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Readiness to change and commitment as predictors of therapy compliance in adolescents with Delayed Sleep-Wake Phase Disorder

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Abstract

Objectives: Recent evidence indicates that adolescents' motivation to change sleep-wake patterns is low, despite significant impact of adolescent sleep problems on many areas of daytime functioning. The aim of the present study is to evaluate components of adolescents' motivation, and subsequent changes in behaviour.

Methods: Fifty-six adolescents, aged 13-23 (*M*=15.8±2.3y; 38%m) diagnosed with Delayed Sleep-Wake Phase Disorder underwent three therapy sessions involving bright light therapy to phase advance sleep patterns. Adolescents were instructed to advance wake-up times by 30-minutes daily. Motivation ratings of desire, ability, need and commitment to change sleep patterns were taken at baseline. Sleep diaries were taken at the end of treatment session 1, with sequentially earlier wake-up times in 30-min intervals indicating compliance.

Results: Adolescents' sleep-onset times were significantly advanced, total sleep time increased and sleep latency decreased (all $p<.05$). Adolescents indicated strong desire, reasons and need, yet moderate ability and commitment to advance their sleep-wake patterns. Therapy lasted 6-27 days (M=13.9 ± 4.5) and clients complied for approximately half the time (between 3-15 days; M= 8.8 ± 2.7). Commitment was associated with ability ($r=.66$, $p<.001$) but not desire, reason or need (all $p>.05$). Adolescents' desire to change ($r=.30$, $p=.03$) and commitment ($r=.30$, $p=.03$) were positively correlated with behaviour change, but their need, ability and reasons were not. A mediation analysis showed that ability and desire were important in predicting behaviour change, by total effects through commitment (i.e., indirectly and directly).

Conclusion: Our findings suggest that the total effects of ability (i.e., confidence) and desire to change are the best predictors of behavioural changes, thus clinicians should focus on these components of the readiness to change model when undertaking treatments with sleep-disordered adolescents.

Keywords: motivational interviewing, adolescents, sleep, commitment, readiness to change, sleep disorders.

Abbreviations

DSWPD: Delayed Sleep-Wake Phase Disorder

LOT: Lights Out Time

OOBT: Out of Bed Time

SE: Sleep Efficiency

SOL: Sleep Onset Latency

SOT: Sleep Onset Time

TIB: Time in Bed

TST: Total Sleep Time

Tx: Treatment

WASO: Wake after Sleep Onset

WUT: Wake-Up Time

Delayed Sleep-Wake Phase Disorder (DSWPD) is a sleep disorder common in young people, and is characterised by an inability to go to sleep and wake up at a socially accepted time (AASM, 2014). For example, most adeolescents fall asleep between 10pm-midnight and awaken by 6-8am in order to meet daytime obligations (Carskadon et al., 1998). However, those with DSWPD may be unable to fall asleep until 2-6am and wake from 10am-2pm, for example. This clearly conflicts with social and occupational functioning in adolescents (e.g., attending school). If the young person nevertheless rises at a socially-acceptable time, they experience severe and chronic sleep restriction (Gradisar, Dohnt, Gardner et al., 2011). Due to this insufficient sleep, individuals suffer daytime impairments such as excessive sleepiness, fatigue, memory deficits as well as other behavioural and cognitive dysfunctions (AASM, 2014; Lovato et al., 2013; Sivertsen et al., 2015; Wilhelmsen-Langeland et al., 2013a). Therefore, this sleep disorder typically leads to negative lifestyle consequences (e.g., substance use, truancy, poor grades, etc.; Crowley & Carskadon, 2007; Bootzin & Stevens, 2005; Hasler et al., 2012) and is associated with an impaired quality of life (Van Maanen et al., 2013).

