.73	0.29	-2.49*	0.48
	Exams	0.28	0.36	0.77	1.32
Behavioural Self-Praise	(Intercept)	-0.84	0.34	-2.45*	0.43
	Weather	0.10	0.40	0.26	1.11
	Illness	-0.06	0.44	-0.12	0.95
	Flareup	-0.53	0.37	-1.45	0.59
	Commitments	-0.73	0.31	-2.33*	0.48
	Exams	-0.15	0.40	-0.37	0.86
Normalizing Difficulty	(Intercept)	0.06	0.26	0.22	1.06
	Weather	-0.02	0.35	-0.06	0.98
	Illness	0.11	0.39	0.29	1.12
	Flareup	-0.30	0.31	-0.98	0.74
	Commitments	-0.60	0.27	-2.22*	0.55
	Exams	0.37	0.34	1.11	1.45
Focus on Enjoyment	(Intercept)	1.27	0.29	4.41***	3.55
	Weather	-0.27	0.37	-0.73	0.76
	Illness	-0.58	0.40	-1.45	0.56

	Flareup	-0.78	0.32	-2.42*	0.46
	Commitments	-0.63	0.28	-2.22*	0.53
	Exams	-0.67	0.35	-1.94	0.51
Self-Kindness	(Intercept)	-0.42	0.25	-1.67	0.66
	Weather	-0.08	0.35	-0.24	0.92
	Illness	-0.53	0.38	-1.37	0.59
	Flareup	0.72	0.30	2.37*	2.05
	Commitments	0.01	0.27	0.03	1.01
	Exams	-0.49	0.35	-1.41	0.61
Graded Task	(Intercept)	0.00	0.25	0.02	1.00
	Weather	-0.05	0.35	-0.14	0.95
	Illness	-0.44	0.39	-1.12	0.64
	Flareup	-0.30	0.31	-0.98	0.74
	Commitments	-0.56	0.27	-2.07*	0.57
	Exams	-0.28	0.33	-0.84	0.76
Action Planning	(Intercept)	-0.95	0.31	-3.06**	1.47
	Weather	-0.36	0.44	-0.83	2.00
	Illness	-0.94	0.50	-1.88	1.48
	Flareup	0.01	0.36	0.03	2.74
	Commitments	-0.50	0.31	-1.62	1.84
	Exams	0.04	0.38	0.09	2.82
Emotional Support	(Intercept)	-0.51	0.31	-1.64	0.40
	Weather	-0.11	0.37	-0.30	0.10
	Illness	0.05	0.41	0.12	0.05
	Flareup	-0.29	0.33	-0.90	0.25
	Commitments	-0.38	0.29	-1.33	0.32
	Exams	-0.57	0.36	-1.58	0.43
Problem Solving	(Intercept)	-0.34	0.27	-1.23	0.71
	Weather	-0.18	0.37	-0.48	0.84
	Illness	-0.10	0.42	-0.23	0.91
	Flareup	-0.99	0.34	-2.94**	0.37
	Commitments	-0.26	0.28	-0.91	0.77
	Exams	-0.36	0.36	-1.02	0.70
Observe Demonstration of Physical Activity	(Intercept)	-0.55	0.26	-2.10*	0.57
	Weather	0.00	0.38	0.00	1.00
	Illness	0.00	0.43	-0.01	1.00
	Flareup	-0.91	0.35	-2.58**	0.40

	Commitments	-0.86	0.30	-2.88**	0.42
	Exams	-0.07	0.37	-0.20	0.93
Self-Talk	(Intercept)	-0.12	0.32	-0.36	0.89
	Weather	0.27	0.38	0.71	1.31
	Illness	0.03	0.42	0.06	1.03
	Flareup	-0.54	0.34	-1.62	0.58
	Commitments	-1.01	0.30	-3.37***	0.37
	Exams	0.07	0.36	0.20	1.07
Finding Meaning in Physical Activity	(Intercept)	0.88	0.32	2.80**	2.42
	Weather	-0.54	0.38	-1.43	0.58
	Illness	-1.34	0.44	-3.02**	0.26
	Flareup	-0.05	0.34	-0.15	0.95
	Commitments	-0.67	0.30	-2.24*	0.51
	Exams	-0.16	0.37	-0.42	0.85
Focus on Past Success	(Intercept)	-0.49	0.29	-1.71	-0.49
	Weather	0.14	0.38	0.36	0.14
	Illness	-0.34	0.43	-0.78	-0.34
	Flareup	-0.11	0.34	-0.33	-0.11
	Commitments	-0.78	0.29	-2.70**	-0.78
	Exams	-0.47	0.38	-1.23	-0.47
Behavioural Self-Reward	(Intercept)	-0.27	0.29	-0.94	0.76
	Weather	-0.31	0.39	-0.81	0.73
	Illness	-0.17	0.43	-0.39	0.85
	Flareup	-0.78	0.34	-2.28	0.46
	Commitments	-0.88	0.29	-3.01	0.41
	Exams	0.08	0.36	0.23	1.08

Note. % Change is calculated from the odds ratio. Odds > 1 = (odds ratio 1*100). Odds < 1 = (1-odds ratio *100). * = p <0.05, ** = p < 0.01, *** = p < 0.001.

