The Development and Implementation of a Motivational Sleep Promotion Program for Adolescents

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Abstract

Lack of sleep in adolescents is associated with a number of negative consequences such as poor school performance, negative mood, car accidents, and poor health. Although there is ample evidence that adolescents are not obtaining sufficient sleep, effective interventions to promote longer sleep duration in this population are lacking. The present research examines the role of adolescent motivation in promoting longer sleep duration. I first conducted a theoretical review of existing programs in order to determine the efficacy of current initiatives to promote adolescent sleep and offer ways in which to improve them. It was concluded that more emphasis should be placed on enhancing the motivation of adolescents to improve their sleep habits in lieu of focusing on knowledge synthesis only. Based on the results of the review, I conducted a survey study with 167 sleep-restricted adolescents (Study 1) and modeled the awareness and motivational predictors of the intention to advance bedtime using structural equation modeling. The results revealed the types of variables (awareness of internal cues to go to bed earlier and positive attitudes towards sleep) that should be fostered in a motivational intervention. Further, Study 1 revealed the potentially effective but novel approach of supporting adolescents' autonomy in promoting earlier bedtimes rather than imposing restrictions on them. Informed by the findings of Study 1, I developed an intervention that targets these awareness and motivational variables, the *Motivating Teens to Sleep More program.* The intervention is a one-on-one, tailored, and stage-based intervention based on the principles of motivational interviewing. In Study 2, I evaluate the efficacy of the *Motivating Teens to Sleep More* program by comparing it to a one-on-one sleep education program that includes no motivational techniques. Following the intervention, the experimental group demonstrated greater improvements in self-reported bedtime, sleep duration, and self-efficacy than the control group, which were not maintained at

the 6-months follow-up. Both groups improved in readiness to change following the program but more experimental participants reached the action stage indicating that they were actively trying to go to bed earlier. Motivational programs that offer booster sessions following program completion are discussed as potentially effective ways to motivate sustained sleep behaviour changes in adolescents.

Résumé

Plusieurs conséquences négatives découlent d'un manque de sommeil chez les adolescents dont de mauvais résultats scolaires, des troubles d'humeur et des troubles de santé. Bien qu'il existe de nombreuses preuves que les adolescents n'obtiennent pas suffisamment de sommeil, nous observons une lacune importante au niveau des interventions afin de promouvoir une plus longue durée de sommeil. Le projet de recherche suivant examine le rôle de la motivation des adolescents dans la promotion d'une durée de sommeil allongée. J'ai d'abord débuté mon projet de recherche avec une analyse des programmes existants afin d'en déterminer l'efficacité pour favoriser le sommeil des adolescents et offrir des façons de l'améliorer. Conséquemment, l'accent devrait être mis sur l'accentuation de la motivation des adolescents à améliorer leurs propres habitudes de sommeil au lieu de se concentrer sur la synthèse des connaissances seulement. Les résultats de mon étude démontrent que certains types de variables, notamment la conscience, la reconnaissance des signes internes indiquant à notre corps le besoin de sommeil et les attitudes positives envers le sommeil, devraient être promues lors de l'utilisation de programmes de motivation.

La première étude démontre également l'importance de supporter les adolescents dans leur choix en valorisant de saines habitudes de sommeil au lieu de leur imposer certaines restrictions. Suite aux résultats obtenus mentionnés ci-dessus, un plan d'intervention, *"Motivating Teens to Sleep More program"*, qui vise à informer les adolescents sur les bienfaits du sommeil a été créé. L'intervention consiste à une rencontre en tête-à-tête sur mesure, fondée sur les principes de l'entrevue motivationnelle. La deuxième étude vise principalement à évaluer l'efficacité du programme, *"Motivating Teens to Sleep More"* en le comparant à un autre programme qui n'inclut aucune technique de motivation. Suite à l'intervention, le groupe

expérimental démontre une nette amélioration comparativement au groupe de contrôle en matière d'efficacité, de l'heure où il se couche ainsi que la durée de leur sommeil. Par contre, les résultats n'ont pas été maintenus au moment du suivi de six mois. L'analyse des études menées indique également que les adolescents sont prêts à apporter des changements dans leurs habitudes de sommeil suite à l'intervention. Finalement, le rapport confirme que les élèves dans le groupe expérimental ont atteint le stade où ils veulent apporter des changements dans leur vie notamment celui de se coucher plus tôt. Les programmes de motivation offerts dans le cadre de cette étude peuvent donc être considérés comme des techniques efficaces pour motiver les adolescents à faire le choix de modifier leurs habitudes de sommeil.

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Contributions of Authors

This dissertation comprises four manuscripts of which I am the first author. For the first manuscript, I communicated with support from Dr. Gruber and Dr. Knäuper with the editor of the journal *Sleep Medicine Reviews* and was invited to submit the review paper. I wrote the first draft of the manuscript along with Sonia Michaelsen and Dr. Gruber and Dr. Knäuper significantly contributed to editing the manuscript. All authors revised the manuscript according to the editors' comments.

For the second manuscript, I conceptualized, designed, and implemented the study with supervision from Dr. Gruber and Dr. Knäuper. Undergraduate student Florida Rushani assisted in creating the survey and managing the database. Dr. Sadikaj and I ran all of the statistical analyses. Florida Rushani and I wrote the first draft of the manuscript and Dr. Gruber and Dr. Knäuper significantly contributed to editing the manuscript. All authors revised the manuscript according to the editors' comments.

For the third manuscript, I led the design and development of the protocol with the support from Dr. Knäuper, Dr. Gruber, and Florida Rushani. I led the data collection with the support of Florida Rushani. I conducted half of the intervention and control sessions and another clinical psychology graduate student, Dr. Ava-Ann Allman conducted the other half. Florida Rushani and I wrote the first draft of the manuscript and Dr. Gruber and Dr. Knäuper significantly contributed to editing the manuscript. All authors revised the manuscript according to the editors' comments.

For the fourth manuscript (submitted), I led the design and development of the protocol with the support from Dr. Knäuper, Dr. Gruber and Florida Rushani. I led the data collection and data

analyses with the support of Florida Rushani. I wrote the first draft of the manuscript and Dr. Gruber, Dr. Knäuper, and Florida Rushani contributed significantly to editing.

Chapter 1

Introduction

Cassoff, J., Knäuper, B., Michaelsen, S., Gruber, R. (2013). School-based sleep promotion programs: Effectiveness, feasibility and insights for future research. *Sleep Medicine Reviews,* 17, 207-214.

Abstract

Adolescent sleep deprivation is prevalent in today's society and is associated with major negative consequences for adolescent development and well-being. In the present review, we examine efforts to prevent adolescent sleep deprivation via school-based sleep promotion programs. Such programs effectively enhance sleep knowledge but do not succeed in maintaining sleep behavioural changes. We hypothesize that this is because insufficient consideration has been given to motivational factors and to the integration of motivational components into the programs. We suggest that future interventions should consider the use of individually tailored approaches to sleep promotion that integrate motivational components. Specifically, we recommend the use of motivational interviewing, which can detect individual differences in the degree of willingness to change, thus allowing motivational barriers to be adequately addressed on an individual basis. Furthermore, we suggest that in the future individually tailored sleep promotion strategies could potentially be delivered a larger number of participants via internet-based interventions.

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Introduction

A reduction in sleep duration has become a common lifestyle pattern in modern society. Mounting evidence indicates that sleep deprivation is particularly prevalent, and of greatest concern, in adolescent populations. While experts state that the optimal amount of sleep in adolescence is approximately 9.2 hours per night (Carskadon et al., 1980; Iglowstein, Jenni, Molinari, & Largo, 2003; Mercer, Merritt, & Cowell, 1998), a recent poll by the National Sleep Foundation (2011) found that a significant proportion of adolescents (61%) are not getting this recommended amount of sleep. The transition from childhood to adolescence is accompanied by several biological and psychosocial changes that may impede attainment of a good night's sleep. First, several studies have demonstrated that the onset of puberty is associated with entry into a delayed sleep phase, at which time adolescents show an endogenous preference for much later bedtimes than children and adults (Carskadon, Vieira, & Acebo, 1993; Knutson, 2005; Laberge et al., 2001). Advanced stages of pubertal development have been correlated with later phase of melatonin offset in the morning, suggesting that biological changes occurring during puberty are associated with delayed circadian timing (Carskadon, Acebo, Richardson, Tate, & Seifer, 1997). In addition to a delay of circadian timing, adolescence is characterized by a slower accumulation of the homeostatic drive with sleep pressure building up more slowly with increasing age (Hagenauer, Perryman, Lee, & Carskadon, 2009), resulting in teenagers feeling tired at later hours and pushing bedtimes into a more delayed direction.

Second, several psychosocial factors unique to adolescence may exacerbate the preference for a delay in sleep phasing. Adolescence is characterized by increased personal autonomy and acceptance of responsibilities associated with a decline in parental influence, an increase in peer influence, and first-time employment opportunities (Krosnick & Judd, 1982; Morisi, 2008). These factors may affect adolescents' attitudes and priorities with regards to

sleep. Given the wide array of extracurricular opportunities available to high school students, sleep may easily descend to the bottom of the priority list. Finally, environmental factors such as consumption of stimulants (e.g., caffeine) and use of technology (e.g., television, the internet, and cell phones) also increase the likelihood that bedtime will be delayed (NSF, 2006, 2011).

The delayed sleep phase preference of adolescents often results in lack of sleep due to societal demands such as early school start times. A national survey conducted in the USA (NSF, 2006) found that the average start time for high schools (grades 9-12) was between 07:51 h and 07:56 h, forcing most adolescents to wake around 06:30 h to allow sufficient time to prepare for and travel to school. The majority of high school students reported feeling fatigued between 08:00 h and 10:00 h during the week (Gibson et al., 2006), indicating that adolescents may not be obtaining a sufficient sleep on school nights. Similarly, Canadian high school students wake up for school each morning at an hour (on average, 6:30AM; Boergers, 2015) that terminates their sleep prematurely (Carskadon, 2011; Olds, Maher, Blunden, & Matricciani, 2010) in order to arrive at school on time (on average, earlier than 8:00AM; Boergers, 2015). Early start times are in direct conflict with the delayed sleep phase preference of adolescence and impose a need to be wakeful during a period when adolescents are naturally inclined to sleep. Adolescents tend to sleep in on the weekend, when wake-up restrictions are lifted. The delayed sleep schedules of weekends are commonly interpreted as a manifestation of fatigue associated with sleep restriction accumulated throughout the week (Giannotti, Cortesi, Sebastiani, & Ottaviano, 2002). Sleeping in on weekends drives the already inherently delayed circadian phase of adolescence in a direction creating even more delay. This results in late bedtimes and wake-up times on weekends. The problem arises when the weekend is over and school begins once more. It is

impossible to maintain the delayed wake-up schedule and accumulation of sleep debt is again initiated (Carskadon, 2011).

The persistent lack of sleep in adolescence is problematic given the substantial body of evidence showing that such shortened sleep is associated with a myriad of negative consequences (Dahl & Lewin, 2002). Poor sleep has been shown to impair cognitive and behavioural processes relevant to academic success, including learning, memory, attention, executive functioning, and emotional regulation (Alhola & Polo-Kantola, 2007; Durmer & Dinges, 2005; Horne, 1988; Nilsson et al., 2005; Pilcher & Huffcutt, 1996). The cognitive and behavioural impairments resulting from sleep restriction impact not only the academic lives of adolescents but also increase the risk of unintentional injury and accident (Groeger, 2006; Lam & Yang, 2007; Pizza et al., 2010; Stallones, Beseler, & Chen, 2006). Examination of epidemiological data on road traffic crashes, stratified by driver age and time of day, has revealed that sleepiness of young drivers is of particular concern. In the USA, for example, 55% of drivers involved in crashes attributable to sleepiness were 25 years of age or younger and most single-vehicle crashes occurred between midnight and 07:00 h. The negative impact of sleep restriction on driving ability and crash risk have been demonstrated in several studies, (Philip et al., 1996; Philip et al., 1999) and an increased incidence of sleep-related crashes has been documented in drivers reporting less than 7 h of sleep per night (Stutts, Wilkins, Osberg & Vaughn, 2003). Further, chronic sleep restriction is also associated with potential long-term negative health consequences, including increased risks of development of cardiovascular disease, hypertension, diabetes, and obesity (see AlDabal & BaHammam, 2011 for a review). Given the high prevalence of sleep restriction in adolescence, the negative impact of such restriction on mental and physical health and academic success, and the multiple barriers that

impede implementation of healthy sleep practices in this age group, school-based programs targeting such issues of adolescence are clearly required.

Several school-based sleep interventions have sought to advance bedtime in adolescents by delivering education on the importance of sleep. The goals of the present article are, therefore, threefold: 1) to review school-based sleep promotional (SBSP) programs aimed at ameliorating adolescent sleep habits; 2) to evaluate the effectiveness of these programs in changing adolescent sleep behaviour and feasibility of implementing these programs in a school setting; and 3) to propose new directions for individualized school-based adolescent sleep promotion programs including the use of motivational interviewing (MI) and internet-based dissemination methods.

School-Based Sleep Promotion Programs

SBSP programs usually take one of two paths. Some seek to synthesize sleep knowledge whereas others employ cognitive and behavioural sleep-related strategies in addition to knowledge synthesis. The former may be termed "school-based sleep education programs" and aim to enhance adolescent sleep knowledge with the assumption that this will create positive attitudes toward sleep and, ultimately, improve sleep habits. Most sleep education programs successfully enhance adolescent sleep knowledge (Bakotić, Radošević-Vidaček, & Košćec, 2009; Cortesi, Giannotti, Sebastiani, Bruni, & Ottaviano, 2004; De Sousa, Araujo, & De Azevedo, 2007) but it is usually not determined whether this actually translates into changes in sleep behaviour. This lack of evidence indicating improvements in sleep, and the fact that knowledge acquisition per se does not necessarily predict behavioural changes in other areas of health (Tobler, 2000), suggest that knowledge synthesis alone is not effective in prevention of adolescent sleep restriction.

A few school-based sleep education programs have evaluated improvements in adolescent sleep behaviour in addition to acquisition of sleep knowledge. For example, the *Sleep-Smart*

Program (Rossi, Campbell, Vo, Marco, & Wolfson, 2002), aimed at preventing poor sleep habits in adolescents, was led by a clinical psychologist and two assistants who taught healthy sleep habits. The comparison group was a health class that participated in another study on adolescent sleep habits. Two pilot experiments were performed and one included objective assessment employing actigraphy. Outcome measures included bedtime, rise time, total sleep time, bedtime delay, and oversleep time on the weekend (compared to during the week); all variables were measured before and after the intervention in all participants. Following the program, a trend was demonstrated such that the intervention group (i.e., those who had received sleep education) reported earlier bed and wake times on both school and weekend nights. (Vo, LeChasseur, Wolfson, & Marco, 2003) Furthermore, actigraphy findings revealed that the intervention participants displayed more consistent sleep patterns on both weekend and weekday nights. Although initial trends toward improved sleep behaviour were observed, the pilot programs had small sample sizes, did not report follow-up data, and employed inadequate control groups. Thus, the evidence for efficacy of school-based sleep education programs must be considered as preliminary in nature.

Sleep promotion programs that incorporate cognitive and behavioural strategies, in addition to sleep education, have also been less than fully successful in improving adolescent sleep. For example, Moseley and Gradisar (Moseley & Gradisar, 2009) created the *Improving Adolescent Well-Being: Day and Night* program with the goal of improving adolescent sleep practices. High-school students whose current bedtimes were documented were randomly assigned to receive the program or not. The program targeted health-related behaviours including eating habits, exercise, and sleep, and offered health education, goal-setting exercises, and behavioural and cognitive strategies to improve well-being and maintain a healthy lifestyle. Sleep behaviour (i.e., total

sleep time, sleep onset latency, and the discrepancy between school and weekend out-of-bed time), daytime sleepiness, and the presence of a depressed mood were assessed via online questionnaires prior to program commencement, when the program concluded, and 6 weeks later. A sleep knowledge quiz was given before and after intervention, and a behaviour intention questionnaire addressing several healthy habits was administered. A significant increase in sleep knowledge post-program was evident in students of the intervention group. When data on all participants were analyzed, the program did not affect any sleep behaviour or the proportion of those experiencing a depressed mood. However, when only adolescents with delayed bedtimes prior to the program were considered, the discrepancy between school and weekend out-of-bed times post-intervention initially decreased in the intervention group compared to controls. This improvement was no longer apparent at the 6-week follow up. The behaviour intention questionnaire revealed that adolescents showed a greater intention to improve other habits (i.e., to exercise more and to eat healthy) than sleep. Qualitative feedback suggested that adolescents were not motivated to apply what they had learned to improve their sleep. The authors propose that this was because the students were not convinced that the strategies taught (e.g., exposure to sunlight in the morning) would actually improve sleep habits. This SBSP study was the first to identify the potential importance of including a motivational element in such programs.

A recent study by Cain et al. (2011) addressed this limitation by applying the principles of motivational interviewing (MI) within a SBSP program Motivational interviewing has been recently defined by its founders, Miller and Rollnick, (2009) as "…a collaborative, person-centered form of guiding to elicit and strengthen motivation for change." This counseling approach is grounded on four unique principles (Miller & Rollnick, 2002), namely: 1) expressing empathy toward the client, 2) encouraging the client to be autonomous rather than assuming an

authoritarian position that imposes ideas on them, 3) rolling with resistance (i.e. not confronting and challenging the client when they make resistant statements), and 4) helping the client realize that there is a discrepancy between their current maladaptive behaviour and their life goals and values. Motivational interviewing is not just a set of strategies (Rollnick & Miller, 1995) but is also a style of interacting with the client, which is commonly referred to as the "spirit" of MI. The MI spirit (Miller & Rollnick, 2002) consists of collaboration between the client and the therapist, evocation of the client's own motivations and reasons for change, and emphasizing the client's autonomy in a way that acknowledges them as the expert in the relationship. A skilled MI interventionist will be attuned to the readiness of their client to change and then utilize the appropriate skills and strategies. Apodaca and Longabaugh (2009) reviewed MI interventions aimed at driving behaviour change in individuals with substance use disorders. They found that significant mediators of behaviour change were the client's ability to verbalize change (i.e. change talk), the client's experience of discrepancy between current behaviour and personal values, (Apodaca & Longabaugh, 2009) and the therapist's tendency to engage in MI-inconsistent behaviour (associated with worse outcomes). Adolescents in the experimental group received group-based MI; four lessons were given that sought to alter attitudes to sleep. The intention was to enhance motivation toward adoption of better sleep habits. Online measures evaluated sleep patterns, the extent of daytime sleepiness, the presence of depression, and the level of motivation toward improvement of sleep habits. Participants were assessed before and after intervention, and 6 weeks later. A sleep knowledge quiz was given in class before and after intervention, and a questionnaire exploring the extent of motivation toward improvement of sleep habits was completed during the program. After program completion, sleep knowledge was enhanced in the intervention compared with the control group. Further, the declared motivation

toward sleeping more and the development of a more consistent sleep/wake pattern was significantly higher in adolescents in the intervention group, who thought it important to get up at the same time every day. However, again, no program effects on sleep behaviour or mood were evident. The incorporation of a motivational component into the sleep promotion program did not result in sleep-related behavioural changes. It is therefore very important to discover effective interventions improving adolescent sleep behaviour.

Effectiveness of school-based sleep promotion programs

Efforts to reduce adolescent sleep restriction via SBSP programs improve sleep knowledge and create short-term (but not sustained) improvements in adolescent sleep practices. This can be attributed to the theoretical and methodological shortcomings of existing SBSP programs.

A potential theoretical limitation of existing programs is the lack of an adequate consideration for motivation. If all components of motivation were identified and harnessed, such programs would potentially be more effective. A potentially useful conceptual framework for motivating health behavioural change is the attitude-social influence-self-efficacy (ASE) model constructed by De Vries and Mudde (1988; 1998). The model is premised on the theory of planned behaviour, (Ajzen & Madden, 1986; (Fishbein & Ajzen, 1975) social learning theory, (Bandura, 1986) and the transtheoretical model. (DiClemente & Prochaska, 1985) The ASE model asserts that health behaviour is predicted by development of an intention to change, in turn determined by motivational elements including attitudes (i.e., affective responses to a particular health behaviour; De Vries, Dijkstra, & Kuhlman, 1988), social influences (i.e., social norms, pressure, and modeling; De Vries, Backbier, Kok, & Dijkstra, 1995), and self-efficacy (i.e., belief in one's capability to perform a task; Bandura, 2006; De Vries et al., 1988). In the context of sleep,

attitude is the positive and negative responses to obtaining adequate sleep and sleep restriction, self-efficacy is the perceived ability to get to bed at a suitable hour, and the relevant social influences are the sleep norms, pressure, and modeling that exist in an individual's social circle.

Motivation is particularly important in promotion of healthy sleep in adolescents because of the motivational barriers precluding development of such behaviour. Specifically, the secondary gains associated with delayed bedtime are participation in enjoyable activities including watching television, engaging in social media, and playing computer games. These are more immediately rewarding than sleep, rendering going to bed unattractive from the adolescent viewpoint. This fact, together with the developmental characteristics associated with adolescence (e.g., increased seeking of autonomy; Krosnick & Judd, 1982), the biological propensity for delayed bedtime (e.g., the delay in circadian rhythm; Carskadon et al., 1993), and the environmental variables that promote sleep reduction (e.g., early school start times; NSF 2006) mean that any motivational component of interventions targeting advancement of bedtime must be strong. It is important to identify effective means of enhancing adolescent motivation toward this end.