It is thought that DSWPD arises due to a delay in one's biological body clock (i.e., 24-hour circadian rhythm; AASM, 2014). The biological body clock is regulated via secretion of melatonin, thus in addition to social obligations to awaken early, circadian and melatonin secretion delays contribute to a delay in feeling sleepy. Circadian rhythm timing is linked with sleep patterns, thus a delay in circadian timing also delays sleep patterns. Sleep timing is also influenced by chronotype, which is a person's natural inclination or preference toward the times of the day when they prefer to sleep or feel most alert and energetic. There is inter-individual variation in chronotype, analogous to the normal distribution, such that some people are generally

morning- and others evening-types. The extremes of a morning or evening preference meet classification for circadian rhythm disorders, and DSWPD is commonly associated with extreme eveningness (AASM, 2014). Evening chronotype and circadian rhythm timing delays are particularly common during adolescence and young people seem most susceptible to DSWPD, showing the highest prevalence rates of any age group (i.e., 7-16%, AASM, 2014; Roenneberg, 2004; Carskadon, 1999; Crowley et al., 2007; Micic et al., 2016b). More relaxed bedtimes (Gangswisch et al., 2010; Short et al., 2011) and increased school and social obligations compound adolescents' risk of developing a delayed 24-hour circadian rhythm (Carskadon, 2011). Given this developmental period is associated with the greatest social and emotional changes that form a person's identity (Kaplan & Kaplan, 1989), the aforementioned negative consequences can have long-term impacts on young people throughout their lifespan (de Souza et al., 2014; Sivertsen et al., 2015; Touitou, 2013).

Empirically-supported treatments that phase shift sleeping patterns to an earlier time include light therapy, exogenous melatonin administration, and maintaining early rise times (Burgess, & Emens, 2016; Auger et al., 2015). Bright light therapy requires the individual to get up 30-min earlier each morning for 2 to 3 weeks and obtain adequate post awakening light exposure (Gradisar et al., 2014; Gradisar et al., 2011). In addition to adolescents' pre-existing low motivation to change sleep patterns (Bootzin & Stevens, 2005; Gradisar et al., 2014), light therapy is associated with poor compliance because of the need to structure activities (e.g., school classes, sports, socialising, etc.) around the timing of daily light exposure (Barion & Zee, 2007).

Many young people may seem apathetic to changing their sleep (Bootzin & Stevens, 2005; Moseley & Gradisar, 2009; Wilhelmsen-Langeland et al., 2012; Micic

et al., 2016a), warranting the need to address the motivational aspects of treatment (Regestein & Monk, 1995; Gradisar et al., 2014). Recent empirical evidence indicates that adults with DSWPD show significantly lower conscientiousness scores on personality measures compared to good sleepers (Wilhelmsen et al., 2013b; Micic et al., 2017). These personality types are said to be less motivated to deal with their problems (Costa & McCrae, 1992). Adolescents may not be motivated to get out of bed earlier as this behaviour change also entails going to bed earlier, and thus implies less time for leisure, extracurricular activities and communicating with friends in the late evening (Cassoff et al., 2013). This lack of motivation might account for the inefficacy of current programs aimed at changing adolescents' bedtime (Saxvig et al., 2014; Wilhelmsen-Langeland et al., 2013a). However, to date and the authors' knowledge, studies have not specifically measured motivation in DSWPD nor adolescence, nor its predictive capacity toward therapy commitment and behaviour change.

Several studies advocate the use of therapeutic procedures such as motivational interviewing to produce better treatment outcomes for adolescents in general (Gayes & Steele, 2014) and in DSWPD (Alvarez et al., 1992; Dagan et al., 1996; Regestein & Monk, 1995; Wilhelmsen-Langeland et al., 2013b; Gradisar et al., 2011; Gradisar et al., 2014). Motivational Interviewing (MI) has been effective in motivating behaviour change, especially when used in conjunction with another intervention (e.g., cognitive-behaviour therapy) (Anton et al., 2006; Hettema et al., 2005; Lundahl et al., 2010). Evaluation of clients' readiness to comply with therapy instructions is used to assess their commitment and, ultimately, behaviour change. Readiness includes their desire, ability, reason, and need (i.e., DARN) to change behaviour. DARN has been shown to predict commitment in therapy sessions (i.e., *"I*

will …"), and has been associated with compliance to therapy instructions (Amrhein, 2003).