Table 6

Odds Ratios and Percentage Changes for COM Predictors in Behaviour Change Techniques from GLMM

Model	Predictors	Estimate (Log-Odds)	Std. Error	Z value	Odd ratios (%)
Self-Monitoring	(Intercept)	-5.71	1.30	-4.38***	0.00 (99.67%)
	Capability	-0.17	0.13	-1.33	0.85 (15.44%)
	Opportunity	0.35	0.12	2.90**	1.41 (41.50%)
	Motivation	0.35	0.11	3.12**	1.43 (42.54%)
	Commitment	-0.29	0.41	-0.70	0.75 (25.00%)
	Gender	3.29	1.16	2.83**	26.95 (100%)
	Ethnicity	-2.72	0.99	-2.75**	0.07 (93.44%)
Obtain Information about Health Consequences	(Intercept)	-4.94	0.93	-5.29***	0.01 (99.30%)
	Capability	-0.18	0.11	-1.63	0.84 (16.20%)
	Opportunity	0.10	0.10	1.01	1.11 (10.80)
	Motivation	0.45	0.10	4.45***	1.58 (57.50%)
	Gender	2.57	0.70	3.67***	13.00 (100%)
	Ethnicity	-1.84	0.57	-3.21**	0.16 (84.00%)
Antecedents	(Intercept)	-4.39	0.83	-5.29***	0.01(98.80%)
	Capability	-0.14	0.11	-1.31	0.87 (13.20%)
	Opportunity	0.28	0.10	2.73**	1.32 (32.40%)
	Motivation	0.27	0.09	2.87**	1.31 (30.70%)
	Gender	0.64	0.62	1.04	1.90 (90.10%)
Task Crafting	(Intercept)	-3.09	0.61	-5.03***	0.05 (95.50%)
	Capability	0.18	0.09	1.92	1.20 (19.90%)
	Opportunity	0.22	0.08	2.60**	1.25 (24.50%)
	Motivation	0.30	0.08	3.52***	1.35 (34.60%)
	Illness	0.67	0.45	1.50	1.95 (95.10%)
	Flare-ups	-0.47	0.35	-1.32	0.63 (37.50%)
Practical Support	(Intercept)	-6.81	1.09	-6.27***	0.00 (100%)
	Capability	0.19	0.12	1.56	1.23 (23.00%)
	Opportunity	0.31	0.11	2.89**	1.36 (36.00%)
	Motivation	0.11	0.10	1.12	1.17 (17.00%)
	Gender	1.42	0.66	2.15*	4.14 (314.00%)
Obtaining Information on How to Perform Physical Activity	(Intercept)	-5.06	0.94	-5.38***	0.01 (99.40%)

	Capability	0.07	0.12	0.59	1.07 (7.30%)
	Opportunity	0.23	0.11	2.12*	1.26 (25.90%)
	Motivation	0.24	0.11	2.26*	1.27 (27.30%)
	Commitment	-0.69	0.38	-1.83	0.50 (50.10%)
Restructuring the Social Environment	(Intercept)	-3.96	0.75	-5.26***	0.02 (98.09%)
	Capability	-0.08	0.09	-0.85	0.92 (7.54%)
	Opportunity	0.39	0.09	4.28***	1.47 (47.15%)
	Motivation	0.23	0.08	2.75**	1.26 (25.62%)
	Flare-ups	0.09	0.37	0.24	1.09 (9.36%)
	Gender	1.63	0.57	2.84**	5.11 (100%)
	Disability	-1.57	0.51	-3.07**	0.21 (79.25%)
Restructuring the Physical Environment	(Intercept)	-5.04	0.93	-5.41***	0.01 (99.40%)
	Capability	0.03	0.10	0.26	1.03 (2.60%)
	Opportunity	0.29	0.09	3.16**	1.34 (33.50%)
	Motivation	0.30	0.09	3.32***	1.35 (34.70%)
	Commitment	-0.23	0.33	-0.69	0.80 (20.20%)
	Gender	1.54	0.66	2.32*	4.64 (100%)
Prompt and Cues	(Intercept)	-4.30	0.87	-4.92***	0.01 (98.60%)
	Capability	0.04	0.10	0.35	1.04 (3.60%)
	Opportunity	0.07	0.09	0.75	1.07 (7.20%)
	Motivation	0.32	0.09	3.39***	1.38 (37.80%)
	Flare-ups	-0.36	0.40	-0.89	0.70 (30.00%)
	Commitment	-0.75	0.33	-2.31	0.47 (53.00%)
	Gender	2.40	0.63	3.78***	11.04 (100%)
	Disability	-1.52	0.54	-2.80**	0.22 (78.20%)
Behavioural Goals	(Intercept)	-3.19	0.59	-5.45***	0.04 (95.90%)
	Capability	0.25	0.09	2.74**	1.28 (28.30%)
	Opportunity	0.09	0.08	1.14	1.09 (9.30%)
	Motivation	0.23	0.08	2.89**	1.26 (25.70%)
	Commitment	-0.69	0.30	-2.34*	0.50 (50.00%)
Outcome Goals	(Intercept)	-3.58311	0.57	-6.26***	0.03 (97.22%)
	Capability	-0.02813	0.09	-0.30	0.97 (2.77%)
	Opportunity	0.25269	0.09	2.94**	1.29 (28.75%)
	Motivation	0.29383	0.08	3.54***	1.34 (34.16%)
Goal Integration	(Intercept)	-2.23	0.54	-4.13***	0.11 (89.20%)
	Capability	0.12	0.09	1.39	1.13 (12.90%)