The use of the ASE model as a theoretical framework in the context of adolescent sleep suggests the need for integration of each motivational element mentioned above into existing SBSP programs aimed at promoting healthy sleep. Although many sleep studies employ a measure of sleep knowledge ("What do adolescents know about sleep?"), few utilize a measure of sleep attitude ("How do adolescents feel about sleep?"). However, two studies have used instruments assessing adolescent sleep attitudes. Beliefs about sleep were recorded (Owens, Stahl, Patton, Reddy, & Crouch, 2006) and perceived barriers to going to bed at an appropriate hour were noted (Noland, Price, Dake, & Telljohann, 2009). It was concluded that, often,

adolescents knew of the need for adequate sleep and the benefits thereof, but that this did not necessarily translate into development of positive attitudes toward sleep or improved sleep behaviour. Thus, sleep attitude is distinct from sleep knowledge and must be separately addressed in SBSP programs. This is consistent with recent evidence suggesting that it may be important to include all relevant motivational elements in SBSP programs (Cain et al., 2011).

In addition to improvements in attitude, social influence is another important motivational element of the ASE (De Vries et al., 1995) model, and may facilitate sustained sleep behavioural changes. Peer engagement in risky behaviour (peer modeling) and/or pressure from peers to engage in such behaviour (peer pressure) have been shown to significantly contribute to the development of risky behaviours in adolescents (Lewis & Lewis, 1984). In the context of adolescent sleep, it may be presumed that such social influences affect sleep habits. As adolescents become autonomous peer groups become more influential (Gifford-Smith, Dodge, Dishion, & McCord, 2005), and such groups may therefore play significant roles in determining sleep behaviour. Although research on the role of peers in determining adolescent sleep timing is limited, recent work (Mednick, Christakis, & Fowler, 2010) has shown that poor sleep behaviour can extend to four degrees of separation (i.e., to the friends of friends of friends of friends) within a social network. Furthermore, if a friend slept for less than 7 hours per night, this increased by 11% the likelihood that the adolescent also slept for less than 7 hours per night. On the other hand, friends also seem to be able to protect adolescents from risky health behaviours (Maxwell, 2002). For example, positive peer influence, such as having friends that model healthy sleep by going to bed at an appropriate time, decreases adolescent violence and substance abuse (Prinstein, Boergers, & Spirito, 2001). When promoting earlier bedtime in adolescents, peer influence may be a motivational challenge (or benefit) and, in addition to

attitude and a sense of self-efficacy, is another potentially valuable component to be addressed in SBSP programs.

It has been shown that parents can directly (e.g. setting bedtimes) and indirectly (e.g. creating the physical sleep environments available to their children) influence children's sleep habits (Brand, Gerber, Hatzinger, Beck, & Holsboer-Trachsler, 2009). In fact, recent research has demonstrated an association between parent-set bedtimes and the tendency for adolescents to report earlier bedtimes, longer sleep duration, less fatigue and longer daytime wakefulness (Short et al., 2011). It can potentially be beneficial for SBSP programs to incorporate parents in the process of behaviour change by advocating their involvement in establishing sleep schedules and healthy sleep environments with their children. Further, it is necessary to assess and modulate the norms, behaviours, and social support systems contributing to the determination of adolescent sleep behaviour. Such work would allow the fostering of positive social influences on good adolescent sleep.

Self-efficacy (an element of the ASE model) is related to behavioural outcomes. Individuals who believe they can perform well on a task (demonstrating high levels of self-efficacy) perform better than their less confident counterparts (Motl et al., 2002). Individuals who believe they can competently make a behavioural change are more likely to form behavioural intentions, develop action plans, and be motivated to reach the set goals and maintain the desired outcome. Self-efficacy is an important bridge toward sustained behaviour change (De Vries & Mudde, 1998). A sense of self-efficacy is needed to motivate adolescents to obtain sufficient sleep. Even when adolescents begin to appreciate the importance of getting enough sleep, they may not feel confident that they can successfully make the necessary behavioural change given the massive shift in life schedules and priorities that such change

entails. For this reason, a proposed method by which adolescents may be motivated to embrace positive sleep behaviour, such as advancement of bedtime, (Cain et al., 2011) is via promotion of bedtime self-efficacy (Motl et al., 2002). Adolescents must develop the confidence necessary to go to bed earlier. It, therefore, may be useful to create SBSP programs that ensure adequate development of self-efficacy in terms of healthy sleep practices. Adolescent belief in personal efficacy in terms of going to bed earlier can be fostered via SBSP programs that promote (Bandura, 1977) 1) positive personal experiences after successful accomplishment of the behaviour; 2) vicarious experiences involving observation of behavioural accomplishment of *parents and/or other positive role models*, 3) social persuasion including encouragement of individual abilities and dissemination of tools assisting accomplishment of behavioural change; and 4) development of an emotional state in which positive mood is enhanced and negative feelings toward the necessary behaviour are reduced. Integration of these features into an SBSP program would require consideration and modulation of the behaviour of individuals who an adolescent finds to be influential, including family and friends. It is not enough to address adolescent sleep behaviour in the absence of consideration of social influences. In sum, motivations developed upon application of an ASE model could potentially translate into earlier adolescent bedtimes; such motivations should therefore be developed in the context of SBSP programs.

The major methodological limitations of SBSP programs include the lack of follow-up data to allow evaluating the sustainability of behaviour change and the failure to deliver the motivational interventions according to evidence-based protocols. Follow-ups in many studies (Cain et al., 2011; (De Sousa et al., 2007; Moseley & Gradisar, 2009) are only until 6 weeks post intervention. This does not allow evaluating the long term success of the intervention effects.

The other limitation is apparent in programs that apply tailored motivational strategies, such as MI on a group (i.e., a classroom of students) rather than one-on-one, which is not the standard protocol for such motivational approach (Britt, Hudson, & Blampied, 2004; Rollnick & Miller, 1995). Although recent efforts have attempted to apply MI at the group level, evidence for the empirical efficacy of this approach is limited. The creators of MI, Miller and Rollnick, suggest some ways by which to optimize group-based MI, but consider it inappropriate to address a group containing over 10 individuals who demonstrate very low levels of initial motivation; this may be the case for adolescent sleep. One-on-one programs may be more effective because the aim of MI, in the context of sleep, is for adolescents to acknowledge the discrepancy between their current sleep behaviour and their life goals and personal values, deciding autonomously to modify their sleep behaviour. Thus, an important feature of MI is that it is tailored to clients (Emmons & Rollnick, 2001) and, hence, conducted on an individual level. In this way, there are potential methodological inconsistencies in current SBSP motivational programs.

In addition to programs targeting adolescent sleep restriction in the school setting, there are other interventions designed specifically for adolescents with clinical sleep disturbances (i.e. delayed phase sleep syndrome; Gradisar et al., 2011) and sleep problems due to substance abuse (Bootzin & Stevens, 2005). They have been administered in group (Bootzin & Stevens, 2005) and individual (Gradisar et al., 2011) formats. These programs have shown success over the long term but because some of the content of the intervention targets the specific clinical problem, it is not known whether these programs are completely generalizable to normally developing adolescents. Nevertheless, these clinical studies remain relevant because they inform effective sleep promotion strategies and simultaneously reveal similar motivational barriers as SBSP programs as evidenced by low treatment adherence, failure to attend sessions, and treatment

drop-out. Therefore, identifying effective ways to motivate adolescents to modify their sleep behaviour may also be helpful in the design of clinical programs in order to decrease dropout rates and sustain benefits. In turn, effective motivational interventions can potentially benefit both interventions designed for normally developing and clinical populations.

Feasibility of School-Based Sleep Promotion Programs

The integration of school-based sleep promotion programs into existing school curricula should be considered from a feasibility standpoint. Studies in other areas such as obesity prevention and healthy eating have shown that if school administrators and teachers are open to the integration of school-based health promotion programs into existing school curricula, then it has the potential to become an acceptable and feasible method to reach adolescents (Story, 1999; Wiecha et al., 2004). The advantage of integrating sleep promotion programs into existing school curricula (e.g. the National Heart, Lung, and Blood Institute circadian biology curricula program (Boergers, 2015) is that it does not burden the school system in terms of logistical changes such as delaying school start times. If the importance of healthy sleep can be internalized by adolescents during high school, then it may have important implications for subsequent years where sleep patterns tend to become less consistent and students become more sleep deprived. It must be acknowledged, however, that integrating such curricula within existing school curricula would not be without challenges. First, areas of heath including eating and exercise are considered a priority in school systems and thus, sleep restriction as a health topic to be addressed in the school setting is not at a stage where it is widely accepted as an important preventative initiative. Second, some high schools may not be receptive to the idea of adding the content into their current lesson plans given their already busy schedules (Kwan, Petersen, Pine, & Borutta, 2005). Third, there are challenges associated with constructing sleep programs that complement existing school curricula, including creating the curriculum, rendering it age-

specific, and incorporating the new material into lesson plans according to school-system, country, or state-wide requirements. Fourth, as the goal of motivating adolescents is to advance their bedtime, it will also be a challenge to ensure that such programs are effective in addressing motivational barriers to improving sleep habits. Essentially, in addition to the school being receptive toward the program, it is a unique challenge for researchers to develop a school-based protocol that is effective in promoting behaviour change particularly for adolescents.

Insights for Future Research

The work reviewed above supports the notion that SBSP programs effectively increase sleep knowledge. However, some limitations of such programs are evident, and long-lasting prevention of adolescent sleep restriction may not be guaranteed. Specifically, the lack of sustained behavioural changes after completion of SBSP programs suggests that the field would benefit from the use of additional approaches toward promotion of healthy sleep in adolescents. Therefore, to complement the present techniques, we suggest that a third, individually tailored, approach to adolescent sleep promotion be considered. We further suggest that this can be rendered feasible by employing computerized means, discussed further below, that allow personalized health programs to be delivered at substantially less cost than that involved when face-to-face meetings are conducted. To the best of our knowledge, individualized health promotion has yet to be evaluated in the context of adolescent sleep.

Individualizing Healthy Sleep Promotion Programs

Tailored health promotion programs target individuals and the design thereof is based on characteristics specific to that person that can influence the behaviour of interest (Kreuter, Lezin, Kreuter, & Green, 2003). Individual differences are respected. This is of course not true of “one size fits all” programs such as the SBSP programs discussed above. Individualized programs are effective in situations where many factors can influence outcome variables, and where desired

outcomes are complex (Kreuter, Strecher, & Glassman, 1999). This is indeed true of sleep promotion programs; the desired complex outcome is advancement of the sleep schedule. The complexity is attributable to the fact that the interplay of factors that determine sleep practices is unique to each individual; and therefore, potentially large individual differences in beliefs regarding sleep and motivation to change current sleep habits exist. For example, it is possible that, for some adolescents, the promise of general health improvement would be an effective incentive to advance bedtime, whereas, for others, the benefits afforded by healthy sleep in terms of school performance would be more effective in creating an intention to change the sleep pattern. The realization or acknowledgment of earlier bedtimes chosen by some of their peers may be enough for certain adolescents to make an effort to modify their own sleep behaviour. It is important to consider individual differences and tailor intervention accordingly to deliver a successful health promotion program (Becker et al., 1977). A potential option is to offer individualized sleep promotion programs that optimally address the interplay of sleep determinants and other personal characteristics, thereby increasing sustained motivation.

Using Motivational Interviewing in Adolescent Sleep Promotion Programs

Evidence from studies seeking to influence other adolescent health behaviours (Suarez & Mullins, 2008), and in agreement with the tenets of the motivation-focused sleep promotion program developed by Cain et al., (2011) shows that MI is a promising technique when used to prevent adolescent sleep restriction. As described above, MI has been shown to be particularly successful when employed as a component of interventions for adolescents (Baer & Petersen, 2002). A review found that such tailored intervention in adolescence successfully improved behaviours relevant to dealing with diabetes, combating obesity by alteration of diet, ensuring dental hygiene, establishing reproductive health, and stopping smoking (Suarez & Mullins, 2008). The MI approach can potentially be applied to changing sleep behaviour.

The health behaviours that improved upon use of MI are similar to sleep restriction in that they adversely affect adolescent health but change is not immediately rewarding; the temptation to change is thus not high. For example, adolescents with diabetes must be highly motivated if they are to engage in appropriate exercise regimens; these can be easily ignored and the time "saved" can be spent on more immediately pleasurable activities. Channon and colleagues (Channon et al., 2007) conducted a randomized controlled trial in which 38 adolescents aged 14–17 years, diagnosed with type 1 diabetes, took part in MI sessions over a period of 6 months. A control group of 28 adolescents received standard support visits. At the end of the intervention, the experimental group had benefited from MI therapy as demonstrated by a higher level of glycemic control, improved psychological well-being and quality of life, and a more positive attitude to diabetes, compared to controls. All benefits were still evident 24 months later. MI had successfully improved healthy behaviour in adolescents; this required a shift in mentality from short-term focus on immediate gains to recognition of the long-term consequences of actions. Similarly, MI may be a particularly suitable interventional framework if problems with adolescent sleep are to be targeted; re-allocation of adolescent priorities is required.

Motivational interviewing may be especially effective if used in conjunction with the motivational factors identified in the ASE model. A key goal of MI is to enhance self-efficacy (Erickson, Gerstle, & Feldstein, 2005). The goal of MI is to enhance individual confidence in the ability to overcome personal challenges and to increase personally perceived competence. The individual must feel that he or she can successfully change the unhealthy behaviour. If adolescents develop confidence in their own ability to go to bed earlier, healthy change may result. It is possible that MI would help adolescents increase their motivation toward

improvement of sleep habits. Motivational interviewing promotes creation of positive attitudes toward healthy behaviour (i.e., sleep) by encouraging participants to recognize the pros and cons of creating change in their own lives (Baer & Petersen, 2002). Finally, MI programs often acknowledge the role played by societal influence; such programs incorporate a normative influence component whereby participants are provided with information on their own behaviour (i.e., sleep pattern) compared to that of a relevant group, such as same-sex peers (Walters & Neighbors, 2005). Social influence can also be targeted within individualized interventions such as MI by identifying social influences and dealing with such factors in a manner that enhances the readiness to improve behaviour. For example, adolescents reporting negative social pressure, such as being verbally persuaded by peers to stay out late, can be offered strategies minimizing such pressure. Conversely, adolescents reporting positive peer influence are provided with strategies allowing such influence (and behaviour) to be internalized. In summary, the goal is to target social influence in a manner that highlights and promotes the positive effects and minimizes the negative.

Motivational interviewing may be particularly suitable for use with adolescents for several reasons related to characteristics inherent to adolescent development. First, MI is a respectful and non-confrontational approach that acknowledges individual points of view and minimizes tensions (Baer & Petersen, 2002). This may be particularly valuable if adolescents are to be assisted, as they tend to challenge authority figures (Erickson et al., 2005). Second, MI supports individual personal ambitions rather than imposing a set of pre-arranged goals or demanding ideal behaviour (Miller & Rollnick, 2002). Use of MI would allow adolescents to personally decide to change sleep habits, thereby supporting the growth of personal identity and role that tends to occur during adolescence (Berg-Smith et al., 1999). Specifically, if adolescents become

autonomously driven to improve sleep habits, they are provided with an opportunity to develop personal identities and increase control over their own lives.

Motivational interviewing is a specifically suitable framework to address certain biological and environmental influences that affect the timing of adolescent sleep. These issues include a biological disposition to fall asleep at late hours, a low value placed on sleep in western cultures, extracurricular activities that may occur at night time, heavy homework loads, and social pressures to stay up late (Dahl & Lewin, 2002). Conversely, there is much pressure for adolescents to succeed academically, perform well during their extracurricular activities, and function appropriately in social settings. This would suggest that obtaining adequate sleep is also a priority. These conflicting issues can result in adolescents feeling highly ambivalent, that is, experiencing both positive and negative feelings regarding changing their sleep habits (Miller & Rollnick, 2002). A primary goal of MI is to resolve this ambivalence in order to foster a positive attitude toward behaviour change. In fact, MI has demonstrated to be especially effective with individuals who initially show high levels of ambivalence and low levels of motivation (Resnicow et al., 2001). The concept of addressing the pros and cons of behaviour change is known as a decisional balance (DiClemente & Velasquez, 2002), and plays a key role in MI. Decisional balance exercises within MI take into account social and cultural factors influencing an individual's perception of the behaviour and their evaluation of the pros and cons associated with behaviour change. It is recognized that an individual's motivational balance and ambivalence cannot be understood outside the social and cultural contexts of family, friends, and community (Miller & Rollnick, 2002). Given the above, MI may be a potentially promising intervention for improving adolescents' attitudes toward sleep, a complex health behaviour influenced by several cultural, societal and personal factors.

Delivering Programs Over the Internet

The existing feasibility challenge is to generate changes in sleep schedules on a large scale, that is, in a large proportion of the normally developing adolescent population. However, as reviewed above, it is necessary to work with each participant individually to address personal needs and characteristics. A suggested method to overcome this feasibility issue is via the implementation of tailored computerized sleep promotion programs that are typically internet-based. Such programs can adapt the content of health promotion materials to the specific characteristics of each participant (Rimer & Kreuter, 2006). Sleep-related motivational factors, including bedtime self-efficacy, sleep attitudes, and social influences on sleep, are ultimately relevant to individual readiness to change sleep behaviour. In other words, such considerations dictate the stage of change. Depending on such individual characteristics, and growth of the intention to change behaviour, individuals are provided with resources and tools that suit personal needs.

Such tailoring is accomplished via the use of algorithms or decision rules programmed to match a specific message with characteristics unique to each participant; these are assessed prior to commencement of the program (Ryan & Lauver, 2002). A review has shown that such internet-based programs exhibit promise when used to motivate behavioural changes in terms of quitting smoking, enhancing fruit and vegetable intake, and increasing physical activity (De Vries & Brug, 1999). The distinct feature of this mode of delivery is that it many individuals can be motivated via interactive tailored programming in a cost-effective manner (Kreuter et al., 1999). Such delivery overcomes the problems with time and cost that are associated with in-person meetings (Lustria, Cortese, Noar, & Glueckauf, 2009). The feasibility challenge

associated with targeting most of the adolescent population on an individual basis is removed. In this manner, tailored approaches to sleep promotion can be implemented on a broad scale.

In addition to the feasibility of such a delivery mode, this is a particularly appropriate manner by which to communicate with adolescents (Moreno, Ralston, & Grossman, 2009) due to its widespread accessibility (Sun et al., 2005), frequency of use on a regular basis (Lenhart, Purcell, Smith, & Zickuhr, 2011), and adolescents' perception of the Internet as a credible source for health information (Borzekowski & Rickert, 2001). For example, in an ethnically diverse sample of 2373 American high school students, more than 99% reported that they had access to the internet either at home or in school (Sun et al., 2005). Furthermore, the majority of adolescents report going on the internet on a daily basis and viewing the internet as a source of reliable information on health behaviour such as contraception use, nutrition, smoking, dieting, and exercising (Borzekowski & Rickert, 2001; Lenhart et al., 2011). Given that adolescents seek out information on the internet and that websites can be designed in such a way that they provide health information in an engaging and interactive manner, it may be particularly effective to deliver sleep promotion programs to adolescents via the internet. In addition, online sleep promotion initiatives would allow teenagers in rural and remote locations to have access to a service that would otherwise be difficult to access (Lenhart et al., 2011; Woodruff, Edwards, Conway, & Elliott, 2001). In fact, research has demonstrated the acceptability and positive impact of internet health initiatives (e.g. virtual chat rooms) for adolescents in rural communities (Woodruff et al., 2001). The internet, being accessible, familiar, reliable, and interactive is potentially an invaluable resource for adolescents while at the same time would add to the feasibility of the approach as it allows to target many adolescents simultaneously.

Recently, computer-tailored interventions improving adolescent health behaviour have incorporated MI principles. Buller and colleagues (Buller et al., 2008) developed an internet-based program aimed at preventing and discontinuing smoking in 10- to 16-year-old adolescent students enrolled in Australian and American high schools. The online content embraced MI principles. The language was non-judgmental, but sought to highlight the inconsistencies evident when smoking was compared with an adolescent's personal values. The program was tailored to the smoking history of each adolescent. In comparison with students in control schools that received standard health education, those in schools in which the intervention was deployed reported lower levels of smoking in the past month and a higher level of intention to not smoke in future. Thus, initial efforts to integrate MI principles into computer-tailored programs have been promising. Although internet based interventions for adolescent insomnia are already underway (De Bruin, Meijer, Oort, & Bgels, 2011), to our knowledge, they have not yet been implemented according to a MI framework and with normally developing adolescents.

An important issue when addressing MI in the context of adolescent sleep is that it is likely that an adolescent may not recognize the negative effects of sleep restriction. This can be compounded by the possibility that poor sleep behaviour is actually consistent with an adolescent's personal values. The key to applying MI in this case is to explore how another life domain that is valued by the adolescent, including but not limited to, academics, personality, athletic performance, or physical appearance, can be improved by obtaining more sleep. Essentially, going to bed earlier does not have reinforcing value but the positive consequences of more sleep will. Every adolescent will have a different motivation for improving their sleep habits, and the potential advantage of individualized programs like internet-based MI is that they can cater to the different values and goals of each adolescent while accessing a substantial

portion of the adolescent population. This tailored approach is expected to decrease ambivalence, increase motivation and develop subsequent adherence to the intervention. Furthermore, the resources required to conduct such a sleep promotion program would be minimized if such programs can be disseminated through Internet-based methods.

Summary

The goal of the present review was to investigate the effectiveness and feasibility of efforts to reduce adolescent sleep restriction. The evidence shows that SBSP programs effectively increase sleep knowledge but do not result in sustained sleep behavioural change. This is potentially attributable to the absence of consideration of motivational elements including a sense of self-efficacy, a positive attitude, and the influence of society. We suggest that individually tailored sleep promotion programs involving MI may be more effective. Such programs acknowledge that individual levels of motivation vary, and are tailored accordingly. Finally, it is suggested that internet-based dissemination of program information may be particularly valuable. Many adolescents could be simultaneously assisted, with tailoring of program information to individual needs and characteristics.