The present study evaluates associations between adolescents' motivation and subsequent behavioural change (i.e., therapy compliance). We aim to discover how desire, ability, reason and need relate to adolescents' commitment and ultimately behaviour change. We initially hypothesise that adolescents will show significant pre- to post-therapy improvements in sleep (e.g., sleep onset latency, sleep onset time, total sleep time, etc.). It is also predicted that the relationship between desire, ability, reason and need, and the outcome variable of therapy compliance (i.e., behaviour change as reflected by waking earlier each day) will be mediated by commitment (Amrhein, 2003).

Methods

Participants

Parents and/or caregivers of 455 adolescents contacted the Child & Adolescent Sleep Clinic at Flinders University. They responded to advertisements in school newsletters, public advertisements and flyers distributed at various school and community events. Eighty three adolescents attended an initial Clinical Sleep History Interview with a psychologist to confirm DSWPD diagnosis (AASM, 2013; see Appendix). Of those, 60 adolescents aged 13-23yrs (M = 15.9±2.3yrs; 38%m) were recruited for the present study. This age range was chosen as adolescents and young adults have a biological tendency toward late chronotype (Roenneberg, 2004). Details of participant characteristics are available in Richardson et al. (2018) and a CONSORT diagram is presented in Figure 1. All adolescents and their caregivers provided informed consent,

and ethics approval was granted by the Southern Adelaide Clinical Human Research Ethics Committee.

Design

A prospective-correlational study design was used to determine whether aspects of readiness to change (desire, ability, reason and need) were related to commitment and behaviour change (i.e., compliance to therapy). Baseline sleep data were collected at the assessment appointment and the week between assessment and first therapy session. Motivation data were collected immediately after the delivery of the first therapy session, at which point compliance data collection commenced and ceased when each individual reached a 6am wake-up time.

Outcome Measures

Motivation Scale

Adolescents completed a 10-pt Likert scale assessing their desire, ability, reason, need and commitment to change, that was developed by the researchers based on previous reports of motivation and commitment (Miller & Rose, 2009; Miller & Rollnick, 2004). Questions were asked at the end of the first therapy session, immediately after outlining each adolescent's tailored, step-by-step, light therapy program for the upcoming week. Each item was rated from 1 = "*Not at All*" to 10 = "*A Lot/Extremely*" and include the following items: (Desire) "*How much do you **want** your body clock to be at a time that doesn't conflict with school/uni?*"; (Ability) "*How **confident** are you that you can keep your body clock at a time that doesn't conflict with school/uni?*"; (Reasons) "*How significant are your **reasons** to keep your body clock at a time that doesn't conflict with school/uni?"*; (Need) *"How important is it for you to have a*

body clock that fits with your school/uni times?"; and (Commitment) "*How much **will** you keep your body clock at a time that doesn't conflict with school/uni?*".

Compliance to Therapy

Therapy compliance or "behaviour change" was calculated by adding the number of mornings the adolescent woke up 30-minutes earlier across the duration of bright light therapy (i.e., up to 3 weeks), and dividing it by the number of therapy days (i.e., [number of days woke up 30-minutes earlier / number of days involved in therapy] x 100), to take account of individual differences in each adolescent's sleep pattern (see Treatment below). These data were taken from sleep diaries, and confirmed with wrist activity monitors (see Measures below).

Online Sleep-Wake Diary. The sleep diary is a daily, subjective record of adolescents' sleeping patterns, including: bedtime, sleep onset latency (SOL), sleep onset time (SOT), waking after sleep onset (WASO), wake up time (WUT), out of bedtime (i.e., treatment compliance variable of interest: OOB), and time of light exposure. Total sleep time (TST) and total time spent in bed (TIB) were also estimated to calculate sleep efficiency (SE = [TST/TIB] x 100). Online sleep diaries have been used in previous interventions with adolescents (Gradisar *et al*., 2011; Moseley & Gradisar, 2009), and show high sensitivity (92.3%) and specificity (95.6%) when compared to gold-standard polysomnography recordings (Rogers, Caruso, & Aldrich, 1993; Short *et al*., 2012).