	Opportunity	0.15	0.08	1.93	1.17 (16.80%)
	Motivation	0.23	0.08	2.84**	1.26 (25.50%)
	Commitment	-0.06	0.29	-0.22	0.94 (6.30%)
Positive Reframing	(Intercept)	-2.23	0.72	-3.09**	0.11 (89.20%)
	Capability	0.17	0.09	1.89	1.19 (18.90%)
	Opportunity	-0.05	0.08	-0.58	0.95 (4.60%)
	Motivation	0.18	0.08	2.23*	1.20 (20.30%)
	Flare-ups	-0.10	0.37	-0.26	0.91 (9.20%)
	Gender	1.07	0.59	1.80	2.92 (100%)
Reflection on the Need to Perform Physical Activity	(Intercept)	-3.34	0.66	-5.05***	0.04 (96.50%)
	Capability	-0.09	0.10	-0.84	0.92 (8.30%)
	Opportunity	0.18	0.09	1.98*	1.20 (20.20%)
	Motivation	0.38	0.09	4.06***	1.47 (46.90%)
	Commitment	-0.16	0.32	-0.49	0.86 (14.50%)
Pros and Cons	(Intercept)	-3.929	0.83	-4.76***	0.02 (98.03%)
	Capability	0.065	0.12	0.53	1.07 (6.71%)
	Opportunity	0.134	0.12	1.10	1.14 (14.39%)
	Motivation	-0.009	0.11	-0.08	0.99 (0.88%)
Self-Praise (Behaviour)	(Intercept)	-4.72	1.03	-4.59***	0.01 (99.10%)
	Capability	0.20	0.11	1.74	1.22 (21.60%)
	Opportunity	0.04	0.10	0.42	1.04 (4.20%)
	Motivation	0.25	0.10	2.53*	1.29 (28.90%)
	Commitment	-0.35	0.35	-1.00	0.71 (29.50%)
	Gender	2.27	0.90	2.51*	9.68 (100%)
	Ethnicity	-2.23	0.79	-2.82**	0.11 (89.30%)
Normalizing Difficulty	(Intercept)	-1.98	0.52	-3.78***	0.14 (86.20%)
	Capability	-0.01	0.09	-0.11	0.99 (1%)
	Opportunity	0.06	0.08	0.81	1.06 (6.40%)
	Motivation	0.28	0.08	3.58***	1.32 (32.40%)
	Commitment	-0.17	0.28	-0.62	0.84 (15.80%)
Focus on Enjoyment	(Intercept)	-3.54	0.69	-5.11***	0.03 (97.10%)
	Capability	0.15	0.10	1.54	1.16 (15.70%)
	Opportunity	0.30	0.09	3.41***	1.35 (35.40%)
	Motivation	0.26	0.09	2.91**	1.30 (29.50%)
	Commitment	-0.05	0.32	-0.15	0.95 (4.80%)
	Flare-ups	-0.09	0.37	-0.25	0.91 (8.70%)