Practice Points:

1. Sleep restriction is prevalent amongst adolescents and has negative implications in terms of general well-being.
2. School-based sleep promotion programs effectively improve sleep knowledge.
3. A possible limitation of school-based sleep promotion programs is that such programs do not adequately consider the importance of using motivational strategies.
4. Individually tailored health promotion programs (i.e., involving motivational interviewing) have been successful when used to modify other adolescent health-related behaviours including those involving reproductive health, and smoking.
5. Investigation of individually tailored adolescent sleep promotion programs is warranted.

Research Agenda:

1. Additional work is needed to dissect the motivational elements (i.e., attitudes, social influences, and the sense of self-efficacy) involved in behavioural change, so that it is possible to determine the respective importance of these features in the context of adolescent sleep.
2. Future studies should examine the effectiveness of individually tailored interventions (i.e., motivational interviewing) in promoting healthy sleep in adolescence.
3. The effectiveness of internet-based sleep promotion programs targeting large groups of adolescents should be evaluated.
4. Sleep health education should commence in elementary school. This may prevent the development of negative sleep behaviour in adolescence, an age characterized by psychosocial and biological changes that render individuals particularly prone to sleeping too little.

Transition from Chapter 1 to Chapter 2

The goal of the literature review was to review and synthesize the methodology and effectiveness of previous school-based sleep promotion interventions for adolescents in order to offer insights for future research in the field. Several conclusions were reached: 1) few sleep interventions exist for adolescents, 2) existing programs are successful in enhancing adolescent knowledge about sleep, 3) the programs that evaluate sleep behaviour in addition to knowledge outcomes find insignificant improvements in sleep behaviour, and 4) interventions may be unsuccessful in improving sleep behaviour because they do not enhance adolescents' motivation but mostly focus on increasing sleep-related knowledge. I recommended a novel individualized approach to adolescent sleep promotion programs whereby the non-confrontational style of Motivational Interviewing is used in order to foster autonomous motivation on the part of the adolescent. The attitudes-social-influence-self-efficacy (ASE) model (De Vries & Mudde, 1998) was postulated as a suitable theoretical model on which to base the development of a motivational sleep promotion program as it contains variables that are relevant to adolescent sleep and that, if manipulated in an intervention, may be instrumental in translating increased sleep knowledge into actual behavioural changes. In order to further contribute to the findings described in the review manuscript, Study 1 sought to investigate which variables might be important to target in an intervention in order to motivate behaviour change. Specifically, Study 1applied the Integrated Change Model (which contains the ASE model) to adolescent sleep in order to investigate awareness and motivational variables that predict intention to go to bed earlier. Study 1 was a preparatory step to create an evidenced-based sleep promotion program aimed at manipulating variables found to be relevant in such a way that it enhances the likelihood of adolescents to go to bed earlier.

Chapter 2

What Motivational and Awareness Variables are Associated with Adolescents' Intentions to Go to Bed Earlier: A Pre-Intervention Study

Cassoff, J., Gruber, R., Sadikaj, G., Rushani, F., & Knäuper, B. (2014). What motivational and awareness variables are associated with adolescents' intentions to go to bed earlier? *Current Psychology*, *33*(2), 113-129.

Abstract

The aim of the study was to test the motivation and awareness variables of the I-change model as predictors of adolescent intention to go to bed earlier. Questionnaires regarding sleep related motivational and awareness variables were administered to 127 sleep restricted (determined by actigraphy) high school students (12–17 years old). The motivational variables positive attitudes towards sleep and parents setting wake time predicted higher intentions to go bed earlier. The awareness variable sleep related cues to action also predicted higher intentions to advance bedtime. Positive attitudes towards sleep partially mediated the effect of sleep related cues to action on intention to advance bedtime. Future sleep promotion programs should train adolescents to detect cues to go to bed earlier to increase their intentions to go to bed earlier. Adolescents should be assisted to develop positive attitudes towards sleep as to enhance their autonomous motivation to advance their bedtime.

Introduction

It is a growing concern in modern society that adolescents do not sleep enough (e.g., obtain less than 8 hours of sleep (NSF, 2006; Roberts, Roberts, & Xing, 2010). The most common reason for insufficient sleep duration is that adolescents go to sleep at late hours on school nights and are forced to wake up for school at a time that terminates their sleep prematurely (Carskadon, 2011). Adolescents go to bed late due to social and extra-curricular activities occurring late in the evening (Roberts et al., 2010), technology distractions before bedtime (Calamaro, Mason, & Ratcliffe, 2009) and delayed circadian timing associated with pubertal development (Carskadon et al., 1993). Insufficient sleep has negative effects on physical health (Lowry et al., 2012), cognition (Gruber, Wiebe, Wells, Cassoff, & Monson, 2010), emotions (Dahl, 1999), and increases the risk of injuries (Pizza et al., 2010). Considering that insufficient sleep in adolescence has such far-reaching consequences, interventions aimed at advancing adolescent bedtime (i.e. shifting bedtime backwards) to prevent insufficient sleep duration are needed.

Several researchers have created programs to help adolescents advance their bedtime. Most of these programs aim to enhance sleep knowledge or offer cognitive-behavioural strategies that facilitate sleep behaviour change (Cortesi et al., 2004). These interventions have been found to be effective in improving sleep knowledge with limited effects on sleep behaviour (e.g. adopting earlier bedtimes). The interventions for which sleep behaviour change was assessed found no effects on sleep behaviour. Researchers have suggested that this lack of behavioural change could be due to insufficient motivation on the part of the adolescent to go to bed earlier (Cain et al., 2011; Cassoff, Knäuper, Michaelsen, & Gruber, 2013). Motivation may thus be an important factor to address in studies on adolescent sleep.

The Integrated Change Model

The current study seeks to investigate motivational and awareness predictors of the intention to advance bedtime. The I-change model (Holm, Kremers, & De Vries, 2003), which was originally conceptualized for adolescent smoking behaviours, was adapted to bedtime variables for its use as a theoretical framework in the current study. The I-change model is rooted in the motivation-focused Attitude-Social Influence-Self-efficacy model (ASE; De Vries & Mudde, 1998)). The ASE model asserts that health behaviour is predicted by an intention to change, which is determined by motivational elements including attitudes (De Vries et al., 1988), social influences (De Vries et al., 1995), and self-efficacy (Bandura, 2006). The ASE model is similar to the TPB, which states that one's behavioural intention depends on one's attitude, social norms and self-efficacy regarding the behaviour (Ajzen & Madden, 1986; Fishbein & Ajzen, 1975) except that there is a stronger focus on social influences in the ASE model. This latter insight concerning social influences is derived from Social Learning Theory (SLT) and other research on adolescent behaviour change, which propose that motivation is also a result of social modeling (Bandura, 1986) and pressure (Evans et al., 1978). The I-change model includes awareness variables as precursors to motivation to advance bedtime and secondary predictors of intention to advance bedtime. The awareness variables are derived from the Health Belief Model (HBM), which stresses the importance of individuals' perceived benefit and threat, self-efficacy, and other moderating variables in predicting intention to change (Janz & Becker, 1984). The transtheoretical model (TTM) of change describes an individuals' readiness to perform a health behaviour (Prochaska & DiClemente, 1983) and is represented by the intention outcome in the I-change model as precontemplation, contemplation and preparation stages of change. In the present research, the aforementioned stages of the TTM will be used to assess the outcome

variable, which is intention to advance bedtime. In terms of the direction of predicted effects, the I-change model states that a higher intention to change a behaviour leads to more behaviour change. More positive attitudes and social influences, and greater self-efficacy (i.e. the motivational factors) determine higher intentions to change a behaviour. More knowledge, risk perception and cues to action (i.e. the awareness factors) lead to the development of the motivational factors. The validity of the I-change model has been supported in the context of adolescent health behaviours such as smoking (Riemsma et al., 2003)and sunscreen use (De Vries, Mesters, Van't Riet, Willems, & Reubsaet, 2006).

Adolescent Awareness About Sleep

The awareness variables of the I-change model (adapted to adolescent sleep) are *sleep knowledge* (i.e., general sleep knowledge), *sleep risk perception* (i.e., risks associated with not sleeping enough) and *cues to go to bed* (i.e., cues coming from the body (e.g., yawning) or the environment (e.g., siblings going to bed) that signal that it is time to go to bed). Although sleep knowledge and risk perception are insufficient in determining behaviour change, they are an important first step for driving motivation such that adolescents must understand the ideal behaviour, in order to identify the discrepancy between this ideal behaviour and their own. Indeed, increased knowledge and risk perception are associated with enhanced motivation to improve sleep habits (Cain et al., 2011). Cues to action have yet to be investigated in the context of adolescent sleep but are related to the intention to adopt other healthy behaviours in adolescence (Elder, Ayala, & Harris, 1999). These awareness variables may be instrumental in driving motivation and thus are relevant for the current study because it would be valuable to understand what type of awareness strategies a sleep promotion program should use in order to enhance motivation to go to bed earlier.

Adolescent Motivation to Sleep

The motivational variables from the I-change model are *positive attitudes towards sleep* (i.e., affective responses to advancing bedtime), *social influences regarding sleep* (i.e., parents setting bedtime, parents waking up the child in the morning and peer social influence related to sleep) and *self-efficacy* (i.e. beliefs in one's capability to attain goals, such as advancing bedtime)**.** Developing positive attitudes towards sleep is an important aim of a current motivational sleep promotion program for adolescents (Cain et al., 2011). Parental set bedtime (Short et al., 2011) and peer influence (Mednick et al., 2010) play a significant role in determining adolescent sleep behaviour. It has been suggested that the lack of activities to promote self-efficacy in existing sleep promotion programs may account for their lack of efficacy in motivating behaviour change (Cain et al., 2011). Despite the potential value of these motivational variables, they have yet to be evaluated together in a theoretical model and as predictors of the intention to advance bedtime. Understanding the motivational predictors of the intention to advance bedtime will allow to create sleep intervention activities that assess and modulate these predictors (Michie, Johnston, Francis, Hardeman, & Eccles, 2008) such that the intention to go to bed earlier increases and, by consequence, adolescents sleep more.

Adolescent Intention to Advance Bedtime

The outcome variable in the current study is the intention to go to bed earlier. As found in other adolescent health domains (e.g. healthy eating; Baker, Little, & Brownell, 2003, physical activity; Araújo-Soares, McIntyre, & Sniehotta, 2009, and active school travel; Murtagh, Rowe, Elliott, McMinn, & Nelson, 2012), the intention to change behaviour is a key predictor of future behavioural change (Ajzen, 1991; Orbell & Sheeran, 2000). A meta-analysis (Sheeran, 2002) with 422 correlational studies examining the intention-behaviour link found that intentions

explained 28% of the variance in behaviour. Further, a meta-analysis (Webb and Sheeran, 2006) with 47 experimental studies investigating the intention-behaviour link concluded that a medium to large change in intention predicted a small to medium change in behaviour. It is worthwhile to investigate awareness and motivational predictors of the intention to go to bed earlier, a prerequisite to behaviour change, in order to effectively design evidence-based interventions that aim to enhance such predictors, and by consequence, intention to advance bedtime. According to the I-change model and consistent with previous motivational sleep promotion programs (Cain et al., 2011), intention is measured by assessing the stage of change of the individual (i.e., precontemplation, contemplation, preparation, action and maintenance) as proposed by the TTM (Prochaska, Norcross, & DiClemente, 2005).

The Present Research

The primary goal of the current study was to apply the awareness and motivational components of the I-change model in the context of predicting adolescent bedtime intentions. It is expected that the awareness variables (i.e. knowledge, risk perception, and cues to action) will predict the motivation variables and the intention to advance bedtime, the motivational variables (i.e. attitudes, social influences, and self-efficacy) will predict the intention to advance bedtime, and the effect of the awareness variables on intention to advance bedtime will be mediated by the motivation variables.

Method

Participants

One hundred and sixty adolescents were recruited from a high school in Canada. Ethics approval was obtained from the Research Ethics Board of the first author's home university. As compensation, students were provided with sleep hygiene information sheets through their school's online portal. Participants completed screening questions that were embedded in the

questionnaire and their data were excluded if they scored above a threshold indicating a potential mental, medical, or sleep condition that could interfere with sleep. Mental disorders were screened with the Global Appraisal of Individual Needs Short Screener (Dennis et al., 2008) and participants were excluded if they had a score higher than five on the externalizing and internalizing subscales. Participants were also excluded if they reported taking medication that could interfere with sleep and/or were diagnosed with medical disorders such as asthma, pain disorders, skin conditions, etc. Sleep disorders were screened with the Pittsburgh Sleepiness Quality Index (Buysse et al., 1989) and participants were excluded if they had a global score higher than five on the measure. Socioeconomic status was assessed with the Family Affluent Scale II (Boyce et al., 2006). Participants' mean affluence score was 7.79, which is within in the highly affluent range (i.e. 6-9) according to the scoring parameters of the questionnaire. Of the 160 participants who initiated the questionnaire, 19 were excluded and 14 did not finish the questionnaire. The sample used in the analysis consisted of 127 adolescents, 63 females and 64 males, whose ages ranged from 12 to 17, with a mean of 14.79 (SD = 1.43). The randomly drawn subsample of students who participated in the actigraphy portion of the study (n = 35) had a mean age of 14.45 (SD = 1.43).

Procedure

Presentations were conducted at the school to inform parents and students about the study. Parents signed consent forms or provided consent online through the school's online portal. All predictor and criterion variables were assessed via online questionnaires completed during a class period lasting 70 minutes. Sleep start and end time were assessed via self-report. To examine whether the self-report data were valid, actigraphy data were collected from a subsample of students. Actigraphy is an objective measure of sleep that assesses sleep timing

according to body movements (Littner et al., 2003). High correlations between the actigraphy and self-report data indicated that the self-report data were valid and could be used in subsequent analyses as the outcome variable. Thirty-five students were randomly selected from the main sample to participate in the actigraphy portion of the study. They were asked to wear the actiwatches (AW-64 series; Mini-Mitter Co., Inc., Bend, OR) and complete a sleep diary for seven consecutive nights.

Measures

The data reported herein are part of a larger study that in addition to the motivation and awareness predictors of intention to advance bedtime addressed in the current research also investigated more distal variables of the I-change model. These distal variables are not directly related to sleep nor relevant for the development of a sleep intervention and thus are not included in the current paper. All materials are available from the authors upon request**.**

Criterion Variables

Intention to advance bedtime. The criterion variable, intention to advance bedtime, was assessed with three measures used in previous interventions based on the TTM. The first measure was a sleep behaviour intention questionnaire evaluating readiness to change sleep habits (Cain et al., 2011). Participants were asked to choose between six responses (*I don't plan to (1), I want to (2), I need to (3), I will (4), I tried (5), I already do (6)* for five items regarding sleep habits related to going to bed (e.g. "Avoid going to sleep on weekends more than 2 hours past my normal school-day bedtime time"). A single indicator was created by calculating a mean score. The second measure, a readiness ruler (LaBrie, Quinlan, Schiffman, & Earleywine, 2005) adapted to sleep was completed such that participants indicated how they presently felt about going to bed earlier on a 10-point ruler. The third measure was the multi-dimensional 12-item

Readiness to Change Questionnaire (RTCQ; Rollnick, Heather, Gold, & Hall, 1992) adapted to sleep. Precontemplation, contemplation, and action were each represented by four items measured on a 5-point scale. A single indicator was created by adding the contemplation, action and reverse coded precontemplation items (Labrie et al., 2005). To examine the convergence of these three measures, a confirmatory factor analysis (CFA) was conducted. The three measures loaded significantly on one latent factor. The fit of the model was excellent (CFI = 1.00; RSMEA = .00; SRMR = .00). Standardized loadings of each of the measures onto the latent variable (i.e., intention to advance bedtime) ranged from .62 to .73 and were statistically significant. Therefore, in subsequent analyses, the dependent variable, intention to advance bedtime, was constructed as a latent variable defined by the three indicators. The use of the latent variable has the advantage of increasing power by controlling for measurement error.

Sleep duration. Sleep duration on school nights was derived by the times that the adolescent reported in the questionnaire going into bed and waking up on a typical weekday.

Awareness Predictors

Please see Table I for operational definitions, sample items and internal reliability of the questionnaires for the predictor variables.

Knowledge and risk perception. These variables were assessed by items from a true or false adolescent sleep quiz (Cain et al., 2011) and items from an adolescent sleep knowledge test (Bakotić et al., 2009).

Cues to action. Cues to action were measured by a 6-item questionnaire asking participants to indicate how often they have noticed internal and/or external triggers to advance bedtime within the past six months. Questionnaire items were adapted to sleep content from a

cues to action questionnaire pertaining to another health behaviour (Umeh & Rogan-Gibson, 2001).

Motivational Predictors

Attitudes. Attitudes were measured by eight items from a modified version of an attitude questionnaire pertaining to another health behaviour (Holm et al., 2003) as well as items that we developed specifically for this study.

Peer influence. Modeled after a questionnaire of another health behaviour (Holm et al., 2003), social norms were assessed by asking participants the extent to which their friends would think that they should modify their bedtime to an earlier/later time. Social pressure was assessed by asking participants how often they had felt pressure from their peers to change their bedtime to an earlier and/or later time.

Parental influence. Parental influence was defined as the frequency in which parents set their child's bedtime and wake time on wake days. Parental influence on adolescent bedtime and wake time were each measured by one question. The questions were based on items from the School Sleep Habits Questionnaire (Wolfson & Carskadon, 1998).

Self-efficacy. Self-efficacy was assessed by the 10-item General Self-efficacy Scale (Luszczynska, Gibbons, Piko, & Tekozel, 2004). The scale measures the overall confidence in the ability to cope a wide range of novel situations.

Results

Descriptive Statistics

Table I provides the means and standard deviations of bedtime, wake time and sleep duration assessed through actigraphy and the questionnaire for the subsample that participated in the actigraphy portion of the study. Table II also presents the Pearson correlations between actigraphy and questionnaire data. Actigraphy data were strongly correlated with their respective

questionnaire data. Thus the questionnaire's sleep data can be considered valid and usable for the subsequent analyses. Based on the questionnaire data of all participants, 98% percent of participants in the current study slept too little (i.e., less than 9.2 hours (Carskadon et al., 1980), with only 3 participants obtaining over 9 hours of sleep on a school night. Table II presents the descriptive statistics and bivariate correlations of all key variables.

Data Analysis

Structural equation modeling was used to examine our proposed model of determinants of the intention to advance bedtime (see Figure 1). To examine whether motivation variables mediated the effect of awareness variables on the intention to advance bedtime, additional regression paths from the awareness variable (i.e. cues to action) to motivational variables were constructed. Lastly, covariances among predictor variables in each group were estimated. Analyses were conducted using the Mplus software package (Version 7; Muthen & Muthen, 1998–2012) and the Maximum Likelihood Estimator with standard errors that are robust to non-normality of observations and to missing data. Fit of the model was examined using the root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), and comparative fit index (CFI). RMSEA and SRMR values of .08 or less (Hu & Bentler, 1999) and CFI values over .90 (Hoyle & Panter, 1995) indicate good model fit. The indirect effects were examined using the MODEL INDIRECT command of Mplus. To minimize model identification issues and enhance parsimony, model building proceeded as follows (Groenland & Stalpers, 2012): First, we examined separate models that included either only (a) awarenesss variables or (b) motivation variables. Non-significant predictors were deleted from the subsequent analyses based also on the evidence of small and non-significant correlations with the other variables in the model (see Table III). Based on these criteria, risk perception and self-efficacy were deleted.

The final model included parents setting bedtime, parents waking up the child, positive attitudes towards sleep, and peer influence on bedtime as direct predictors and sleep-related cues to action as an indirect predictor of the intention to advance bedtime (Figure 2).

Modeling the Relationship Between Predictor Variables and Intention to Advance Bedtime

Results from the model suggested that a significant proportion ($R^2 = .49$, $p < .001$) of the variance in the dependent variable (intention to advance bedtime) was accounted for by the other variables in the model. As expected, the motivation variables i.e., *parents waking up the child* and *positive attitudes towards sleep* were positively associated with the intention to advance bedtime (see Table IV for unstandardized and standardized path coefficients, *p*-values and fit indices). Participants who reported more positive attitudes towards sleep, compared to participants with less positive attitudes, also reported an increased intention to advance bedtime. In addition, participants who reported greater frequency of parents waking them up in the morning, compared to participants who reported lower frequency of parents waking them up in the morning, also reported an increased intention to go to bed earlier. There were no significant associations between peer influence and parents' setting bedtime and the intention to advance bedtime. As anticipated, the awareness variable *cues to action* was positively associated with the motivational variables *positive attitudes towards sleep* and *peer influence on bedtime* (see Table IV). Relative to participants reporting lower levels of cues to action, participants who reported higher levels of cues to action also reported (1) increased positive attitudes towards sleep and (2) increased peer influence on bedtime. Surprisingly, sleep-related cues to action were negatively related to parents setting bedtime, such that participants reporting higher levels of cues to action, compared to participants reporting lower cues to action, also reported a lower frequency of their parents setting bedtime. Further, the awareness variable, cues to action, directly predicted

stronger intentions to go to bed earlier. There was no association between the motivational variable *parents waking up the child* and the awareness variable *cues to action.*

The motivation variable *positive attitudes towards sleep* was a partial mediator of the effect of the cues to action on the intention to advance bedtime (see Table IV). Cues to action predicted an increase in positive attitudes towards sleep, which in turn resulted in stronger intentions to go to bed earlier (β = .15, z = 2.66, p < .01; 95% CI = .05 to .28).