Actigraphy. The wrist actigraph (Micromini-Motionlogger Actigraph, Ambulatory Monitoring Inc., NY, USA) is a non-invasive portable device that provides an objective indication of one's daily sleep-wake pattern across a 24-hour period in 1-minute epochs. Adolescents wore an activity motion monitor throughout

therapy. Motionlogger Analysis Software Package [Action W-2, NY, USA] was used to download and process recorded data. Adolescent sleep onset and offset times were scored using an algorithm validated for adolescents (AMI-Sadeh, Action 4, Ambulatory Monitoring Inc, Ardsley, NY). These data were analysed and compared with sleep diary data to ensure consistency in the treatment compliance variable (out of bedtime). Discrepancies between sleep diary and wrist actigraphy were noted at sleep onset times, however both tools were reliable measures of sleep offset (Richardson et al, *in press*). Ultimately, sleep diary data were used to calculate treatment compliance (i.e., out of bed time) as actigraphy has been shown to reliably detect sleep timing (i.e., sleep onset/offset) (Ancoli-Israel et al., 2003) rather than out of bed time. Furthermore, although actigraphy devices are sufficiently sensitive to detect sleep, they have poor specificity to correctly classify states of wakefulness (Marino et al., 2013; Short et al., 2012). However, as they can reliably detect sleep timing, the devices are commonly used in the evaluation of circadian rhythm disorders (Ancoli-Israel et al., 2003).

Procedure

Eligible adolescents' parents completed a brief screening via phone or email. The DSWPD diagnosis was confirmed from data derived from a semi-structured Clinical Sleep History Interview (Gradisar et al., 2011), and the sleep diary and actigraphy. The objectives of the treatment program were to improve adolescents' sleep and daytime functioning by using bright light therapy (via portable LED glasses; Wright et al., 2004) to re-time adolescents' sleep timing to an earlier time (Richardson et al., 2018). Adolescents were randomised to receive either green (active) or red (control) bright light, as well as either performing physical activity (motion-sensing video game) or sedentary activity (watching TV; Richardson et al.,

2018). While adolescents' sleep outcomes improved over time (see Table 1), there were no statistically significant interaction effects between treatment groups and time for all outcome variables ($p > 0.05$; Richardson et al., 2018), thus all adolescents were grouped together for the present study.

Adolescents' first therapy session covered psychoeducation, including information about 24-hour circadian rhythms, delayed circadian rhythms, and the use of bright light to phase advance delayed circadian rhythms. Individualised therapy plans were collaboratively developed between the psychologist, adolescent, and their parent, to create a plan for when to wake-up and get out of bed for the following week. On the first day of therapy, adolescents were instructed to sleep-in until their natural wake-up time (e.g., 11:30am), and thereafter wake up 30 minutes earlier each morning, for up to 3 weeks of therapy, until they achieved a 6am wake-up time (Gradisar et al., 2011; Gradisar et al., 2014). Adolescents were provided with their LED glasses and instructed to wear these 30-60 minutes per day, within the first 10 minutes upon waking up. They were also instructed to perform their set activity (motion-sensing videogame or sedentary activity [e.g., watch TV]) for the same amount of time. Parent and the adolescent were asked report for how long they completed the activity and wore the glasses each day at the end of each week (i.e., during each treatment session).

Adolescents were asked to continue wearing the actigraphy monitor and record their sleep using the online sleep diary. At the end of session 1, they completed the Motivation Scale with respect to what they thought will occur over the next 3 weeks. Sessions 2 and 3 consisted of reviewing and monitoring light therapy progress. Once a 6am wake-up time was reached, adolescents ceased using the LED glasses, and were asked to maintain a regular rise time.