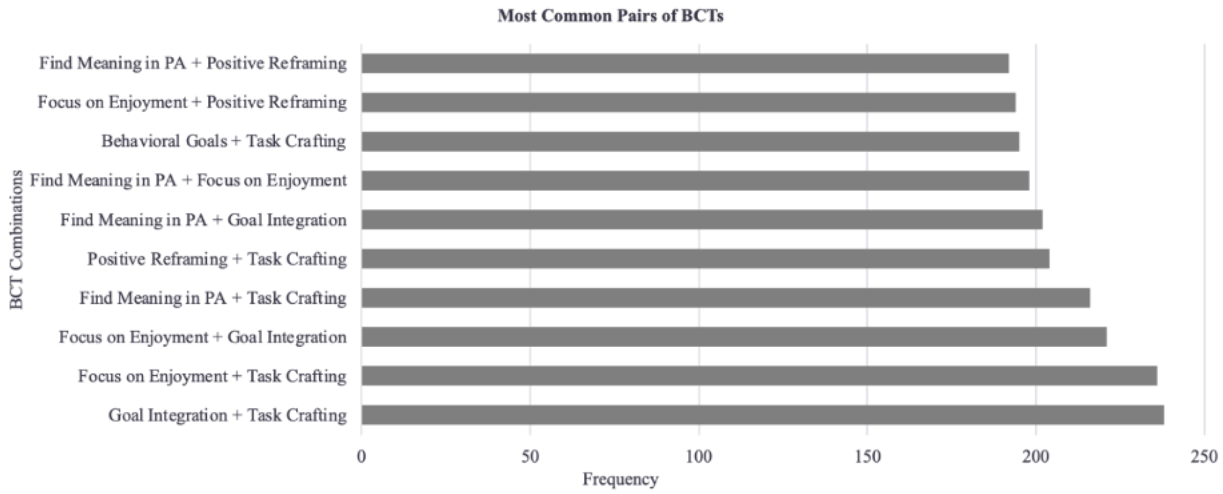
Self-Kindness	(Intercept)	-1.89	0.50	-3.75***	0.15 (84.90%)
	Capability	0.03	0.08	0.37	1.03 (3.20%)
	Opportunity	0.03	0.08	0.41	1.03 (3.20%)
	Motivation	0.15	0.07	2.05*	1.17 (16.60%)
	Flare-ups	0.96	0.32	3.01**	2.62 (100%)
Graded Tasks	(Intercept)	-4.73	0.75	-6.29***	0.01 (99.10%)
	Capability	0.06	0.09	0.59	1.06 (5.70%)
	Opportunity	0.20	0.09	2.32*	1.22 (22.40%)
	Motivation	0.45	0.09	5.05***	1.57 (57.20%)
	Commitment	0.11	0.31	0.35	1.12 (11.70%)
Action Planning	(Intercept)	-3.98	0.73	-5.42***	0.02 (98.10%)
	Capability	0.11	0.10	1.13	1.12 (11.80%)
	Opportunity	0.21	0.09	2.29*	1.23 (23.40%)
	Motivation	0.18	0.09	2.10*	1.20 (19.60%)
	Ethnicity	-0.81	0.55	-1.47	0.45(55.40%)
Problem Solving	(Intercept)	-4.25	0.80	-5.28***	0.01 (98.60%)
	Capability	0.21	0.10	2.13*	1.23 (23.00%)
	Opportunity	0.06	0.09	0.73	1.07 (6.50%)
	Motivation	0.16	0.08	1.97*	1.18 (17.90%)
	Flare-ups	-0.66	0.38	-1.72	0.52 (48.30%)
	Gender	1.29	0.58	2.24*	3.63 (100%)
Observe Demonstration of Physical Activity	(Intercept)	-3.95	0.73	-5.40***	0.02 (98.10%)
	Capability	-0.03	0.10	-0.25	0.98 (2.50%)
	Opportunity	0.25	0.10	2.60**	1.28 (28.30%)
	Motivation	0.27	0.09	3.14**	1.32 (31.50%)
	Flare-ups	-0.39	0.37	-1.05	0.67 (32.60%)
	Commitment	-0.30	0.31	-0.98	0.74 (26.20%)
Self-Talk	(Intercept)	-4.51	0.97	-4.67***	0.02 (97.90%)
	Capability	-0.14	0.11	-1.33	0.91 (8.80%)
	Opportunity	0.24	0.10	2.35*	1.21 (21%)
	Motivation	0.47	0.10	4.53***	1.62 (62.20%)
	Gender	1.08	0.71	1.53	1.08 (8.30%)
	Commitment	-0.35	0.34	-1.02	0.70 (30.40%)
Finding Meaning in Physical Activity	(Intercept)	-2.26	0.61	-3.72***	0.11 (89.50%)
	Capability	0.00	0.09	0.04	1.00 (0.40%)
	Opportunity	0.12	0.09	1.44	1.13 (13%)

	Motivation	0.36	0.09	4.24***	1.44 (43.90%)
	Illness	-1.13	0.46	-2.44*	0.32 (67.70%)
	Commitment	-0.19	0.32	-0.61	0.82 (17.60%)
Focus on Past Success	(Intercept)	-4.36	0.79	-5.52***	0.03 (97.10%)
	Capability	0.04	0.10	0.38	1.16 (15.70%)
	Opportunity	0.11	0.09	1.22	1.35 (35.40%)
	Motivation	0.44	0.10	4.57***	1.30 (29.50%)
	Commitment	-0.23	0.33	-0.70	0.95 (4.80%)
Behavioural Self-Reward	(Intercept)	-5.85	0.97	-6.05***	0.00 (99.70%)
	Capability	0.16	0.10	1.58	1.18 (17.80%)
	Opportunity	0.13	0.09	1.43	1.14 (14.10%)
	Motivation	0.33	0.10	3.37***	1.39 (38.70%)
	Gender	1.51	0.70	2.17*	4.52 (100%)
Emotional Support	(Intercept)	4.38	0.79	-5.57***	0.01 (98.74%)
	Capability	-0.01	0.10	-0.12	0.99 (1.25%)
	Opportunity	0.44	0.10	4.40***	1.55 (54.65%)
	Motivation	0.12	0.09	1.33	1.13 (12.92%)
	Ethnicity	0.11	0.61	0.18	1.12 (11.54%)