Discussion

Our sample was comparable to the sample described in the 2006 National Sleep Foundation poll (NSF, 2006) such that the majority of participants in the current study do not sleep enough. In the current study, we evaluated whether sleep-related awareness and motivation variables of the I-change model are predictors of the intention to go to bed earlier in order to inform the development of an adolescent sleep promotion program. The results for the most part were consistent with our predictions: The awareness variable *cues to action* predicted the intention to go to bed earlier. The motivation variables *parents waking up the child* and *positive attitudes towards sleep* also predicted the intention to go to bed earlier. Additionally, the indirect effects supported our hypothesis that motivation variables (i.e., parents waking up the child and positive attitudes towards sleep) were partial mediators of the relationship between the awareness variable *sleep-related cues to action* and the outcome variable *intention to go to bed earlier.*

This is the first study to examine predictors of the intention to advance bedtime in a sample of typically developing adolescents in order to inform the development of a sleep promotion program. The significance of the sleep-related cues to action findings is two-fold. First, sleep-related cues to action directly predicted stronger intention to go to bed earlier. This is consistent with other research findings demonstrating that adolescents who report experiencing external cues to action also report stronger intentions to carry out certain behaviours such as returning for

Papanicolaou smear screening (Kahn, Goodman, Slap, Huang, & Emans, 2001) and wearing a bicycle helmet (Lajunen & Räsänen, 2004). As such, it may be worthwhile for sleep promotion programs to call attention to adolescents' external cues to go to bed earlier as it seems to be that attending to these cues influences sleep behaviour changes. Sleep promotion programs may also benefit from training adolescents to detect their internal cues to go to bed earlier. This can be possibly accomplished through mindfulness activities such as body scans (Thompson & Gauntlett-Gilbert, 2008) that train adolescents to become more in tune with bodily signals (e.g., burning eyes), which may allow internal signals of tiredness to become more salient. Indeed, mindfulness-based approaches have been effective in elongating sleep duration in adolescents with substance use disorders (Britton et al., 2010). Mindfulness based approaches may also be an effective strategy with normally developing adolescents who may benefit from becoming better able at recognizing their body's signs of tiredness.

Second, cues to action predicted more positive attitudes towards sleep, which in turn predicted stronger intentions to go to bed earlier. Perhaps the self-regulated recognition on the part of the adolescent that his/her body is tired is instrumental in foreseeing the personal advantages associated with going to bed earlier (i.e., developing positive attitudes towards sleep), which in turn results in an increased desire to go to bed earlier. Indeed, research has shown that positive attitudes and recognizing cues to action are positively associated with each other and are both related to greater intention to engage in healthy reproductive behaviours (Wang, Charron-Prochownik, Sereika, Siminerio, & Kim, 2006)**.**

The importance of recognizing cues to action is further supported by the current study's finding that adolescents who perceived cues to go to bed were woken up by their parents in the morning, which in turn resulted in stronger intentions to go to bed earlier. Perhaps adolescents

who are cognizant of feeling tired seek out the help of their parents to wake them up in the morning and thus are motivated to change their sleep behaviour in order to prevent being tired in future mornings. The interaction between the delayed circadian rhythm of adolescents and the need for adolescents to wake up at a time that allows them to arrive at school on time results in adolescents waking up at a time that terminates their sleep prematurely (Carskadon, 2011). Thus, it is possible that the time at which a parent is waking up his/her child in the morning is the point in the day where the adolescent's internal signals of tiredness are strongest. This experience of fatigue may increase the adolescent's intention to go to bed earlier. Future research should investigate the potential reason for why recognizing cues to action is effective in improving attitudes towards sleep, maximizing parental influence on waking their child during the week and leading to intention to advance bedtime.

The finding that the variable *positive attitudes towards sleep* was a direct predictor of the intention to advance bedtime is consistent with other health behaviour studies demonstrating that adolescents' positive attitudes towards behaviours such as healthy eating (Pedersen, Grønhøj, & Bech-Larsen, 2012) and exercise (Graham, Sirard, & Neumark-Sztainer, 2011) predicted the intention to improve each of the behaviours. In fact, a recent motivational intervention was successful in increasing adolescent motivation to obtain more sleep by enhancing beliefs regarding the importance of sleep (Cain, 2012). The current study also supports recent research advocating a shift from only educating adolescents about sleep to also motivating them by enhancing their positive attitudes towards sleep (Cain et al., 2011; (Cassoff et al., 2013).

The current study found that parents setting bedtime was not associated with intentions to go to bed earlier. This finding is inconsistent with previous research demonstrating the positive consequences of parents setting bedtime on advancing bedtime, prolonging sleep duration and

reducing daytime tiredness in their children (Short et al., 2011). One explanation for this inconsistency is that although parents setting bedtime may result in adolescents going to bed earlier, these behavioural changes may not be occurring in a way that is autonomous on the part of the adolescent and thus he/she does not feel a personal intention to change. This postulation is supported by research investigating educational outcomes suggesting that adolescents who feel autonomous rather than externally regulated to perform well in school demonstrate positive attitudes towards and feel personally invested in the behaviour (Deci, Vallerand, Pelletier, & Ryan, 1991). Indeed, the current study showed that cues to action predicted less parental bedtime setting. This effect can be interpreted as showing that adolescents who are able to autonomously recognize internal and external signs to go to bed do not need their parents to tell them to go to bed, i.e. they show a self-determined willingness to go to bed earlier. Together, the findings of the current study along with research examining novel approaches to adolescent sleep promotion (Cassoff et al., 2013) suggest that the ideal goal of adolescent sleep promotion programs should be for the adolescent to feel supported by his/her parents to go to bed earlier but in ways that the adolescent feels autonomously motivated to change, thereby experiencing a personal drive to make a sleep behaviour change.

In sum, adolescents who are able to identify internal and external cues to action report positive attitudes towards sleep and have parents who wake them up in the morning seem to have greater intentions to advance bedtime. Sleep promotion programs should aim to enhance adolescents' intention to advance their bedtime in a way that promotes their autonomous motivation to advance bedtime.

This was the first study to apply a theoretical model to examine adolescent predictors of the intention to go to bed earlier. Furthermore, objective data (actigraphy) were used to validate

the self-report sleep data. Consistent with other research concluding that it is important to assess adolescent self-reported sleep estimates (Short, Gradisar, Lack, Wright, & Chatbum, 2013), the current study demonstrates that indeed self-report measures of sleep may a valid tool to assess sleep in the normally developing adolescent population. Despite these theoretical and methodological strengths, several limitations should be noted. First, although structural equation modeling was performed, the study was cross-sectional and thus the results do not provide inferences about temporal sequence. Second, the sample was recruited from a private high school suggesting that our findings may not be generalizable to adolescents of a lower socioeconomic status. For example, adolescents from lower SES communities report later bedtimes than their higher SES counterparts. Further, students from private high schools may experience more pressure by their parents to perform well academically, more have opportunities to participate in extra-curricular activities that occur on weekday evenings, and may have more electronic devices available in the home, which can concurrently impact their sleep habits in a negative manner. The different social and cultural circumstances presented to adolescents suggest that the MTSM program may not adequately address the needs of adolescents from high schools in the public sector. Third, the knowledge measure utilized in the current study had low internal reliability and thus the variable could not be investigated as potential predictor of the intention to advance bedtime. Fourth, the degree to which adolescents perceived pressure from their peers to change their bedtime was measured. However, it was not specifically assessed whether peers pressured the adolescent to go to bed earlier or later, i.e. the direction of the peer pressure was not assessed, thereby introducing a measurement limitation. Despite these limitations, the present study provides valuable information for the development of adolescent sleep promotion programs by determining significant predictors of the intention to go to bed earlier.

Table I

Means and Standard Deviations for Key Sleep Variables and Pearson Correlations Between Actigraphy and Questionnaire Sleep Variables (n = 35)

	Actigraphy (sleep time)	**Self Report (time in bed)**	**Correlation between questionnaire and actigraphy**
Bedtime (Mean (*SD*))	11:07 (0:47)	10:49 (0:59)	.71**
Wake time (Mean (*SD*))	7:00 (0:35)	6:58 (0:33)	.77**
Total Sleep Time (hours)	7.87 (0.73)	8.14 (0.93)	.63**

** Correlation is significant at the .01 level

Note. Self-reported sleep duration was calculated as a function of bedtime and wake time responses. The data above represents sleep on weekdays. Bedtime was calculated as per the time the participant fell asleep in the actigraphy analysis.

Table II
Descriptive Statistics and Pearson Correlations of Key Variables

	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**
1. Behavioural intention												
2. Readiness to change	.19*											
3. Readiness ruler	.24**	.45**										
4. Parents setting bedtime	.01	-.24**	-.19*									
5. Parents waking up child	.23*	.10	.10	.08								
6. Attitudes towards sleep	.27**	.44**	.38**	-.28**	.01							
7. Peer social influence	.11	.27**	.18*	-.12	-.001	.21*						
8. Cues to action	.04	.40**	.17	-.19*	.06	.25**	.37**					
9. Sleep duration	.22*	-.25**	-.05	.32**	.13	.04	-.17	-.37**				
10. Knowledge	-.02	.002	.07	.12	-.14	.08	.02	-.02	-.05			
11. Risk Perception	.05	.127	.15	-.13	-.001	.34**	.15	.12	-.06	.14		
12. Self-efficacy	.10	.001	.13	-.14	-.11	.10	-.04	.03	-.18	-.10	-.01	
Mean	3.20	16.46	4.94	1.66	2.63	2.97	2.20	2.18	7.86	.51	.90	3.03
SD	1.02	6.86	2.14	.88	.82	.45	1.26	.57	.98	.26	.18	.48
Range	4.6	34	10	3	3	2.5	5	2.5	5	1	1	2.4

Note. *$p < .05$; **$p < .01$

Table III

Operational definitions, sample items and internal reliability of the questionnaires for the predictor variables.

Predictor Variables	**Operational Definition**	**Sample Item**	**Internal Reliability**
Awareness predictor variables			
Knowledge	Awareness of sleep information relating to bedtime.	Most teenagers need at least nine hours of sleep each night.	*Kuder–Richardson* (*KR21*) *coefficient* = .12
Risk perception	Perceived risks associated with delayed bedtimes.	Getting one hour less sleep per night than I need will have an effect on my daytime performance.	*Kuder–Richardson* (*KR21*) *coefficient* = .57
Cues to action	Internal and external cues to advance bedtime in adolescents.	How often have you noticed symptoms of lack of sleep (e.g.: tiredness, lack of concentration, poor mood) in the past six months?	α = .68
Motivational predictor variables			
Attitudes	Beliefs regarding the importance of advancing bedtime.	Please state how much you agree with the following statement: Sleep is a priority in my life.	α = .68
Peer influence	Perceived social norms and social pressure.	Do your friends go to bed at a different time than you (either earlier or later)?	α = .67

Parental influence	Frequency in which parents set participant's bedtime and wake time on wake days.	How often is the following option the reason you go to bed on school days? My parents have set my bedtime.	N/A
Self-efficacy	Perceived control over daily activities.	It's easy for me to stick to my aims and accomplish my goals.	$\alpha = .86$

Table IV

Estimates of the Direct Path and Indirect Paths from Cues to Action to Intention to Advance Bedtime

Paths	**Unstandardized Path Coefficients (S.E)**	**Standardized Path Coefficients (S.E.)**	***Unstandardized p-value***
Cues → Intention	.35(.13)	.25(.09)	.001
Attitudes → Intention	1.38(.29)	.45(.08)	.000
Peer Influences → Intention	.19(.11)	.17(.09)	.061
Parents waking up the child → Intention	.24(.12)	.18(.09)	.041
Parents setting bedtime → Intention	-.11(.12)	-.09(.09)	.334
Cues → Attitudes	.11(.04)	.25(.08)	.001
Cues → Peer Influences	.52(.11)	.42(.08)	.000
Cues → Parents waking up the child	.06(.08)	.06(.08)	.464
Cues → Parents setting bedtime	-.21(.08)	-.19(.09)	.021
Indirect Paths			
Cues → Attitudes → Intention	.15(.06)	.11(.04)	.008
Cues → Peer Influences → Intention	.10(.06)	.07(.04)	.079

Cues → Parents setting bedtime → Intention	.02(.02)		.01(.02)			.481
Cues → Parents waking up the child → Intention	.02(.03)		.02(.02)			.394
Fit Indices						
χ^2	df	RMSEA	SRMR	CFI/TLI	AIC	BIC
11.38	10	.03	.04	0.99/0.97	3293.48	3390.18

Fig. I Proposed Relationship Amongst Sleep Variables Based on the I-Change Model

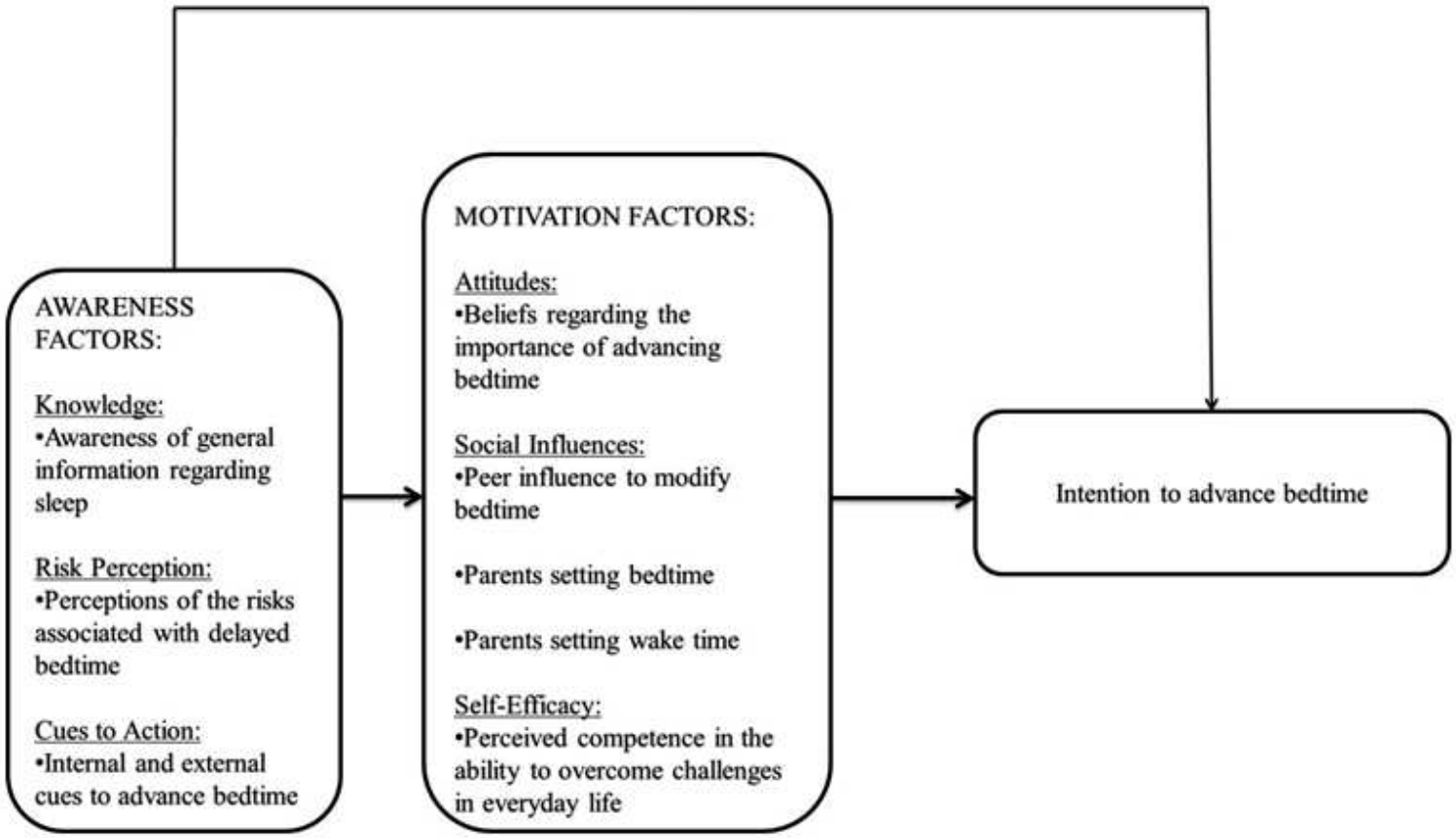
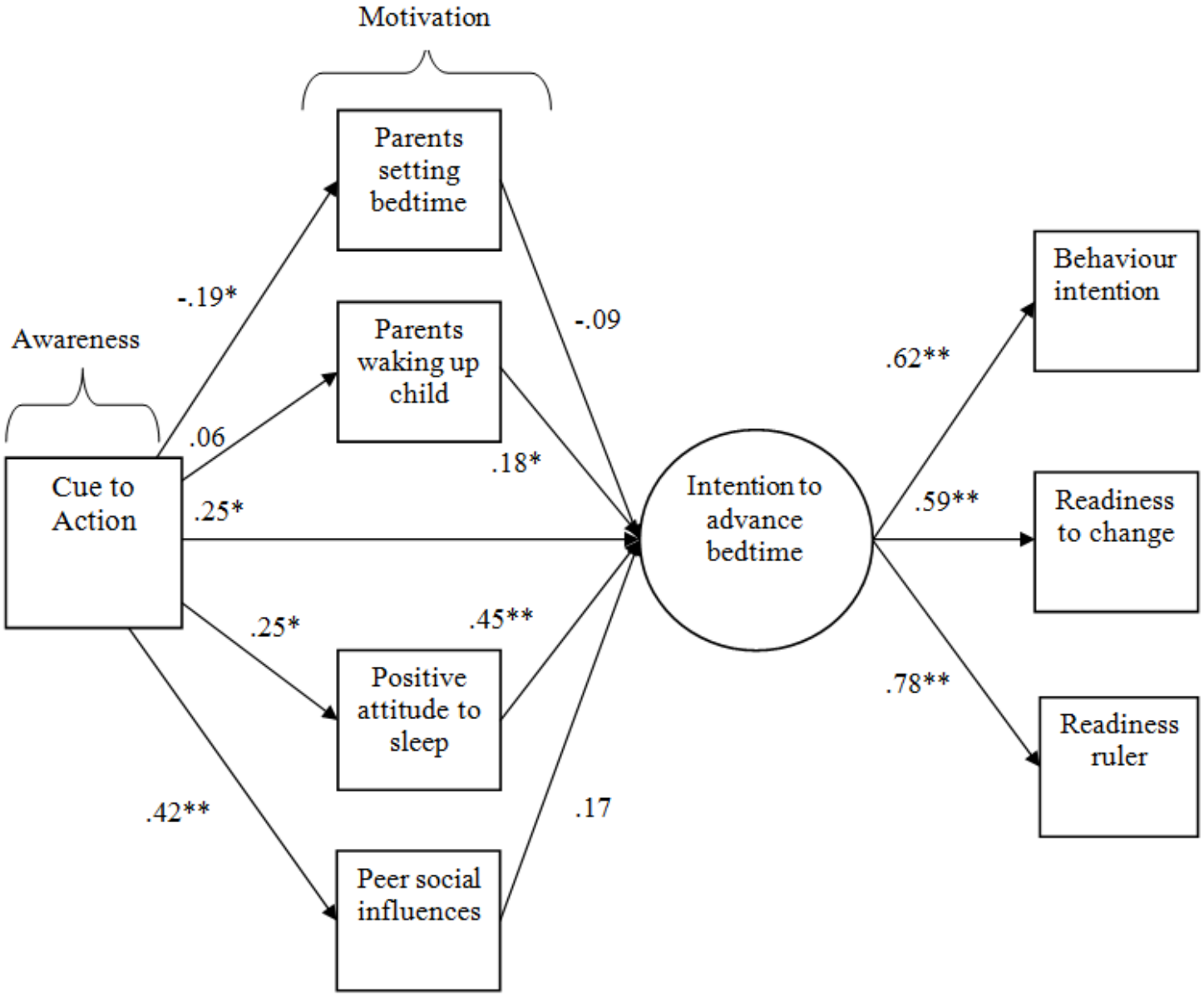


Fig. II Intention to Advance Bedtime as Predicted by the Motivational and Awareness Factors



Transition from Chapter 2 to Chapter 3

The purpose of Study 1 was twofold. The first goal was to investigate the applicability of the I-change model (a theoretical model of behaviour change that includes motivation and awareness precursors to intention to change) in the context of adolescent sleep. The goal was to investigate the motivational and awareness variables associated with adolescents' intention to go to bed earlier. The rationale was that once I understand what variables may be influential in enhancing intention to go to bed earlier, I will then use techniques to enhance these variables in a sleep promotion program. Thus, the overall purpose of conducting the first study was to build a solid theoretical and empirical framework to increase the likelihood that the intervention to be created for Study 2 will be effective in motivating sleep behaviour change. Structural equation modeling identified the variables *sleep related cues to action* and *positive attitudes towards sleep* as predictors of a higher intention to advance bedtime and the variable *parental set bedtime* as a predictor of a lower intention to advance bedtime. The findings of Study 1 were used to inform the development of the *Motivating Teens to Sleep More* program implemented and evaluated in Study 2. Specifically, I created and implemented activities into the program aimed at enhancing adolescents' ability to detect cues to go to bed earlier (e.g. body scan directed to body parts that may signal fatigue) and to develop positive attitudes towards sleep (e.g. decisional balance exercise tailored to sleep). Study 1 also showed that adolescents may be more likely to have a personal intention to change their sleep behaviour if they have a sense of autonomous motivation. As such, my program incorporated a supportive motivational interviewing style and tailoring techniques to enhance the perceived autonomy on the part of the adolescent in making a sleep behaviour change.