Note. % Change is calculated from the odds ratio. Odds > 1 = (odds ratio 1*100). Odds < 1 = (1-odds ratio *100). * = p <0.05, ** = p < 0.01, *** = p < 0.001

Figure 1

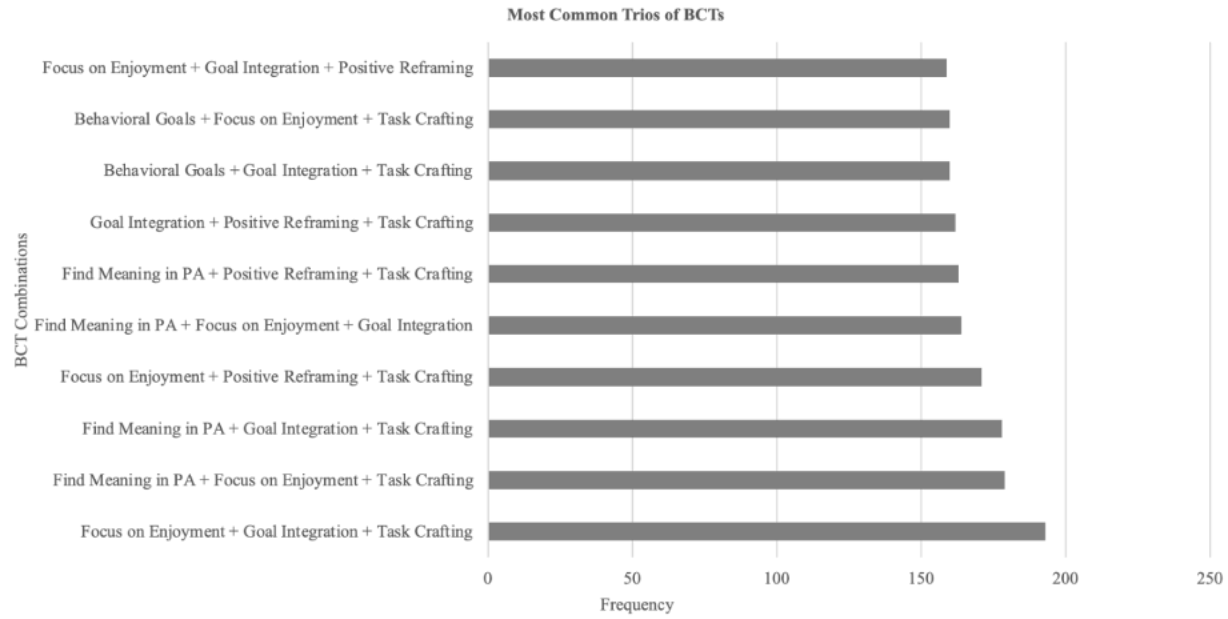
Most Common Pairs of Enacted BCTs and their Occurrences across 10 Days



Note. BCTs = Behaviour change techniques. The chart demonstrates the most common pairs of BCTs based on their frequency of occurrences across the 10 days. The total occurrences counted is n = 534.