Chapter 3

Study Protocol of the Motivating Teens to Sleep More Program Aimed at Improving Motivation and Advancing Bedtime in Adolescents

Cassoff, J., Rushani, F., Gruber, R., & Knäuper, B. (2014). Evaluating the effectiveness of the motivating teens to sleep more program in advancing bedtime in adolescents: a randomized controlled trial. *BMC Psychology*, *2*(6), 1-10.

Abstract

Background: Sleep restriction is a prevalent issue for adolescents and has been associated with negative cognitive, emotional, and physical health (e.g., poor attention, depressed mood, obesity). Existing sleep promotion programs are successful in improving adolescents' sleep knowledge but not sleep behaviour. The aim of this randomized controlled trial is to evaluate the effectiveness of *Motivating Teens to Sleep More* program – a sleep promotion program with embedded sleep education that combines three approaches: motivational interviewing style, tailoring activities, and stage-based intervention – as compared to a sleep education only control in motivating adolescents to go to bed earlier leading to prolonged sleep duration.

Methods/Design: The *Motivating Teens to Sleep More* study will be conducted with adolescents at a Montreal high school. Half of the participants will be randomly assigned to the Motivating Teens to Sleep More program condition and the other half to the sleep education control condition. Each condition will consist of four 1-hour sessions spanning four consecutive weeks. Bedtime will be assessed by sleep logs completed for a week prior to the start of the program, in the middle of the program and following the program. Sleep onset and total sleep time will be assessed by actigraphy for one week prior to the start and following the program.

Discussion: The Motivating Teens to Sleep More program is a novel intervention that contributes theoretically to the field of pediatric sleep by merging three approaches to motivate normally developing adolescents to adopt earlier bedtimes. Should the program be successful in advancing bedtimes and increasing total sleep time, the study would offer insights in how to design effective motivational sleep promotion programs for adolescents, which can potentially improve adolescent health and well-being.

Trial registration: ISRCTN19425350

Introduction

Evidence indicates that sleep restriction (the elimination of sleep from one's needed amount for optimal performance) is particularly prevalent in adolescent populations (Reynolds & Banks, 2011). While experts state that the optimal amount of sleep in adolescence is 9.2 hours per night (Carskadon et al., 1980; Iglowstein et al., 2003; Mercer et al., 1998), a recent poll by the National Sleep Foundation found that 61% of adolescents are not getting this recommended amount of sleep (NSF, 2011). Delayed bedtime is the primary cause of insufficient sleep duration in this population, i.e. adolescents go to bed too late. In a longitudinal study (Iglowstein et al., 2003) comparing the sleep timing of three birth cohorts (1974, 1979 and 1986) until the age of 16 years old, it was found that adolescents' sleep duration was lowest in the most recent decades. The decreased sleep duration was attributed to later and later bedtimes but unchanged wake up times. The latter finding can likely be attributed to set wake up times for school in the morning but increasing distractions at nighttime including technology, social life and extracurricular activities. Further, adolescence is associated with a delayed sleep phase resulting in an endogenous preference for much later bedtimes than children and adults. Sleep restriction due to late bedtimes is associated with poor attention, deficits in academic achievement, depressed mood, psychoactive substance use, car accidents, and obesity in adolescents (Curcio, Ferrara, & De Gennaro, 2006; Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010; Durmer & Dinges, 2005; Knutson, Spiegel, Penev, & Van Cauter, 2007; Dewald, Oort & Meijer, 2013) have shown that gradual advancement of adolescent bedtime is a feasible approach and is associated with increased total sleep duration. Given the negative impact of sleep restriction on adolescent health, widespread efforts to create sleep interventions aimed at advancing bedtime in order to increase sleep duration are needed.

Existing adolescent sleep promotion programs mainly focus on sleep education and have indeed been found to be successful in enhancing adolescent knowledge about sleep (Bakotić et al., 2009; Cain et al., 2011; Cortesi et al., 2004; Moseley & Gradisar, 2009) but the programs for which sleep behaviour in addition to knowledge outcomes has been evaluated find insignificant improvements in sleep behaviour (Cain et al., 2011; Moseley & Gradisar, 2009). Adolescents may not be motivated to go to bed earlier as the behaviour change implies less time for leisure, extracurricular activities, communicating with friends, etc. (Cassoff et al., 2013). This lack of motivation might perhaps account for the inefficacy of current programs in changing adolescents' bedtime.

Thus, the current adolescent sleep research is in need of further research to consider and investigate the role of adolescent motivation in the development and implementation of sleep promotion programs (Cassoff et al., 2013). The focus on solely enhancing sleep knowledge rather than also addressing motivational readiness to improve sleep behaviour may explain why efforts to reduce adolescent sleep restriction remain mostly unsuccessful. Therefore, we developed the Motivating Teens to Sleep More (MTSM) program. It aims to fill the gaps of previous research by enhancing motivation to go to bed earlier in a way that is congruent with adolescent developmental characteristics. The MTSM program aims to enhance motivation by incorporating three main active ingredients, namely a motivational interviewing (MI) style, a stage-based intervention approach and a tailored intervention approach.

Motivational Interviewing

Motivational Interviewing is a collaborative, person-centered counseling style that elicits and strengthens motivation for change (Miller & Rollnick, 2002). It is based on unique principles including expressing empathy towards the client, encouraging the client to be autonomous rather

than assuming an authoritarian position that imposes ideas on them, rolling with resistance (i.e. not confronting and challenging the client when they make resistant statements), and helping the client realize that there is a discrepancy between their current maladaptive behaviour and their life goals and values (Baer & Petersen, 2002). MI has been found to be effective in motivating behaviour change especially when used in conjunction with another intervention (Hettema, Steele, & Miller, 2005). As such, the effects of MI in motivating advanced bedtime may be enhanced when applied with stage-based and tailored intervention components. Additionally, its non-confrontational nature encourages adolescents to make autonomous decisions to advance their bedtime. This is fitting with the tendency for adolescents to rebel against authority figures as well as the increase in independent decision-making associated with the adolescence developmental period (Elliott & Feldman, 1990). The interaction between the interventionist and participant will be in the form of a conversation rather than authoritarian instruction, which is characteristic of the MI style. Further, due to its efficacy in motivating adolescents to make positive behavioural changes in health areas including smoking, alcohol use, and diet, MI has recently been proposed as a potentially suitable intervention for promoting healthy sleep habits in adolescent populations (Gold & Dahl, 2010). Thus far, the effects of MI on adolescent sleep behaviour have been evaluated in the school context (Cain et al., 2011) where motivational sessions were offered to groups of students at once. Although motivation to improve sleep habits was increased following the intervention, no differences in sleep behaviour were found. The current study will investigate MI delivered in a one-on-one context because the principles of MI are best suitable for one-on-one programs, especially when targeting complex behaviours such as sleep (Britt et al., 2004; Rollnick & Miller, 1995).

Tailored Intervention

Tailored interventions are created by assessing personal data related to the particular health behaviour in order to determine the most appropriate information and/or strategies to meet the individual's unique needs (Kreuter et al., 2003). This information and/or strategies are then delivered to the person in the intervention. Personalizing information or tailoring messages for each individual have been shown to be more effective than presenting generic information in engaging individuals, building their self-efficacy and improving health behaviours (Noar, Benac, & Harris, 2007; Sohl & Moyer, 2007). There is growing evidence for the use of tailoring in complex health behaviour interventions (e.g. for nutrition; Hoelscher, Evans, Parcel, & Kelder, 2002, exercise; Salmon, Booth, Phongsavan, Murphy, & Timperio, 2007 etc.). Tailored interventions are most effective with complex health behaviours that involve multiple actions (Kreuter et al., 2003). Bedtime (i.e. putting oneself to bed) can be considered a complex behaviour because it encompasses multiple actions including employing sleep hygiene behaviours that occur before bedtime, ignoring a multitude of distractions that occur at bedtime, and physically putting oneself into bed. Due to the complexity of bedtime and the effectiveness of tailored intervention with complex health behaviours, the current sleep promotion program will be tailored. Specifically, the MTSM program will be 'tailored' to important determinants of sleep and to other personal characteristics of the participant that could be helpful in further enhancing the effectiveness of the activities used in each session. While the stage-based part of the sleep promotion program will customize content depending on the stage of change, that is, individuals similar in their readiness to change levels will receive similar strategies; the tailored part of the intervention will further customize intervention activities to personal characteristics including personality, goals, values, and other determinants of sleep behaviour change.

Adolescents may respond well to tailored interventions because it allows for the development of personal and direct intervention content based on elements such as likes/dislikes, needs, and current health behaviours or behavioural intentions. For example, because the MTSM program is tailored to the needs and preferences of each participant, the extent to which parents are involved varies between participants. There is ample opportunity for the adolescent to express how his/her parents could support his/her decision to go to bed earlier. However, in some cases, the adolescent expresses that a sibling or friend would be better suited as his/her support system.

One-on-one interventions have been developed to improve the sleep patterns of adolescents diagnosed with delayed phase sleep disorder (Gradisar et al., 2011; (Saxvig et al., 2013; Wilhelmsen-Langeland et al., 2013). Results indicate the treatments involving one-on-one cognitive behavioural therapy (CBT) aimed at motivating the individual in addition to a chronobiology-related treatment (e.g. bright light therapy, melatonin administration) result in more sustained advancements in circadian rhythm alignment than protocols without CBT (Gradisar et al., 2011). To our knowledge, tailored motivational interventions have yet to be applied in the context of normally developing adolescents' sleep.

Stage-Based Intervention

Stage-based interventions, grounded in the Transtheoretical Model of Behaviour Change (TTM), deliver stage-tailored content that is aimed at promoting movement through stages of change and leading to improvements in health behaviour, decisional balance, and self-efficacy (Prochaska & Velicer, 1997). The majority of the current study will be modeled according to a stage-based intervention as the program will involve first identifying the readiness to advance bedtime of the adolescent and then identifying the corresponding processes of change that the TTM proposes to be necessary in enabling and facilitating stage advancement (see Table 1).

Once the processes are identified, the interventionist will employ activities (found efficacious in previous sleep studies) in order to boost those processes, with the goal of enhancing motivation and readiness to advance bedtime. Stage-based interventions have been found to be effective in the cessation of maladaptive behaviours such as smoking, cocaine abuse, and delinquent behaviour, and in the acquisition of positive behaviours such as safer sex practices, sunscreen use, and regular exercise in adolescents (Prochaska & Prochaska, 2010; Riemsma et al., 2003; Weinstock, Rossi, Redding, Maddock, & Cottrill, 2000). This is relevant for the current intervention because going to bed earlier, like the aforementioned health behaviours, is a behaviour that adolescents tend to be unmotivated for. Another reason why a stage-based intervention is fitting for a sleep promotion program is because the activities used to boost TTM processes (i.e. to progress an individual through the stages of change) overlap significantly with intervention strategies currently used to promote adolescent sleep (see Table 1). All existing adolescent sleep promotion programs incorporate sleep knowledge (Bakotić et al., 2009; (Bootzin & Stevens, 2005; Cain et al., 2011; Cortesi et al., 2004; De Sousa et al., 2007; Moseley & Gradisar, 2009). Some have used strategies including cognitive restructuring (Bootzin & Stevens, 2005; Moseley & Gradisar, 2009), mindfulness exercises (Bootzin & Stevens, 2005; Cain et al., 2011), stimulus control (Cain et al., 2011; Moseley & Gradisar, 2009), role playing, goal setting (Cain et al., 2011), cues to action (De Sousa et al., 2007), and personal action exercises (Moseley & Gradisar, 2009). Strategies that have demonstrated to be effective in previous sleep promotion programs will be incorporated in the current intervention. Please see Table 1 for a detailed explanation of how the activities used in previous sleep promotion programs will be integrated within the Motivating Teens to Sleep More program. To our knowledge, stage-based interventions have yet to be applied in the context of adolescent sleep.

The Current Study

The objective of this trial is to compare improvements in sleep habits immediately following the completion of the program and at 3-month and 6-month follow-up periods in adolescents receiving the *Motivating Teens to Sleep More* program, an individualized sleep promotion program (embedded with a sleep education component) aimed at enhancing motivational readiness to go to bed earlier in comparison to adolescents in a one-on-one sleep education only condition. The active sleep education control group will be used to parse the beneficial effect of one-on-one aspect of the intervention from the beneficial effect of stage-based, tailored sleep education and motivational techniques (i.e., the active ingredient of the MTSM) in regard to these sleep-constructs. The effects of the Motivating *Teens to Sleep More* Program will be assessed according to the following bedtime-related constructs: (1) time that the adolescents go into bed (i.e. bedtime), (2) time that the adolescents fall asleep (i.e. sleep onset), and (3) duration for which the adolescents are asleep (i.e. total sleep time).

Methods

Design

The current study is a parallel randomized controlled trial in which the experimental group receives the one-on-one MTSM program including tailored motivational strategies and sleep education as a component within the program and the control group receives one-on-one sleep educational sessions only.

Participants

The participants will be high school students aged 12-18 years old. Previous research (Treasure, 2004) suggests that the effect sizes of interventions based on adaptations of motivational interviewing as well as manualized versions of motivational interviewing have a

small effects (i.e. d = 0.25). Assuming an effect size of 0.25, the required number of participants was calculated for a power level of .80 and an alpha level of .05. Given the within subject design with sleep measured at pre, post and 6-months follow-up, power analyses revealed that a sample size of 30 adolescents would be required. Inclusion criteria will consist of having a late bedtime (i.e. a bedtime that results in less than eight hours of sleep on a school-night) and reporting being in the contemplation stage of change (i.e. considering advancing bedtime within the next 6 months). Exclusion criteria will consist of any sleep disorder and/or medical and mental condition that interferes with sleep. The screening procedure for medical and mental conditions that interfere with sleep is that a parent of the child responds to the following question in an online survey: "Please indicate whether your child has been suffering from any of the following within the past 12 months." If the parent chooses "asthma attacks," and/or "skin condition," and/or "Attention Deficit Disorder (ADD)," and/or "Attention Deficit and Hyperactivity Disorder (ADHD)," and/or "conduct disorder," and/or "anxiety disorder," and/or "depression" then the child is in ineligible to participate. The screening procedure for sleep disorders is that the parent and children together respond to the Sleep Disorder Inventory for Students – Adolescent Version (SDIS-A). As per the scoring instructions for this instrument, if the overall score is above 104, then the child is ineligible to participate. Furthermore, in the beginning of each session the interventionist inquires about the level of stress the participant experienced in the past week and gauges for any event that might affect the participant's sleep schedule. If a participant reports experiencing excessive levels of stress during the sessions, it could lead to the partial or total occlusion of the participant's data from the analyses.

Procedure

The parent of an interested adolescent will contact the research team at which time he/she will be invited to complete an online parental consent form followed by a screening questionnaire on sleep, medical and psychiatric disorders. We will sequentially assign each participant a unique personal identifier to be entered into the screening questionnaire. Once the parent completes the form to screen for whether his/her child has a sleep disorder and if his/her child remains eligible (his/her child will be contacted (via email and/or telephone call) to complete the rest of the screening process. The remainder of the screening process will consist of the adolescent completing an online questionnaire to assess his/her stage of change and bedtime. Should the participant be ineligible to participate both he/she and his/her parent/legal tutor will be notified. If the participant is eligible to participate, the RA will contact the participant and ask him/her to complete the baseline questionnaire, which will occur online at a time of his/her convenience. The baseline questionnaire will assess variables that are important in individualizing the sessions including personal values, attitudes towards sleep, confidence in ability to change sleep habits, sleep-related social influences, and sleep knowledge, risk perception, and cues to action. At this time, the RA will also schedule the first session and provide the participant with general information about the study including the location, duration and number of the sessions. The first page of the baseline questionnaire will contain an assent text that will describe the study according to developmentally appropriate reading and comprehension levels of the youngest age group (12 years old). Participants will be instructed that by clicking “I agree” they are providing assent and agree to participate in the study.

Students will meet with the RA at their school (1-week before the start of the sessions) to be provided with an actiwatch and instructions for using it for seven nights in a row. An

actiwatch is a small watch-like device worn on the wrist. It assesses sleep-wake patterns through body movement during the night. They will also be asked to fill in a sleep log indicating their bed and wake times, and napping schedule during this period. After one week, the participants will return the actiwatch and the sleep log sealed in an envelope (provided by the RA to ensure confidentiality) to their school's administrative office to be picked up by the RA, at which point the sessions will begin. The same procedure will take place during actigraphy data collections after the sessions.

All sessions will be one hour in duration and will take place once a week for four consecutive weeks. Two graduate students in psychology will each administer half of the sleep education sessions and half of the MTSM program sessions. Questionnaires assessing sleep behaviour will be completed immediately following each session and at three and six months following program completion.

Randomization

We will employ a randomization process where the participant will be allocated to either group A (MTSM program with an embedded sleep education component) or group B (Sleep education sessions only). A randomization sequence will be created using a secure online randomization service (www.randomization.com). The randomization sequence will be assigned on a 1:1 ratio to the intervention and control groups. Only the research team will have access to the online randomization scheme. Please see Figure 1 for a description of the study flow.

Control Group: Sleep Education

Each sleep education session will be one-on-one (interventionist and participant) and will consist of the interventionist presenting information concerning different aspects of sleep. In session 1, the interventionist will teach the participant about sleep in general, in session 2 about

teenagers and sleep, in session 3 about sleep disorders, and in session 4 about sleep hygiene. Although the participant will be invited to ask questions if they do not understand, the responses offered by the interventionist will be directly related to content clarification and will not involve any personalized or motivational strategies.

Experimental Group: MTSM Program with Embedded Sleep Education

The difference between the sleep education only sessions and the MTSM program with an embedded sleep education component will be that in the latter the interventionist will not only teach about sleep but will also use activities that are matched to the participant's readiness to change their bedtime and are aimed to increase their motivation to go to bed earlier. Specifically, the interventionist will choose the activities to conduct in the session depending on the current readiness to advance bedtime of the participant. Sleep education will be embedded in the program in that participants who are unfamiliar with particular aspects of sleep will be provided with the information that they are missing. However, this will not be provided in a 'one size fits all' format as is the case in the sleep education sessions. Rather, participants will be provided with sleep education in a way that is tailored to what they currently do and do not know. For example, if the participant is aware of the consequences of sleep on their mood but not the consequences of sleep on their academic performance (as concluded by result on the baseline questionnaire), the interventionist will provide him/her with the information they are missing by discussing the potential negative effects of sleep deprivation on attention and behaviour in school. Due to the inclusion criterion of being in the contemplation stage of change, at the start of the first session the activities used will be similar across participants. All activities that could be further tailored to individual characteristics of the participant will be done so in a way that is standardized in the study manual. For example, during the sleep hygiene action plan activity of

choosing a sleep hygiene behaviour to improve (please see Figure 2), the interventionist will congratulate the adolescent regarding sleep hygiene behaviours that he/she already does and will only suggest that he/she chooses a sleep hygiene behaviour needing improvement. Sleep hygiene behaviour information will be provided in the baseline questionnaire by each participant. Finally, all of the sessions will be conducted in a MI style. A MI style will consist of expressing empathy towards the adolescent, encouraging the adolescent to be autonomous rather than assuming an authoritarian position that imposes ideas on them, rolling with resistance (i.e. not confronting and challenging them when they make resistant statements), and helping the adolescent realize that there is a discrepancy between their current maladaptive behaviour and their life goals and values. A specific bedtime will not be prescribed for the teens because this would go against the motivational interviewing approach. Rather, the interventionist will work together with the participants to set a bedtime goal that is realistic based on the teen's personal schedule and level of motivation. Further, although a set bedtime goal is created with the teens in the first session, the participant is encouraged by the interventionist to update this goal (by either making their bedtime goal earlier or later) depending on their progress throughout the program. Reminders for the interventionist to engage in motivational interviewing congruent behaviours are present throughout the study manual.

Fidelity Assessment

We will measure the fidelity of the intervention by 1) conducting standardized training sessions for the interventionists consisting of a 2-day training on the study procedures, the MTSM program and the sleep education program as well as over 20 hours of clinical training some of which were delivered by members of the Motivational Interviewing Network of Trainers (MINT) and 2) by audio-recording the sessions to be listened to by two RAs who will complete

assessments measuring how adherent the interventionist was to the study manual and procedures. We created the fidelity assessment for the current study and they consist, in part, of the Motivational Interviewing Treatment Integrity Code (Moyers, Martin, Manuel, Miller, & Ernst, 2010).

Measures

Bedtime and time in bed. Bedtime is the time the adolescent reported on the sleep logs going into bed at night. Time in bed is calculated as a function of bedtime and wake time reported on the sleep logs.

Sleep onset and total sleep time. Sleep onset and total sleep time will be assessed through actigraphy assessments in conjunction with daily sleep logs for the week prior and the week after the four sessions. Actigraphy is a method used to measure sleep-wake patterns through body movement (Littner et al., 2003) by recording data from accelerometers several times per second. These computerized wristwatch-like devices collect data generated by movements. Actiwatches are not intrusive and can record sleep timing without affecting the child's bedtime routine. Actigraphy has been validated against polysomnography with agreement rates for minute-by-minute sleep-wake identification > 90% (Ancoli-Israel et al., 2003). One-minute epochs will be used to analyze actigraphic sleep data. The bedtime and wake time reported in the sleep logs will be used as the start and end times for the current analyses. For each 1-min epoch, the total sum of activity counts will be computed. If they exceed a threshold (threshold sensitivity value = mean score in active period/45), then the epoch will be considered waking. The first time it falls below that threshold will be considered "sleep onset". The actigraphic sleep measures to be used in this study include parameters pertaining to actual time

spent asleep during the night (i.e. total sleep time) and the time in which the participant falls asleep (i.e. sleep onset).