Figure 2

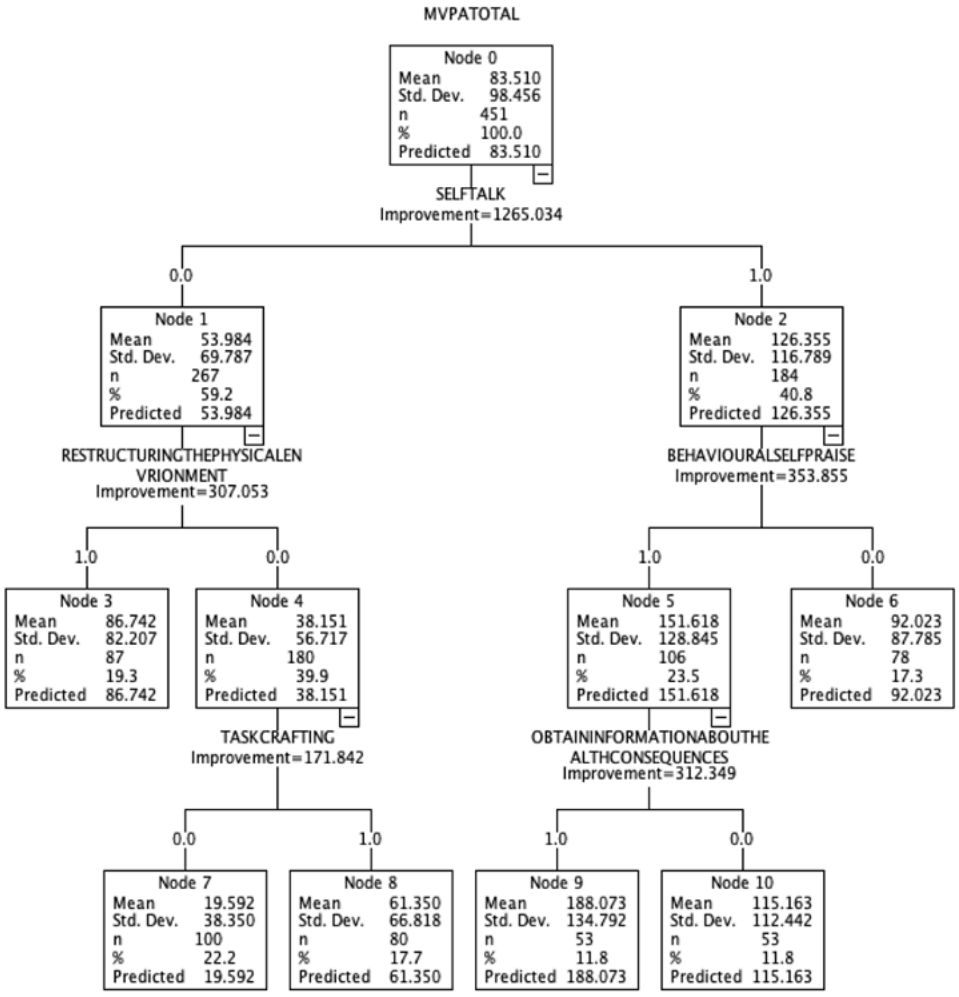
Most Common Triads of Enacted BCTs and their Occurrences across 10 Days



Note. Behaviour change techniques. The chart demonstrates the most common triads of BCTs based on their frequency of occurrences across the 10 days. The total occurrences counted is n = 534.

Figure 3

Decision Tree Analysis of BCTs predicting Moderate to Vigorous Physical Activity (MVPA)



Note. n = represents the number of occurrences of BCTs at each node. Only the MVPA mean was used in the decision tree analysis.

Appendix A

Daily Leisure Time Physical Activity Questionnaire

Aerobic Activities

Activities that typically increase heart rate and breathing. These activities include but are not limited to sport.

1. In the last 24 hours, how many hours or minutes did you spend doing vigorous leisure time physical activities (e.g.,required a lot of physical effort)?

2. In the last 24 hours, how many hours or minutes did you spend doing moderate leisure time physical activities (e.g., required some physical effort)?

3. In the last 24 hours, how many hours or minutes did you do mild leisure time physical activities (e.g., required very light physical effort)?

Strength Training

These exercises should work your major muscle groups. This includes exercises such as lifting weights or using elastic resistance bands.

1. In the last 24 hours, how many hours or minutes did you spend doing vigorous leisure time physical activities (e.g., required a lot of physical effort)?

2. In the last 24 hours, how many hours or minutes did you spend doing moderate leisure time physical activities (e.g.,required some physical effort)?

3. In the last 24 hours, how many hours or minutes did you spend doing mild physical activities (e.g.,required very light physical effort)?

Appendix B

Physical Activity and Behavior Change Strategies Questions: Modified Physical Activity Strategies:

Prompt: When reading the following physical activity strategies, please selected "**yes**" to the strategies you **used to support** your physical activity engagement **today**. Please select "**no**" if you **did not use** the physical activity strategy to support your physical activity engagement today.

1. had instructions from qualified others on the best ways to do my physical activity (e.g., Someone taught me how to lift weights).

Yes or no

2**.** I changed my social environment to help me do physical activity (e.g., I spent more time with active friends).

Yes or no

3. I changed my physical environment to help me do physical activity (e.g., I kept my workout gear near the door).

Yes or no

4. I set prompts, cues, and reminders to do my physical activity (e.g., I set an alarm to ring when it was time to do physical activity).

Yes or no

5. I set physical activity goals that I wanted to achieve (e.g., I will swim for 20 minutes today).

Yes or no

6. I set a physical activity goal for the benefits I wanted to achieve (e.g., I did yoga to improve my balance today).

Yes or no

7. I did my physical activity at the same time as another personal interest (e.g., I walked while listening to music).

Yes or no

8. I made a plan to help me work through my physical activity challenges (e.g., I found a solution so I could do physical activity when I was too busy).

Yes or no

9. I took on a more positive view of my current situation in physical activity (e.g., I said to myself, "Something is better than nothing" when I did not feel like doing physical activity).

Yes or no

10. I made a list of reasons for wanting or not wanting to do physical activity (e.g., I made a list of all the pros and cons of doing physical activity).

Yes or no

11. I reflected on my reasons and need for being physically active (e.g., I asked myself "Why is doing physical activity important today?").

Yes or no

12.I linked my physical activity to something meaningful to me (e.g., Physical activity helps me be healthy, which I value).

Yes or no

13.I thought about previous successes when I was doing physical activity (e.g., I thought about one time I hit a personal record).