Readiness to go to bed earlier. Readiness to go to bed earlier will be assessed by two measures. First, a readiness ruler (LaBrie et al., 2005) adapted to sleep will be completed such that participants will indicate on a 10-point ruler how they presently feel about going to bed earlier. Anchors included "Never think about my bedtime," Sometimes I think about advancing my bedtime," "I have decided to advance my bedtime," "I am already trying to advance my bedtime," "My bedtime has changed, I now go to sleep earlier." The readiness ruler has shown good criterion validity with self-reported behaviour in the areas of condom use and alcohol consumption (LaBrie et al., 2005). The readiness ruler will be completed at baseline, after each session and at follow-up assessments. The second measure will be the 11-item Readiness to Change Questionnaire (RTCQ; (Rollnick et al., 1992) adapted to sleep. Precontemplation, contemplation, and action were each represented by four items measured on a 5-point scale (−2 = *strongly disagree* to +2 = *strongly agree*). Stage of change as measured by the RTCQ has been validated as a good predictor of health behaviours (Heather, Rollnick, & Bell, 1993). A single indicator of readiness to change will be calculated by adding up the scores for the contemplation and action questions and the reverse scores for the preparation questions.Stage of change, as measured by the RTCQ has been validated as a good predictor of health behaviours (Heather et al., 1993).

Sleep-related self-efficacy. Sleep specific self-efficacy will be measured by a sleep self-efficacy questionnaire (Watts, East, & Coyle, 1995) modified to assess control over putting oneself into bed. Sample items include "How much do you feel that you have the ability to go into your bed at an earlier hour?" and "How much do you feel that the time it takes to go into

your bed is under your control?" rated on a 4-point scale. Responses (1 = *not at all to* 4 = *to a great extent*) were modified to fit with the question stem. Another sleep self-efficacy instrument was developed for the present study. Items include the semantic structure, " I can manage to get into bed at an earlier hour,… even if (barrier)," which is the rule of thumb for domain specific self-efficacy questions (Luszczynska & Schwarzer, 2005). Sample barriers created for this study include "even if it meant watching less television" and "…even if it meant not seeing my friends" and are rated on a 4-point scale (1 = *very uncertain* to 4 = *very certain*).

Attitudes towards sleep. A decisional balance instrument will be used to assess attitudes towards sleep at baseline, at the end of each session and at follow-up assessments. The questionnaire was developed for this study based on the work of Orzech (2013), Noland, Price, Dake & Telljohann (2009), and Pawlak & Colby (2009), and it consists of twenty-two items: twelve items about the pros and the rest about the cons of going to bed earlier. Positive attitudes towards sleep are computed as the difference between the standardized pros scores and the standardized cons scores.

Statistical Analyses

Prior to analyzing the impact of the MTSM intervention in improving adolescents' sleep behaviour, t-tests will be run to examine to which extent randomization was successful. Specifically, it will be tested whether participants in the experimental and control group differ in the following characteristics: sleep deficit (i.e., hours of sleep by which the participants deviated from the optimal 9.2 hours of sleep), readiness to change bedtime, sleep-related self-efficacy, and attitudes toward sleep. Variables on which experimental and control group that differ significantly will be controlled for in the subsequent analyses. Three two-way mixed ANOVAs with time (pre- vs. post-assessment vs. 3-month follow-up vs. 6-month) as the within-subjects

factor and group (experimental vs. control) as the between-subjects factor will be performed to test whether adolescents receiving the Motivating Teens to Sleep More program differ significantly after the intervention and at three- and six-month follow-up from the adolescents receiving only sleep education in the following sleep variables: 1) bedtime, 2) sleep onset, 3) total sleep time. Significant results will be further examined by planned comparisons.

Study Progress

The data collection is currently underway such that 13 participants have completed the four sessions and 4 participants have provided 3-month follow-up data. The study will be terminated once 6-month follow up data from 30 participants are collected.

Ethics

The study has obtained approval by the McGill Research Ethics Board in November 2012 (REB# 115-0912).

Discussion

In the current study, we are evaluating the impact of a motivational sleep promotion program with an embedded sleep education component compared with sleep education only on sleep improvements in adolescents. The MTSM program is a novel intervention that merges three promising motivational initiatives – a motivational interviewing style, tailoring activities, and stage-based interventions. To the best of our knowledge, this is the first one-on-one sleep promotion program aimed at motivating normally developing adolescents to adopt earlier bedtimes.

The current study can contribute theoretically to the field of pediatric sleep by applying health behaviour theories (e.g. the TTM) in conceptualizing ways in which to motivate adolescents to improve their sleep habits. The current study can also contribute practically by

offering insights in how to design effective motivational sleep promotion programs for adolescents. Should the MTSM program be successful in advancing bedtimes and increasing sleep duration, it can have a positive impact on adolescent health and well-being including improved physical health (e.g. weight regulation; Lowry et al., 2012, less car accidents; Pizza et al., 2010) cognitive health (e.g. academic performance; Gruber et al., 2010), and emotional health (e.g. mood; Dahl, 1999).

A limitation of the current study is the generalizability of results. Because the participants are being recruited from a private high school, our findings may not generalize to adolescents of a lower socioeconomic status. Further, it will be difficult to implement the program on a wide-scale as meeting with normally developing adolescents on a one-on-one basis is resource intensive. Should the program be successful, one way to translate the findings on a wide-scale is to implement tailored computerized sleep promotion programs. Such programs are often Internet-based and can tailor the content of health promotion materials to the specific characteristics of each participant (Rimer & Kreuter, 2006). Not only is delivering the program over the Internet more feasible than in person, but it is considered an appropriate way in which to communicate with adolescents due to its accessibility and the tendency for adolescents to view the Internet as a credible source for health information (Borzekowski & Rickert, 2001).

Table 1. The stages of change and corresponding TTM processes, MTSM activities, variables measured at baseline, and integration with previous adolescent sleep interventions

Stage of change	**Example of TTM process**	**Example of a MTSM program activity designed to enhance the process**	**Variables measured at baseline that allow to tailor this activity**	**Integration with previous sleep promotion programs**
Precontemplation	**Consciousness raising**: raising awareness about sleep deprivation	• **Sleep education**: Discussing with the adolescent in an interactive way about sleep-related facts and consequences related to sleep deprivation.	• Knowledge • Risk perception • Information needs • Personal values	Sleep hygiene education (Bakotić et al., 2009; Bootzin & Stevens, 2005; Cain et al., 2011; Cortesi et al., 2004; Moseley & Gradisar, 2009)
Contemplation	**Self-reevaluation:** examining how one thinks and feels about oneself with respect to the current behaviour	• **Decisional balance**: Eliciting from the adolescent thoughts on the pros and cons of going to bed earlier, while the interventionist highlights and elaborates on statements that reveal discrepancy between current sleep behaviour and future goals and values, thus encouraging behaviour change.	• Attitudes towards sleep • Personal values	Cognitive restructuring (Bootzin & Stevens, 2005; Cain et al., 2011; Moseley & Gradisar, 2009)
Preparation	**Dramatic relief:** experiencing and expressing feelings to help motivate	• **Role playing and personal testimonies**: Improvising a situation where the adolescent focuses on the consequences of delayed bedtime in his/her life and then	• Self-efficacy	Sleep-related role playing (Cain et al., 2011; Moseley &

	change	relieving this evoked emotional discomfort by providing personal testimonies of individuals who have successfully changed their bedtime and enjoy the positive ramifications of that change.		Gradisar, 2009)
Action	**Self-liberation:** choosing to act or belief in ability to go to bed earlier	• **Sleep hygiene action plan:** Offering the participant an agenda setting chart (please see Figure 2) from which to autonomously choose a sleep hygiene behaviour to improve.	• Personal values • Sleep hygiene behaviour	Personal action, goal setting exercises (Cain et al., 2011)
Maintenance	**Stimulus control**: avoiding or countering stimuli that make the adolescent go to bed late	• **Stimulus control exercise:** Presenting the adolescent with instructions on ways to: (i) remove cues from the environment that promote late bedtimes, and (ii) add prompts for earlier bedtimes.	• Social influence (identifying positive and negative influences)	Stimulus control (Bootzin & Stevens, 2005; Cain et al., 2011; Moseley & Gradisar, 2009)

Note. The activity included in Table 1. corresponding to each stage of change is one of several examples. A single activity may be suitable for multiple stages of change. Furthermore, the process by which one proceeds through the stages of change is fluid. Although all participants included in the study report being in the contemplation stage of change during the screening phase, they may revert back to the precontemplation stage at a later time in the intervention.

Figure 1. The MTSM study flow diagram

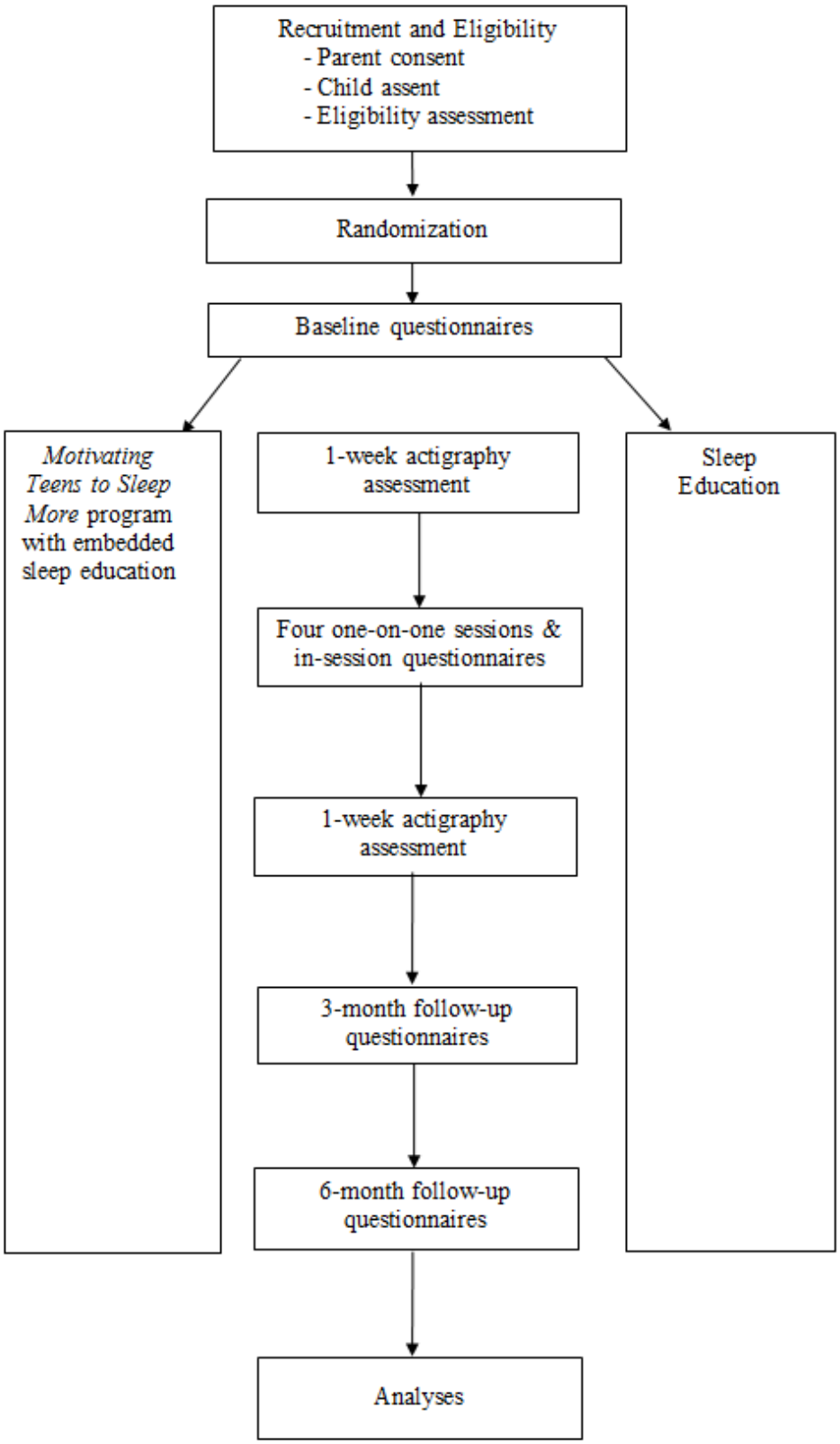


Figure 2. The sleep hygiene action plan activity as per the MTSM study manual

Description of the activity
The interventionist first describes various sleep hygiene behaviours (using the agenda setting diagram as a visual aid) and praises the adolescent on the negative sleep behaviours he/she does not engage in. The interventionist then encourages the participant to choose a negative sleep behaviour they might want to change. Lastly, the interventionist works with the participant to create "*if-then"* implementation intention statements, a concrete plan that will help them attain their sleep hygiene behaviour change.

Interventionist script
I wanted to show you this chart because on this chart are things that we talk about with teens who are thinking of going to bed earlier. As you can see there's cell phones, electronics, exercise, food, caffeine, bright lights and more.
We use this chart to show people areas they might consider, but decisions you make yourself are much more likely to be the better ones. So today is about seeing where you feel like starting.
[After the participant has chosen a sleep hygiene habit] *Now that you've chosen a sleep hygiene habit to change, what are some steps you can take to put your plan into action?*

Chapter 4

Results from the Motivating Teens to Sleep More Program: A Pilot Randomized Controlled Trial

Cassoff, J., Knäuper, B. Rushani, F., & Gruber, R. A pilot randomized controlled trial evaluating a stage-based and tailored motivational intervention to advance bedtime in adolescents. Submitted to *Sleep Medicine.*

Abstract

Objective: To evaluate the effectiveness of the Motivating Teens to Sleep More (MTSM) program in comparison to a sleep education control program in increasing adolescent motivation to go to bed earlier and improving adolescent weekday bedtime and sleep duration.

Patients/Methods: A pilot randomized controlled trial compared the MTSM program with a sleep education control program. Participants were 22 adolescents (11 males, mean age = 14.27) high school students (grade 7-11) recruited from high schools and community settings in Montreal. The MTSM program was delivered one-on-one, for an hour a week for four consecutive weeks. The program included a motivational interviewing style and stage-based and tailored activities to promote earlier bedtime based on the transtheoretical model of change. Bedtime, wake time and sleep duration were measured at pre-, mid- and post- program using sleep logs, and at 6 months follow-up with an online questionnaire. Actigraphy data were collected for a week pre- and post-intervention. Motivational variables (positive attitudes towards sleep, sleep-related self-efficacy, and readiness to go to bed earlier) were assessed with online questionnaires.

Results: Groups did not differ in sleep and motivation variables at baseline. Following the intervention, the experimental group demonstrated greater improvements in self-reported bedtime, sleep duration, and self-efficacy compared to the control group, which were not maintained at the 6-months follow-up. Although both groups improved in readiness to change, more MTSM participants reached the action stage of change. Positive attitudes towards sleep did not increase in either group.

Conclusions: This motivational sleep promotion program was effective in motivating adolescents to go to bed earlier in the short term. Future programs should aim to address how to sustain behavioural change and investigate motivational mediators of intervention efficacy.

Keywords: motivational interviewing, adolescent sleep, tailored intervention, sleep promotion program, adolescent bedtime

Trial registration: ISRCTN19425350.

Introduction

Adolescent sleep deprivation is a growing concern in today's society (NSF, 2006, 2011; Roberts et al., 2010). Although it is recommended that adolescents obtain approximately nine hours of sleep per night, sleep polls indicate that the majority are not obtaining this recommend amount (NSF, 2006). Moreover, 70% of adolescents are obtaining less than 8.5 hours of sleep on weekdays and are considered sleep restricted (Gibson et al., 2006). While 81% of adolescents are adopting bedtimes later than 10:00PM on a school night (NSF, 2011), many of them must wake up for school each morning at an hour (on average, 6:30AM; Boergers, 2015) that terminates their sleep prematurely (Carskadon, 2011; Olds, Maher, Blunden, & Matricciani, 2010) in order to arrive at school on time (on average, earlier than 8:00AM; Boergers, 2015). Thus, one of the primary factors impeding adolescents from obtaining sufficient sleep on the weekdays are their late bedtimes (Cassoff, Rushani, Gruber, & Knäuper, 2014). Indeed, evidence indicates that reversing late bedtimes has been effective in prolonging sleep duration in adolescence (Dewald-Kaufmann et al., 2013). Adolescents adopt late bedtimes due to psychosocial factors including social life, technology use and homework (Samson, Blunden, & Banks, 2013) as well as physiological processes, such as delayed circadian rhythm (Carskadon et al., 1997) and slower accumulation of homeostatic pressure (Jenni, Achermann, & Carskadon, 2005). Late bedtimes lead to insufficient sleep duration, which is associated with a myriad of negative daytime consequences (Beebe, 2011) such as poor academic performance (Gruber et al., 2010), worsened mood, poor emotional regulation (Baum et al., 2014), and an increased risk of accidental injury (Beebe, 2011). Thus, interventions are needed to promote earlier in order to elongate sleep duration in adolescents.

Existing sleep promotion programs for adolescents are often administered in the form of sleep education sessions to high school students in a classroom setting and have been found to be

effective in enhancing adolescents' knowledge about sleep (Bakotić et al., 2009; Beijamini & Louzada, 2012; Cain et al., 2011; Cortesi et al., 2004; Moseley & Gradisar, 2009; Vollmer et al., 2014). Not all studies evaluating sleep education programs assess the impact on behavioural sleep outcomes (Bakotić et al., 2009; Cortesi et al., 2004). Studies that assess sleep behaviour change find that adolescents improve their knowledge about sleep, which unfortunately does not translate to earlier bedtimes (Beijamini & Louzada, 2012; Cain et al., 2011; Moseley & Gradisar, 2009; Vollmer et al., 2014). One sleep education program resulted in decreased sleep irregularity and sleep onset latency, this study, however, did not employ a control group to discern whether it was the sleep intervention that actively caused the sleep improvements (De Sousa et al., 2007). A recent study evaluating a sleep education found that adolescents increased sleep duration by 10 minutes (by delaying wake up time) but improvements were not sustained at the follow-up assessment (18 weeks following baseline; Gabrielle et al., 2015). A study that assessed qualitative feedback from adolescents to gain understanding about their suggestions for future improvements to adolescent sleep education programs concluded that adolescents are not motivated to change their sleep patterns (Moseley & Gradisar, 2009). Specifically, adolescents may not be motivated to go to bed earlier because the behaviour change implies less time for leisure, extracurricular activities, communicating with friends, etc. (Cassoff et al., 2013) This lack of motivation is increasingly believed to account for the inefficacy of current programs in changing adolescents' bedtime. Thus, it is possible that the majority of existing adolescents sleep promotion programs have been unsuccessful in effecting sustained sleep behavioural changes (e.g. earlier bedtimes) due to a focus on primarily educating adolescents about sleep, rather than also offering motivation enhancement with regard to adopting earlier bedtimes. (Cassoff et al., 2013; Gold & Dahl, 2010)

A recent sleep promotion program developed by Cain and colleagues (Cain et al., 2011) used motivational strategies (e.g. decisional balance exercises, role playing, relapse prevention) with the goal of translating enhanced sleep knowledge into sustained sleep behavioural changes. Although adolescents demonstrated increased sleep knowledge and motivation to obtain more sleep and develop more consistent sleep schedules, the program did not lead to longer sleep duration.

Interventions, therefore, are needed to enhance motivation that adequately captures the barriers that prevent adolescents from going to bed earlier (Cassoff et al., 2013; Gold & Dahl, 2010). A recent review (Blunden, Chapman, & Rigney, 2012) suggested that specific motivational elements to be targeted more in future adolescent sleep promotion programs include attitudes towards sleep and sleep-related self-efficacy. These recommendations are congruent with those of other researchers who suggest that insufficient sleep-related self-efficacy is a primary reason why adolescents are unmotivated to adopt earlier bedtimes (Cain et al., 2011). It has also been suggested to assess adolescent motivation (and thereby be able to tailor an intervention to the individual's motivational level) through their readiness to make a positive sleep-related behaviour change (Blunden et al., 2012). Similarly, Gold and Dahl (2010) suggested that future programs should address adolescents in a way that is congruent with their developmental characteristics, such as their desire to be independent and their tendency to disapprove authoritative relationships. Consequently, we developed the Motivating Teens to Sleep More (MTSM) program, which aims to fill the gaps of previous adolescent sleep interventions, namely enhancing motivation (i.e. attitudes, self-efficacy and readiness to change) in order to drive earlier bedtime and longer sleep duration in normally developing adolescents.

The Current Study

The MTSM program aims to enhance motivation by incorporating three main active ingredients, namely a motivational interviewing (MI) style, a stage-based intervention approach and a tailored intervention approach (Cassoff et al., 2014). MI is a non-confrontational counselling style that aims to enhance motivation for behaviour change (Rollnick & Miller, 1995). MI has been successful in the context of health behaviours and has been recommended for use with adolescent sleep (Gold & Dahl, 2010). Stage-based interventions, are grounded on the transtheoretical model of change (TTM; Prochaska & Velicer, 1997) and deliver stage-tailored content that is aimed at promoting movement through the stages of change (precontemplation, contemplation, preparation, action, and maintenance). Staged-based health interventions have been found to increase decisional balance (Frenn, Malin, & Bansal, 2003; i.e. positive attitudes towards the behaviour), self-efficacy (Frenn et al., 2003; i.e. perceived competence in making the behaviour change), and the health behaviour itself (Prochaska & Prochaska, 2010). Thus, stage-based interventions offer differential strategies depending on the current stage of change, also known as readiness to change, in order to elicit stage progression and enhance positive attitudes and self-efficacy related to the target behaviour and the target behaviour itself. Tailored interventions enhance the efficacy for behaviour change through incorporating personalized activities characteristic to the individual, such as their self-identified values and health knowledge (Kreuter et al., 2003; Noar et al., 2007). See Cassoff et al. (2014) for a detailed description of the theoretical rationale of the MTSM program.