Yes or no

14. I reminded myself how I can be physically active even if I'm unsure (e.g., I used statements like “I CAN do it” to encourage myself).

Yes or no

15. I noticed on how someone else did their physical activity (e.g., I watched someone perform a squat either in person or on video).

Yes or no

16. I verbally rewarded myself after I did my physical activity (e.g., I said to myself “Great Job!”).

Yes or no

17. I gave myself a reward after I did my physical activity (e.g., I treated myself with my favorite snack after doing physical activity).

Yes or no

18.I reminded myself that it is okay for there to be challenges while doing physical activity (e.g., I did not take my difficulties as a personal failure).

Yes or no

19.I made sure that my physical activity was enjoyable (e.g., I focused on having fun during my physical activity).

Yes or no

20. I was kind and accepting towards myself and my physical activity difficulties (e.g., I did not criticize myself when I missed the gym today).

Yes or no

21. I started with a simple physical activity and gradually made it harder (e.g., I gradually increased the intensity of my physical activity).

Yes or no

22. I kept track of my physical activity (e.g., I wrote down my physical activities in a diary).

Yes or no

23.I learned about the effects of physical activity for my health (e.g., I searched online or asked professionals for information about the effects of physical activity).

Yes or no

24. I had emotional support from my friends or family to do my physical activity (e.g., I talked to a friend to help me feel better about my physical activity setbacks).
Yes or no

25. I created a detailed list of how and when I wanted to do physical activity (e.g., I scheduled my physical activity in my calendar).

Yes or no

26. I had practical help from friends or family to do my physical activity (e.g., My family took over some of my responsibilities so that I could do my physical activity).
Yes or no

27. I learned about things that help me be physically active (e.g., I searched online or asked qualified others for information about things that help me be physically active).

Yes or no

28. I chose a physical activity that matches my skills and ability (e.g., I chose weights that are not too heavy or too light).

Yes or no

29. Are there any other strategies that you use to help you engage in physical activity? If so, please write below.

Appendix C

Behaviour Change Technique Selection Process

Step	Description	BCTs
Step One	Conducted a literature search in PsycINFO, PubMed, and Medline to identify BCTs in physical activity interventions from 26 meta-analyses/reviews. Selected 8 BCTs based on frequency and effectiveness.	**Chosen BCTs:** • Social support • Self-monitoring • Goal setting • Action planning • Problem-solving • Graded task • Credible source • Goal setting behavior
Step Two	Consulted the self-enactable compendium list. Identified 13 new chosen BCTs	**Chosen BCTs:** • Behavioural goals • Outcome goals • Action planning • Problem-solving • Self-monitoring of behavior • Restructuring physical environment • Goal integration • Focus on the enjoyment of the behavior • Obtain emotional support • Prompt/cues • Task Crafting • Normalize difficulty • Graded Tasks
Step Tree	Aligned the 13 BCTs with the theoretical domain	**Chosen BCTs:**

	framework and COM-B model. Identified 15 new BCTs to cover all domains.	• Self-kindness • Self-praise (behavior) • Self-reward (behavior) • Observing the demonstration of the behavior • Self-talk • Focusing on past success • Finding meaning in the target behavior • Reflecting on the need to perform the behavior • Pros and cons • Positive reframing • Restructuring the social environment • Obtain instruction on how to perform the behavior • Obtain practical social support • Obtain information about antecedents • Obtain information about health consequences
Total of BCTs (28)		• Behavioural goals • Outcome goals • Action planning • Problem-solving • Self-monitoring of behavior • Restructuring physical environment • Goal integration

		• Focus on the enjoyment of the behavior • Obtain emotional support • Prompt/cues • Task Crafting • Self-praise (behavior) • Self-reward (behavior) • Observing the demonstration of the behavior • Self-talk • Focusing on past success • Finding meaning in the target behavior • Reflecting on the need to perform the behavior • Pros and cons • Positive reframing • Restructuring the social environment • Obtain instruction on how to perform the behavior • Obtain practical social support • Obtain information about antecedents • Obtain information about health consequences • Graded tasks • Normalizing difficulty • Self-Kindness

Step Four	Simplified BCT definitions and validated them with Ph.D., master's, and undergraduate students. Revised definitions based on feedback to ensure clarity and accuracy.	**Ph.D. and Master's Students (Trial 1):** Missed BCTs: • Graded task • Task crafting • Obtaining information about health consequences • Obtaining information about antecedents • Observing the demonstration of the behavior • Goal integration **Undergraduate Student (Trial 1):** Missed BCTs: • Task crafting • Obtaining practical help • Observing the demonstration of the behavior • Focusing on enjoyment **Ph.D. Student (Trial 2):** Missed BCT: • Goal integration

Appendix D

Capability, Opportunity, Motivation Questionnaire for Behaviour Change Skills

This questionnaire will ask questions about your capability, opportunity, and motivation to use behaviour change skills related to physical activity. Behaviour change skills are active ingredients or strategies that you may use to change or facilitate your physical activity behaviour. Common examples of behaviour change skills are goal setting (creating an objective to reach), action planning (a schedule of when, where, how, what) and self-monitoring (tracking what you are doing).

Opportunity

1. What is physical opportunity?

The environment provides the opportunity to engage in strategies.

a. I had the physical opportunity to use behaviour change strategies in my physical activity today.

Please rate: Strongly Disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

2. What is social opportunity?

Interpersonal influences, social cues, and norms that support behaviour change strategies.

a. I had the social opportunity to use behaviour change strategies in my physical activity today.

Please rate: Strongly Disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

Motivation

1. What is reflective motivation?

Conscious planning and evaluations (beliefs about what is good and bad)

a. I was motivated to use behaviour change strategies in my physical activity today

Please rate: Strongly Disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

2. What is automatic motivation

Involves doing something without thinking or having to consciously remember. (e.g., is something I do before I realize I'm doing it).

a. Using behaviour change strategies in my physical activity today is something that I did automatically.

Please rate: Strongly Disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9

Capability

1. What is physical capability?

Physical skills, strength, or stamina to engage in the strategies

a. I was physically able to use behaviour change strategies in my physical activity today.

Please rate: Strongly Disagree Strongly Agree

0 1 2 3 4 5 6 7 8 9 10

2. What is psychological capability?

The knowledge or psychological skills to engage in thought process of the strategies

a. I was psychologically able to use behaviour change strategies in my physical activity today.

Please rate: Strongly Disagree Strongly Agree
0 1 2 3 4 5 6 7 8 9 10

Appendix E
Situational Questions

1. Did you have an exam or course assignment worth > 10% of your final grade today?
Yes or no

2. Has weather prevented you from participating in physical activity today?
Yes or no

3. Has any illness (e.g., cold, caught, flu, etc.) has prevented you from participating in physical activity today?
Yes or no

4. Has any factor related to your disability or chronic condition prevented you from doing physical activity today?
Yes or no

5. Has any other personal responsibilities or commitments (e.g., work,) prevented you from doing physical activity today?
Yes or no

Appendix F

Step 1: Hierarchical BCT Groupings (Michie et al., 2014) for the Decision Tree Analysis

Grouping and BCTs		
1. Goals and planning 1.1. Goal setting (behavior) 1.2. Problem solving 1.3. Goal setting (outcome) 1.4. Action planning 1.5. Goal Integration	**6. Comparison of behaviour** 6.1 Demonstration of the behaviour	**11. Regulation** N/A
2. Feedback and monitoring 2.1 Self-monitoring	**7. Association** 7.1 Prompt/cues	**12. Antecedents** 12.1 Restructuring the physical environment 12.2 Restructuring the social environment
3. Social support 3.1 Practical social support 3.2 Emotional social support	8. **Repetition and substitution** 8.1 Graded task 8.2 Task Crafting	**13. Identity** 13.1 Positive reframing 13.2 Reflection on the need to perform PA 13.3 Finding Meaning in PA 13.4 Focus on enjoyment
4. Shaping knowledge 4.1 Instruction on how to perform the behaviour 4.2 Obtaining information about antecedents	**9. Comparison of outcomes** 9.1 Pros and Cons	**14. Scheduled consequences** N/A
5. Natural consequences 5.1 Information about health consequences	**10. Reward and Threat** 10.1 Behavioural self-reward	15. **Self-belief** 15.1 Focus on past success 15.2 Self talk 15.3 Behavioural self-praise 15.4Normalizing difficulty 15.5 Self- Kindness
16. Covert learning		
N/A		

Appendix G

Step 2: Final List of Michie et al. (2014) Hierarchical BCT Groupings BCTs for the Decision Tree Analysis

Grouping and BCTs		
1. Goals and planning 1.1. Goal setting (behavior) 1.2. Problem solving 1.5. Goal Integration	**6. Comparison of behaviour** 6.1 Demonstration of the behaviour	**11. Regulation** N/A
2. Feedback and monitoring 2.1 Self-monitoring	**7. Association** 7.1 Prompt/cues	**12. Antecedents** 12.1 Restructuring the physical environment 12.2 Restructuring the social environment
3. Social support 3.1 Practical social support 3.2 Emotional social support	8. **Repetition and substitution** 8.1 Graded task 8.2 Task Crafting	**13. Identity** 13.2 Reflection on the need to perform PA 13.3 Finding Meaning in PA 13.4 Focus on enjoyment
4. Shaping knowledge 4.1 Instruction on how to perform the behaviour 4.2 Obtaining information about antecedents	**9. Comparison of outcomes** 9.1 Pros and Cons	**14. Scheduled consequences** N/A
5. Natural consequences 5.1 Information about health consequences	**10. Reward and Threat** 10.1 Behavioural self-reward	15. **Self-belief** 15.2 Self talk 15.3 Behavioural self-praise 15.4 Normalizing difficulty
16. Covert learning		
N/A		