The objective of the current study was to compare the effectiveness of the one-on-one MTSM program with a one-on-one sleep education program on improvements in weekday bedtime, sleep duration, self-efficacy related to advancing bedtime, positive attitudes towards

sleep, and readiness to go to bed earlier. An active sleep education control group was used to parse the beneficial effect of the one-on-one aspect of the intervention from the beneficial effect of the active ingredients of the intervention (i.e. stage-based, tailored sleep education, and MI style). It was hypothesized that participants obtaining the one-on-one MTSM program will demonstrate more positive changes in the sleep and motivational outcomes, than participants obtaining the one-on-one sleep education program.

Methods

Participants

Participants were 22 (11 males, mean age = 14.27) high school students (grade 7-11) recruited primarily from private high schools in the Montreal area. Other recruitment venues included advertisements in community settings (e.g., recreation centers, grocery stores). Adolescents who participated in the pre-intervention study of this research program were not eligible to participate in the current study. Inclusion criteria included reporting less than ideal sleep duration (i.e., having approximately 9 hours or less of sleep on a school night) and reporting being within the contemplation stage of change (i.e., those who are considering changing their bedtime within the next six months but are not currently taking steps to do so). The exclusion criteria included any sleep, medical and/or mental condition that may interfere with sleep. The screening procedure for medical/mental health conditions consisted of having parents indicate whether their child has been suffering from any of the following medical/mental health conditions within the past twelve months. If they indicated “yes” to asthma attacks, and/or skin condition, and/or Attention Deficit Disorder (ADD), and/or Attention Deficit and Hyperactivity Disorder (ADHD), and/or conduct disorder, and/or anxiety disorder, and/or depression, their child was ineligible to participate in the study. The screening procedure for sleep disorders consisted of having the parent and child together complete the Sleep Disorder Inventory for Children (SDIS-A). A child was excluded if

he/she obtained a total score of 104 or higher (Luginbuehl, Bradley-Klug, Ferron, Anderson, & Benbadis, 2008), indicating potential sleep disorders including obstructive sleep apnea, periodic limb movement disorder, delayed phase sleep disorder, excessive daytime sleepiness, and narcolepsy. A total of 48 participants were initially screened and 17 were excluded based on selection criteria. Ethics approval was obtained by the McGill Research Ethics Board. See Figure 1 for a CONSORT diagram describing the study flow.

Design

The study was a parallel-group randomized control trial (trial registry # ISRCTN19425350) in which the experimental group obtained the one-on-one MTSM program and the control group obtained one-on-one sleep education. Weekday bedtime, sleep duration, readiness to advance bedtime, positive attitudes towards sleep and sleep-related self-efficacy were determined at four time points (pre, mid and post program, and at six months follow-up). Assuming an effect size of 0.25, (Treasure, 2004) the required number of participants was calculated for a power level of .80 and an alpha level of .05. Given the between-within subject design with variables measured at pre, mid, post and 6-months follow-up, power analyses revealed that a sample size of 24 adolescents would be required. In order to account for a potential drop-out rate of 20%, approximately 30 participants were targeted for recruitment. In order to determine whether sleep data collected through survey measures were valid, the present study compared actigraphy and self-reported survey data before and after the intervention to determine whether the two measures provided similar results. Actigraphy data was not used as the primary sleep outcome because the study was underpowered (i.e., power = 0.13) to detect significant differences. Conversely, using the sleep data from the sleep logs provided sufficient power (i.e., 0.6-0.8) because the 22 participants completed an additional assessment (i.e. mid-intervention), thus

resulting in four within-subject time points in lieu of only two for the actigraphy data. In the original protocol, there was a three month follow-up assessment. However, this assessment fell during the summer school vacation months for the majority of participants and therefore was not included in the current analyses as per the current focus on school night bedtime and sleep duration.

Procedure

See Cassoff et al. (2014) for a detailed description of study procedures. All contact with the potential participants prior to enrollment was conducted by research assistants who did not deliver the program. Following parental consent and screening assessments, eligible participants were contacted and provided with information regarding the study's location (at either the participant's home or in a classroom at his/her school), duration (1 hour per week) and number of sessions (four sessions total), to schedule their first session, and to complete online baseline questionnaires (e.g. personal values, sleep knowledge) at their own convenience. These measures were used to tailor the activities within the sessions. Prior to beginning the baseline questionnaires, participants were presented with an assent text, which included information regarding the study written at a reading and comprehension level suited for individuals aged 12, and were asked to give their informed assent and agreement to participate in the study. Each participant was randomly assigned to either the MSTM program (group A) or sleep education (group B) sessions. A secure randomization service (www. randomization.com) was used to create the randomization sequence, which was assigned a 1:1 ratio for group A and B and generated by a research assistant who did not deliver the program. Participants were blind to the condition to which they were assigned.

Students met with the interventionist at their school or home (one week before the start of the sessions) and were provided with an actiwatch and sleep log instructions for using it for seven nights in a row. The same procedure was replicated for a week following the program. All sessions were one hour in duration and took place once a week either at the child's school or home for four consecutive weeks. Following program completion, participants were compensated with a $15 gift certificate to a local movie theatre. Interventionists were two graduate students in psychology who each delivered the sleep education program and the MTSM program with half of the participants in the control and experimental groups. The interventionists completed a standardized two-day training session on the study procedures, the MTSM program, and the sleep education program. One of the interventionist also had over 20 hours of clinical training by the Motivational Interviewing Network Trainers and subsequently trained the other interventionist in MI. Two research assistants listened to audio-recordings of the sessions and completed fidelity assessments throughout the course of the study in order to ensure reliability of the interventionists in delivering the study protocol. The fidelity assessment was developed for the current study and includes a section of the Motivational Interviewing Treatment Integrity Code (Moyers et al., 2010). Study recruitment and follow-up assessment took place between November 2012 and January 2015. Recruitment ended when the desired sample size was reached.

One-on-One Sleep Education (Control Condition)

Participants in the control condition obtained four one-on-one sleep education sessions. The sleep education sessions included topics such as "sleep in general," "teenagers and sleep," "sleep disorders," and "sleep hygiene." The interventionist answered content-related questions but did not provide any motivational strategies delivered in the experimental condition.

One-on-One MTSM Program with Embedded Sleep education (Experimental Condition)

Please refer to Cassoff et al. (Cassoff et al., 2014) for an additional description of the MTSM program. The MTSM program employed a stage-based approach such that the interventionist chose activities to conduct in the session that were congruent with the participants' current readiness to advance bedtime. For example, if the participant was in the contemplation stage, knowledge provision was conducted while if the participant was in the action stage, goal setting exercises were conducted. Each activity was further personalized according to the unique characteristics of the participants. For example, participants were provided with sleep education in a way that was tailored to what they currently did and did not know in lieu of a 'one size fits all' approach as in the control condition. Finally, the interventionists delivered the sessions in a MI style. A MI style consisted of expressing empathy towards the adolescent related to their sleep behaviour change, encouraging the adolescent to autonomously decide to go to bed earlier rather than imposing a set bedtime, rolling with resistance related to adopting earlier bedtimes, and helping the adolescent realize that there is a discrepancy between their current late bedtime and their life goals and values. A primary focus was to guide the participant in realizing that their current late bedtime is incongruent with their personal life values (e.g. athletic performance, academic success, interpersonal relationships etc; Cassoff et al., 2014).

Measures

The measures and data reported herein are part of a larger study that also included secondary variables of interest such as social influences, cues to action, and sleep hygiene. These variables are not directly related to the impact of the MTSM intervention on bedtime advancement and therefore are not included in the current paper, which focuses on the primary variables of interest. All materials are available from the authors upon request. Sleep variables were assessed

at baseline, mid-intervention, post-intervention and at follow-up. All other outcomes were assessed at baseline, following each of the four sessions and at follow-up.

School night bedtime and sleep duration.

Sleep logs. Bedtime and sleep duration were assessed through daily sleep logs for a week before, during, and after the intervention. Sleep duration was calculated by measuring the time duration in between bedtime and wake time as indicated in the sleep log.

Actigraphy. In order to validate the entries in the sleep logs, actigraphy was conducted for a week prior to and following the intervention. Actigraphy is a method used to measure sleep-wake patterns through body movement (Short, Gradisar, Lack, Wright, & Carskadon, 2012) by recording data from accelerometers several times per second. It uses a small device usually attached to the wrist of the participant's non-dominant hand. Actigraphy has been well-validated against polysomnography with in pediatric populations (Johnson et al., 2007).

Self-Report. A 1-item self-reported assessment of sleep duration and bedtime on the weekdays was completed six months following the intervention to assess long-term behaviour change.

Readiness to go to bed earlier. A readiness ruler (LaBrie et al., 2005) adapted to sleep was completed such that participants indicated on a 10-point ruler how they presently feel about going to bed earlier. Anchors included "Never think about my bedtime," Sometimes I think about advancing my bedtime," "I have decided to advance my bedtime," "I am already trying to advance my bedtime," "My bedtime has changed, I now go to sleep earlier." The readiness ruler has shown good criterion validity with adolescent self-reported behaviour in the areas of marijuana use and alcohol consumption (Maisto et al., 2011). The readiness to change questionnaire (RTCQ; Rollnick et al., 1992) was administered before and after the intervention

to assess participants' discrete stage of change. Precontemplation, contemplation, and action were each represented by four items measured on a 5-point scale (−2 = *strongly disagree* to +2 = *strongly agree*). The highest sum of responses on each scale represented the current stage of change.

Sleep-related self-efficacy. Sleep-specific self-efficacy was measured with the sleep self-efficacy questionnaire (Watts et al., 1995) modified to assess control over putting oneself into bed. Sample items include "How much do you feel that you have the ability to go into your bed at an earlier hour?" and "How much do you feel that the time it takes to go into your bed is under your control?" rated on a 4-point scale. Responses (1 = *not at all to* 4 = *to a great extent*) of the 4-item questionnaire were modified to fit with the question stem. This scale demonstrated good internal reliability (Chronbach's alpha = 0.93) in the current study.

Attitudes towards sleep. A decisional balance instrument was used to assess attitudes towards sleep. The questionnaire was developed for this study based on the work of Orzech (2013), Noland, Price, Dake, & Telljohann (2009), and Pawlak & Colby (2009), and it consists of twenty-two items: twelve items about the pros and the rest about the cons of going to bed earlier. Positive attitudes towards sleep were computed as the difference between the standardized "pros" scores and the standardized "cons" scores. A score of zero would imply an equal amount of pros and cons, while higher scores imply more pros than cons (i.e. more positive attitude). In the current sample, the pros and cons subscales had good (Chronbach's alpha = 0.92) and adequate (Chronbach's alpha = 0.75) internal reliability respectively.

Statistical Analyses

Data analyses were conducted using the Statistical Package for the Social Sciences (SPSS v. 20, SPSS Inc, Chicago, USA). For the sleep variables, only weeknights (including Sunday

night but not Friday night) were considered. For the psychological variables, the mid-intervention time point was calculated as the mean responses following session 2 (before session 3). Unpaired-samples t-tests were used to assess differences between the experimental and control groups at baseline. For the sleep variables, a series of two-way repeated measures analysis of covariance (ANCOVA) with age and gender as covariates were conducted with time (pre-intervention vs. mid-intervention vs. post-intervention) as the within-subjects factor and group (experimental vs. control condition) as the between-subjects factor. Age and gender were entered as covariates as they have been found to impact sleep timing in adolescent populations.

For the motivational variables, a series of two-way repeated measures analysis of covariance (ANCOVA) with age and gender as covariates were conducted with time (pre-intervention vs. mid-intervention vs. post-intervention vs. 6-month follow-up) as the within-subjects factor and group (experimental vs. control condition) as the between-subjects factor. Prior to analyses, data were examined for missing values, normality, and outliers. Please see Figure 1 for a CONSORT diagram describing data excluded from analysis.

At the six months assessment, two questions were completed in lieu of sleep logs for bedtime and sleep duration. Therefore, between-group ANCOVAs were conducted to assess differences between groups six-month post intervention. In both analyses the independent variable was group while the dependent variable was the sleep variable (i.e. sleep duration or bedtime) and the covariate was the baseline assessment of the sleep variable. The assumptions for all ANCOVAs were met such that the homogeneity of the regression effect was evident for the covariate, and the covariate was linearly related to the dependent measure.

Effect sizes for the analyzed variables (i.e., bedtime, sleep duration, readiness to change and self-efficacy) between and within groups at each time point were calculated by computing

standardized differences in means using Comprehensive Meta-Analysis, Version 2.2.057 CMA; (Borenstein, Hedges, Higgins, & Rothstein, 2005). Additionally, mean effect sizes for both within-group and between-group analyses at different time points (i.e., Mid, Post, and 6-months follow-up) were calculated by pooling effect sizes of all analysed variables using a random effect model rather than a fixed model in order to account for the variability between the different measures. For both groups, we calculated Hedge's *g*, its 95% confidence interval (95% CI), and the associated *z* and *p* values (Hedges, 1981). Effect sizes were interpreted according to Cohen's criteria of 0.2 for a small effect, 0.5 for a moderate effect, and 0.8 for a large effect (Cohen, 1977).

Results

Table 1 presents the Pearson correlations between actigraphy and survey data for the sleep variables. All variables measured through actigraphy were significantly correlated to their respective variables assessed in the survey.

Pre-Intervention Measures

Refer to Table 2 for means and standard deviations of sleep and motivational variables in the control and experimental groups at baseline. No significant differences were found between the experimental and control group on all variables (all $p > 0.05$).

Evaluation of the MTSM Program vs. Sleep Education on Sleep Outcomes

As expected due to consistent school start times there were no statistically significant differences in wake time on weekdays between or within either group at all three time points. While controlling for age and gender, a two-way repeated measures ANCOVA revealed a significant time by group interaction ($F(2, 36) = 3.61$, $p = .037$) for bedtime (please see Figure 2a). Post-hoc analyses (pairwise comparisons) revealed that immediately post-intervention, the experimental group reported a significantly ($F(1,18) = 8.01$, $p = .011$, Cohen's $d = 1.42$) earlier

bedtime (10:30 PM) than the control group (11:16 PM). Further, the experimental group reported a significantly (p = .028, Cohen's d = 0.71)) earlier bedtime at post intervention (10:30PM), as compared to pre intervention (11:00PM). In contrast, the control group's bedtime did not change over the course of the intervention. Further, there were no significant changes in either group from pre to mid intervention or mid to post intervention. Pertaining to the six months post intervention assessment, a between-group ANCOVA showed no difference between the two groups when controlling for bedtime (assessed with online questionnaires) at baseline.

When controlling for age and gender, a significant time by group interaction $F(2, 36) = 3.46$, $p = .042$) for sleep duration was found (please see Figure 2b). Within-group pairwise comparisons ($F(2,17) = 4.12$, $p = .035$) indicated that participants in the experimental group reported significantly longer sleep duration at mid intervention (8.84 hours; p = .019, Cohen's d = 0.58) and post intervention (9.10 hours; p = .022, Cohen's d = 0.91), as compared to pre intervention (8.28 hours). The control group, however, reported no improvement in sleep duration at any time point. Further, there were no significant changes within either group from mid to post intervention or between groups at any time point. Similar to bedtime, at six months post intervention, there was a non-significant difference between groups in sleep duration (assessed with the online questionnaires) after controlling for sleep duration at baseline.

Evaluation of the MTSM Program vs. Sleep Education on Motivational Outcomes

A two-way repeated measures ANCOVA,controlling for age and gender, revealed a significant main effect of time for readiness to go to bed earlier on a school night ($F(3, 54) = 3.43$, $p = .023$) . Pairwise comparisons ($F(3,16) = 22.83$, $p = .00$) showed an advancement of stage of change from pre to mid program (p = .003, Experimental group Cohen's d = 1.34*;* Control group Cohen's d = 0.79) and pre to post program (p = .00, Experimental group Cohen's

d = 1.93*;* Control group Cohen's *d* =1.46) in both groups. At the 6-months assessment, participants reverted to an earlier stage of change, which remained improved compared to pre intervention (p = .032). A Mann-Whitney test was conducted to determine whether stage of change at the post intervention assessment was different between groups as per the discrete stage distribution assessed by the RTCQ (Rollnick et al., 1992). Analysis revealed that stage of change was statistically significantly higher in the experimental group as compared to the control group (U = 27.5, p = .012). Specifically, at the post program assessment, 73% of experimental participants reached the action stage of change while only 18% of control group participants advanced to this stage.

Additionally, there was a significant time by group interaction $F(3, 16) = 3.71$, p = .034, η_p^2 = .41, for sleep-related self-efficacy while controlling for age and gender. While the experimental group reported increased self-efficacy at mid intervention (p = .007, Cohen's *d* =1.07) and post intervention (p = .001, Cohen's *d* =1.45) as compared to pre intervention ($F(3,16) = 5.59$, p = .008), the control group did not increase at any time point. At the six month time point, the experimental group reverted back to sleep self-efficacy levels comparable to baseline (p = .023).

There were no statistically significant increases in positive attitudes towards sleep between or within groups at any time.

Pooled Effect Size

Mean effect-size estimates suggested large effects at post treatment for the MTSM group (Hedge's g = 1.15; 95% CI [.20, 2.11], $p < .05$). Between-group analyses suggested that MTSM program was largely more effective than the sleep education program at post treatment (Hedge's

g = 1.20; 95% CI [.32, 2.08], p < .01). Analyses at mid treatment and at 6-months follow-up for both within and between groups were not statistically significant.

Discussion

The present study was the first to use a one-on-one MI intervention to advance bedtime in normally developing adolescents. Unlike previous interventions (Cain et al., 2011; Moseley & Gradisar, 2009), the MTSM program was tailored to the motivational readiness and personal values of each adolescent in order to maximally increase motivation. In line with recent evidence, it was hypothesized that a motivation-focused intervention as compared to a sleep education only intervention would to lead to sustained earlier bedtimes in this population (Cain et al., 2011; Cassoff et al., 2013; Gold & Dahl, 2010). Results revealed that experimental participants did adopt earlier bedtimes and longer sleep duration on school nights. Further, given that wake times did not change, it is likely that the longer sleep duration was due to earlier bedtimes. Following the program, participants in the experimental group reported obtaining on average 9.1 hours of sleep a night, which is the ideal amount of sleep recommended for this age group (NSF, 2006). In fact, the large effect sizes of the current study with an active control group in comparison to the medium effect sizes found in other motivational sleep studies using passive control groups (Cain et al., 2011; Moseley & Gradisar, 2009) further demonstrates the efficacy of the MTSM program. The effectiveness of the MTSM program is consistent with a recent meta-analysis concluding that MI can be successfully applied to improve a wide range of adolescent health behaviours. (Cushing, Jensen, Miller, & Leffingwell, 2014) However, in the current study, the group differences in bedtime were not sustained at the six months follow-up assessment. The inability to sustain earlier bedtimes is consistent with findings from a previous motivational sleep promotion study (Moseley & Gradisar, 2009) offered to classrooms of students in which a reduced discrepancy between weekend and weekday out of bed times

disappeared at the follow-up assessment. Offering the sleep promotion program to adolescents on a one-to-one basis, as in the current study, is not sufficient to maintain sleep behaviour changes.

In addition to driving earlier bedtimes and longer sleep duration, the MTSM program was effective in enhancing motivational variables consistent with the TTM, namely, sleep-related self-efficacy and stage of change (i.e. readiness to go to bed earlier). Increases in self-efficacy and progression through the stages of change are consistent with other successful stage-based interventions for adolescent health behaviours such as smoking (Erol & Erdogan, 2008), dieting (Frenn et al., 2003) and healthy eating (Di Noia, Schinke, Prochaska, & Contento, 2006). Inconsistent with previous research indicating the importance of fostering positive attitudes towards sleep in order to motivate earlier bedtimes (Cain et al., 2011), positive attitudes towards sleep were not improved following the MTSM program. The current study employed a decisional balance measure (i.e. pros to go to bed earlier minus cons to go to bed earlier) to assess positive attitudes towards adopting earlier bedtime. Thus, it is possible that adolescents did adopt more positive attitudes towards sleep but that their negative attitudes negated the improvements. This is consistent with previous research (Cassoff et al., 2013; Gold & Dahl, 2010) describing adolescents' high ambivalence with regards to making earlier bedtimes a priority in their lives.

Surprisingly, in the current study, participants in the control group also improved in their readiness to go to bed earlier (albeit way fewer of them reached the action stage). This is inconsistent with previous research suggesting that sleep education is not sufficient to drive motivational change (Blunden et al., 2012). It is possible that the one-on-one interaction with the interventionist during the sleep education sessions engaged the participant more so than previous

sleep education programs delivered to classrooms of student (Cain, 2012) thus resulting in increased motivation. Importantly, significantly more participants in the experimental group compared to the control group reported being in the action stage of change following the program, which indicated that they were actively trying to go to bed earlier. Indeed, reaching the action stage of change is also associated with adolescents adopting other health behaviours including healthy eating (Frenn et al., 2003), physical activity (De Bourdeaudhuij et al., 2005) and consistent teeth brushing (Ayo-Yusuf, Reddy, & Van Den Borne, 2009).

Given that only participants in the experimental group reported earlier bedtime and longer sleep duration following the program, it can be inferred that there was an active ingredient unique to the MTSM program driving the behaviour change. Further, given that sleep-related self-efficacy increased in only the experimental group and that significantly more participants in the experimental group reached the action stage of change, it is likely that increases in motivation (i.e. self-efficacy, readiness to change), facilitated the behaviour change.

In addition to motivational strategies, the MTSM program offered individualized action planning such as implementation intentions (i.e. if-then plans that link situational cues with behavioural responses (Gollwitzer, 1999) in order to facilitate the behaviour change once motivation was elicited. Thus, it may be possible that action planning was instrumental in translating participants' motivational readiness into behavioural change. This is supported by MI research indicating that once motivation is elicited, action planning is an integral next step to translate the enhanced motivation into behaviour change (Resnicow & McMaster, 2012). Future research should investigate the active role of action planning in combination with motivational strategies in driving earlier bedtimes in adolescents.

Given that participants who obtained the MTSM program did not maintain earlier bedtimes and self-efficacy improvements after six months, they may have benefitted from 'booster' sessions (Luszczynska & Haynes, 2009) following the completion of the MTSM program. At the six months assessment, adolescents decreased in their readiness to change to a level that remained significantly higher than baseline, suggesting that their motivational readiness persisted but to a lesser degree at the long term follow-up. Therefore, it is possible that 'booster' sessions including implementation intentions and self-efficacy strategies in combination with their relatively sustained improvements in readiness to change may prevent them from reverting back to their late bedtimes and ensure that they remain in the action stage of change. Indeed, booster implementation intentions have been effective in maintaining increases in fruit and vegetable consumption over six months (Chapman & Armitage, 2010). Future research should consider providing adolescents with motivational and goal setting strategies even after the sleep intervention is complete as a way to maintain initial sleep behaviour changes.

This study had several limitations. First, participants did not complete weekly sleep logs at the six months assessment and therefore the follow up data could not be included in the main repeated measures analyses. Second, actigraphy data were collected at only two time points (before and after the intervention) and therefore were not the primary outcome in the current study due to insufficient power to detect significant differences. Despite this limitation, a strength of this study was the use of adolescent self-reported sleep timing, which has been recommended in lieu of parent estimates of adolescent sleep patterns (Short et al., 2013). Future longitudinal research should assess both subjective (i.e. weekly sleep logs) and objective (i.e. Actigraphy) sleep outcome measures at each time point. Third, the majority of the sample was recruited from private high schools in the Montreal area and would be characterized as only

borderline sleep restricted (i.e. between 8 and 9 hours of sleep) according to the National Sleep Foundation (2006). Future research should also evaluate the effectiveness of one-on-one motivational sleep intervention for adolescents who display more severe sleep restriction (i.e. < 8 hours) on school nights. Finally, future studies should investigate the mechanisms of action in motivational sleep promotion studies for normally developing adolescents by constructing studies that are powered to detect the motivational mediators of sleep behaviour change. Despite these limitations, the MTSM program was found to be largely more effective than the sleep education program at post intervention.

Conclusion

The current study provided initial evidence that the MTSM program was more effective than standard sleep education in motivating adolescents to adopt earlier bedtimes, thereby leading to longer sleep duration. Further, the active ingredients of the MTSM program – motivational interviewing, tailoring, and stage-based activities have shown to lead participants to adopt higher self-efficacy to go to bed earlier as well as reach the "action" stage of change. The results of this pilot study suggest that offering individualized and motivational sleep promotion interventions may be an effective approach to promoting healthy sleep in adolescents.

Table 1

Means and Standard Deviations for Key Sleep Variables and Pearson Correlations Between Actigraphy and Sleep Logs at Pre and Post Intervention for all participants

	Pre			Post		
	Actigraphy	Self-report	Correlation	Actigraphy	Self-report	Correlation
Bedtime *M* (*SD*)	11:18 (0:42)	11:01 (0:46)	.96**	11:18 (0:41)	10:55 (0:45)	.56**
Wake Time *M* (*SD*)	7:14 (0:55)	7:23 (0:59)	.99**	7:13 (0:39)	7:32 (0:3)	.67**
Sleep Duration *M* (*SD*)	7.36 (0.90)	8.39 (1.03)	.48*	7.78 (0.65)	8.40 (0.76)	.59**

Note. * $p < .05$; ** $p < .01$; The data above represents actigraphy and self-report data for all participants ($N = 22$) on weekdays in which the participant employed the Actiwatch; Self-reported sleep duration was calculated as a function of bedtime and wake time. Bedtime was calculated as per the time the participant fell asleep (i.e. sleep onset) in the actigraphy analysis.

Table 1

Means and Standard Deviations of Bedtime, Sleep Duration, Readiness to Go to Bed Earlier, Sleep-Related Self-Efficacy and Attitudes and Actigraphy Variables in the Experimental and Control Conditions from Time 1 (Pre-Intervention), Time 2 (Mid-Intervention), Time 3 (Post-Intervention) and Time 4 (Six Months Follow-Up).

	Control				Experimental			
	Time 1	Time 2	Time 3	Time 4	Time 1	Time 2	Time 3	Time 4
Readiness to change	5.09 (2.43)	6.82 (1.37)	7.91 (1.22)	7.27 (2.41)	5.09 (2.34)	7.57 (1.20)	8.91 (1.14)	7.27 (2.74)
Self-efficacy	2.31 (0.50)	2.55 (0.53)	2.36 (0.58)	2.50 (0.77)	2.00 (0.59)	2.62 (0.57)	2.77 (0.47)	2.14 (0.94)
Positive Attitudes	0.05 (1.47)	0.41 (1.79)	2.71 (0.98)	2.21 (0.58)	0.003 (1.02)	-0.19 (0.69)	2.49 (0.85)	2.27 (0.74)
Bedtime	10:54 (0:49)	11:06 (0:35)	11:16 (0:35)	10:58 (0:38)	11:00 (0:45)	11:00 (1:05)	10:30 (0:38)	11:58 (0:48)
Wake time	7:09 (0:31)	7:11 (0:33)	7:25 (0:36)	N/A N/A	6:51 (0:27)	7:24 (1:22)	7:11 (0:30)	N/A N/A
Sleep Duration (hours)	8.73 (0.75)	8.60 (0.64)	8.48 (0.71)	7.52 (0.43)	8.28 (0.94)	8.84 (0.98)	9.10 (0.87)	7.48 (1.02)
Actigraphy variables								
Sleep onset	11:25 (0:48)	N/A N/A	11:39 (0:36)	N/A N/A	11:11 (0:35)	N/A N/A	10:58 (0:36)	N/A N/A
Sleep offset	7:44 (1:02)	N/A N/A	7:28 (0:45)	N/A N/A	6:45 (0:26)	N/A N/A	6:58 (0:27)	N/A N/A
Total sleep time	7.06 (1.25)	N/A N/A	6.91 (0.81)	N/A N/A	6.61 (0.64)	N/A N/A	6.93 (0.72)	N/A N/A

Note. Sleep duration and bedtime were assessed with a single item question at the six months follow-up in contrast to weekly sleep logs at the other time points. Sleep onset = time the participant fell asleep at night; sleep offset = time the participants woke up in the morning

Figure Legends

Figure 1. CONSORT diagram indicating participant flow throughout the study

Figure 2. Weekday bedtime (a) and sleep duration (b) in the experimental and control conditions at Time 1 (Pre-intervention), Time 2 (Mid-intervention) and Time 3 (Post-intervention)

Figure 1.

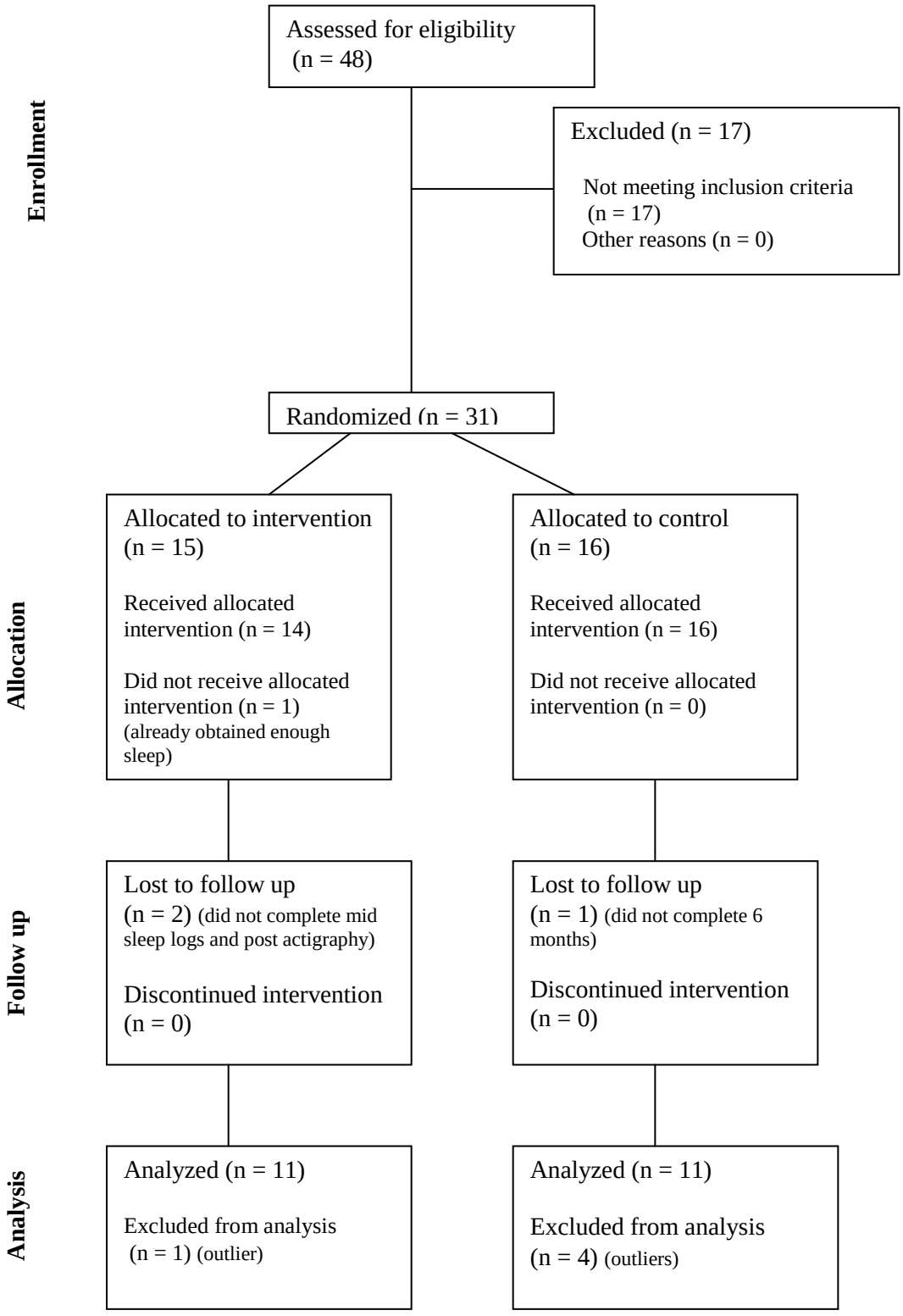
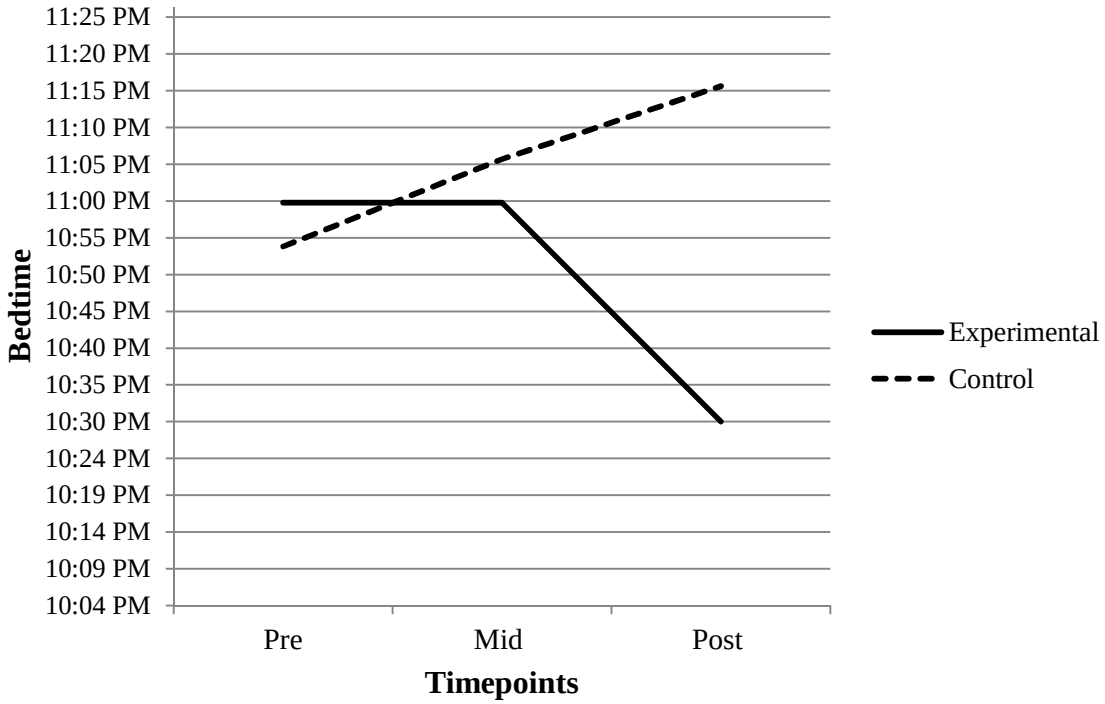
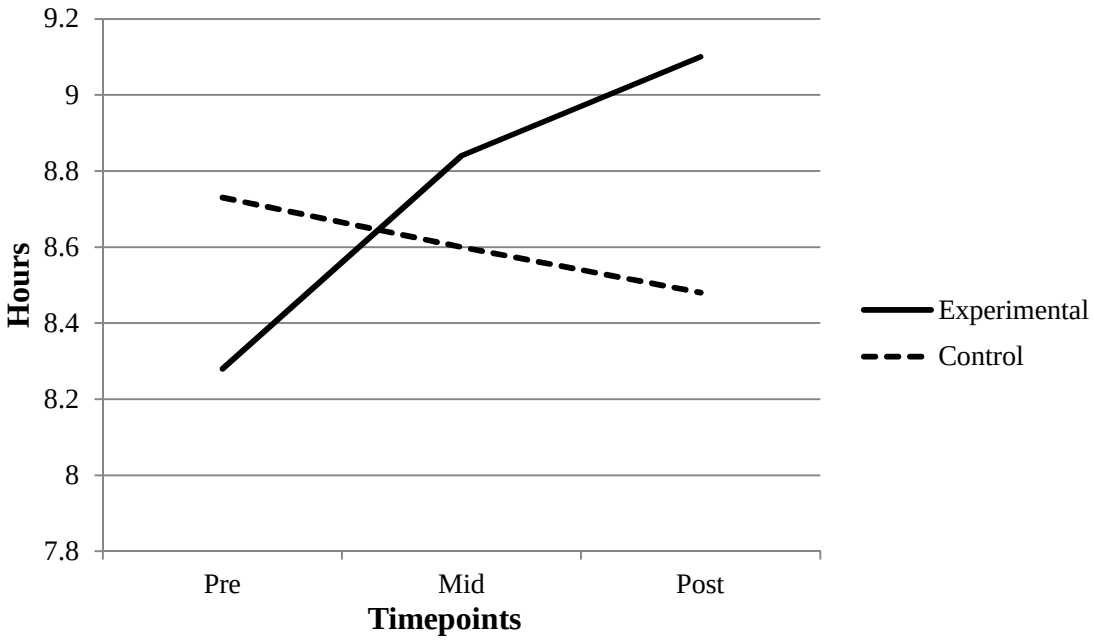

Enrollment
Assessed for eligibility (n = 48)
Excluded (n = 17)
Not meeting inclusion criteria (n = 17)
Other reasons (n = 0)
Randomized (n = 31)
Allocation
Allocated to intervention (n = 15)
Received allocated intervention (n = 14)
Did not receive allocated intervention (n = 1) (already obtained enough sleep)
Allocated to control (n = 16)
Received allocated intervention (n = 16)
Did not receive allocated intervention (n = 0)
Follow up
Lost to follow up (n = 2) (did not complete mid sleep logs and post actigraphy)
Discontinued intervention (n = 0)
Lost to follow up (n = 1) (did not complete 6 months)
Discontinued intervention (n = 0)
Analysis
Analyzed (n = 11)
Excluded from analysis (n = 1) (outlier)
Analyzed (n = 11)
Excluded from analysis (n = 4) (outliers)

Figure 2.

(a)



(b)



Note. Bedtime was assessed with weekly sleep logs at Pre-, Mid-, and Post-intervention but with a single self-reported item at six-months follow-up. Therefore, the six-month bedtime data were not included in the repeated measures analysis or the figures herein.

CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	Title Page
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	Abstract
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	Introduction
	2b	Specific objectives or hypotheses	p.6
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	p.8
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	N/A
Participants	4a	Eligibility criteria for participants	p.7
	4b	Settings and locations where the data were collected	p.7
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	p.9-10
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	p.10-12
	6b	Any changes to trial outcomes after the trial commenced, with reasons	p.8
Sample size	7a	How sample size was determined	p.8
	7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	p.9
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	p.9
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	p.9 p.8-9
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to	p.9

		interventions	
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	p.9
	11b	If relevant, description of the similarity of interventions	p.10
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	p.12-13
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	p.12-13
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	Figure 1
	13b	For each group, losses and exclusions after randomisation, together with reasons	Figure 1
Recruitment	14a	Dates defining the periods of recruitment and follow-up	p.9
	14b	Why the trial ended or was stopped	p.10
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	p.7 (in-text)
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	Figure 1
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	p.14-16
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	N/A
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	N/A
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	N/A
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	p.19
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	p.19
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	p.16-20
Other information			
Registration	23	Registration number and name of trial registry	Abstract
Protocol	24	Where the full trial protocol can be accessed, if available	p.6, 8, 10
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	Title page

General Discussion

Through conducting a literature review and two studies, I investigated the question of how adolescents can be motivated to go to bed earlier. My first publication outlines existing sleep interventions aimed to promote healthy sleep in adolescents and concluded that current programs are not effective in improving sleep behaviour. I hypothesized that this was because they did not target the motivation of adolescents but rather only focused on enhancing their sleep knowledge. Only one intervention has attempted to enhance adolescent motivation and although results were promising in terms of increasing motivation levels, sleep behaviour change still did not occur. The methodological limitation of this study was that the intervention tool, *motivational interviewing*, was delivered simultaneously to a group of adolescents rather than individually. The theoretical limitation of the study was that important elements of motivation such as self-efficacy to make a sleep behaviour change were not targeted and thus adolescents did not develop sufficient motivation to translate their knowledge about the importance of sleep into behavioural improvements.

Given the scarcity of motivational sleep promotion programs for adolescents and the need to develop effective programs that result in behaviour change, Study 1 aimed to identify variables that can increase adolescent motivation. The intention was to utilize the insights gained from in Study 1 in order to develop an evidenced-based sleep intervention for Study 2. Specifically, my plan was to identify significant variables in Study 1 and later assess and manipulate these variables in a sleep intervention in a way that enhances adolescent motivation to sleep more and results in earlier bedtimes. For Study 1, I derived sleep-related awareness and motivation variables that should theoretically predict adolescent intention to go to bed earlier according to the Integrated Change Model. I then evaluated whether this model was valid in a

sample of sleep deprived adolescents. This was the first study to apply a health behaviour theoretical model in the context of adolescent sleep and to evaluate predictors of adolescent intention to advance bedtime. Results from Study 1 indicated that adolescents who perceived cues to go to bed earlier and who had positive attitudes towards sleep expressed a greater intention to go to bed earlier and that parental bedtime setting was associated with less intention to go to bed earlier. Based on the results of Study 1, I concluded that the intervention developed for Study 2 should aim to enhance adolescents autonomous motivation (as opposed to controlled motivation) to adopt earlier bedtimes and offer ways in which adolescents can independently detect cues to go to bed earlier and develop positive attitudes regarding sleep. I created the *MTSM* program, which aims to enhance adolescent awareness and motivation to adopt earlier bedtimes as well as offer adolescents goal setting techniques in order for them to be well-equipped to carry out the behaviour change. The 'active ingredients' of the intervention included engaging in a motivational interviewing style, performing activities that seek to enhance processes necessary for the participant to progress through the stages of change and tailoring the activities to the participant's relevant personal characteristics such as life values. Results from the intervention study demonstrated that the *MTSM* program was more effective than sleep education alone in advancing bedtime, elongating sleep duration and enhancing sleep-related self-efficacy in the short but not long term. Further, significantly more participants in the experimental group compared to the control group reached the action stage of change indicating that they were currently attempting to go to bed earlier. Additionally, we found large effect sizes using an active control group in comparison to the medium effect sizes found in other motivational sleep studies using passive control groups further suggesting the effectiveness of the program in enhancing motivation and improving sleep behaviour in the short term. Future

research should investigate whether offering booster sessions to solidify motivational readiness and support goal setting result in sustained earlier bedtimes and longer sleep duration even after the program is completed. In addition to offering booster sessions, future research should attempt to replicate this intervention through a channel that is able to target many adolescent simultaneously (e.g. Internet) while still maintaining the collaborative, engaging and supportive relationship created by the one-on-one, direct contact with an interventionist.

Together, the manuscripts in this dissertation have found that in addition to providing sleep education, engaging the adolescents to adopt earlier bedtimes in a way that is individualized and non-confrontational is needed to foster the motivation to go to bed earlier. Once motivation is elicited, goal setting strategies should be implemented that translate the motivation into action in order to first enable and then maintain the actual behaviour change (i.e. earlier bedtimes).

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