Statistical Analyses

All data were analysed using the IBM SPSS Statistics Software version 25, in which descriptive statistics including means, confidence intervals, effect sizes, inferential statistics and zero-order correlations were derived. The results of zero-order correlations merited the use of mediation analyses (Baron & Kenny, 1986). Hence, the PROCESS for SPSS macro (Preacher & Hayes, 2014) was used to assess direct and indirect effects (indicating mediation) of desire, ability, reason and need (DARN) to change, on commitment and ultimate behaviour change. Age, gender, severity (greater severity=later pre Tx WUT on weekend) and chronicity (how long adolescents experienced the sleep problem) were firstly assessed as potential covariates of the model using zero-order correlation analyses. However, none were significantly related to the outcome variable ($p>0.05$, see Supplement Table 1). Thus, behaviour change was entered as the dependent variable, DARN were the predictors and commitment was the mediator. The effect between the predictor and the dependent variable is termed the 'direct effect', and an 'indirect effect' is that of the predictor on the dependent variable, via the mediator. The 'total effect' is the sum of both the indirect and direct effect of the predictor on the dependent variable (Preacher & Hayes, 2014). The *b* values are unstandardized regression coefficients. Number of bootstrap samples for bias corrected bootstrap confidence intervals is 10,000 and 95% confidence intervals are used. Cohen's *ds* were derived by calculating the mean difference between groups and dividing the result by the pooled standard deviation (Cohen, 1988).

Results

Sleep outcomes

Adolescents' sleep improved in all areas, with the exception of a trend for reduced time in bed (Table 1). Of 60 adolescents who attended the first treatment session, 56 attended all 3 treatment sessions, with only 4 dropping out of therapy, hence data for these participants was excluded from the final analyses. Of the 4 participants who withdrew from the study, two adolescents did not complete the motivation scale during this first therapy session hence were excluded from the present study. One adolescent ceased treatment due to travel, and the last withdrew due to low compliance and potentially low motivation.

Motivation and Compliance Descriptives

Overall, adolescents indicated a strong desire (8.9 ± 1.8; out of 10), need (8.5 ± 1.8), and reason (8.9 ± 1.1), yet moderate ability (6.4 ± 1.8) and moderate-to-strong commitment (8.0 ± 1.2) to advance sleep-wake patterns.

Bright light therapy lasted 6-27 days (M = 13.9 ± 4.5), depending on the number of days adolescents took to achieve a 6am wake-up time, and they complied between 3-15 days (M = 8.8 ± 2.7). Compliance percentage (i.e., [number of days adolescents woke up earlier/number of days of therapy] x 100) ranged from 31.6% – 100% with a mean of 65.9% ± 19.3% compliance. Adolescents were also instructed to wear the LED glasses for 30-60 minutes, adolescents reported wearing the glasses for M = 26.1 ± 11.2 minutes (range: 0 – 55 minutes) and engaged in their set activity for 23.3 ± 13.3 minutes (range: 0-60 minutes). There were no statistically significant differences in self-reported daily light exposure, $F(3,50) = 0.15$, $p = 0.93$, nor self-reported daily activity duration between groups, $F(3,52) = 0.97$, $p = 0.41$), adding further justification for analysing motivation data for the combined sample.

Readiness to Change, Commitment and Compliance

When the individual items of motivation were summed to obtain an overall motivation score, adolescents' overall motivation ratings were significantly associated with their compliance percentage (r=0.40, p=0.003). Thus, a further investigation into DARN model was warranted and clinically useful, in order to examine whether individual components of motivation could predict commitment to therapy and ultimately, therapy compliance. Mediation analyses were used to assess the relationship between DARN, commitment and therapy compliance. Prior to the analyses, zero-order Pearson's correlations were used to examine relationships between individual components of the readiness to change model, commitment to therapy and ultimate behaviour change (i.e., compliance to therapy). Results show that commitment to therapy was not associated with desire, need and reason, but strongly correlated with ability (Table 2). Clients' desire to change and commitment was also positively correlated with compliance, yet their desire, need, and their reason was not associated with compliance.

There was a significant total effect of Desire and Ability to predict behaviour change directly and indirectly through commitment (see Supplement Table 2). However, there were no statistically significant direct effects of desire, ability, reason or need to predict behaviour change. Likewise, there were no statistically significant effects of desire, ability, reason or need to affect behaviour change indirectly through commitment (Supplement Table 3). There was a potential trend to suggest that desire may have a direct effect on behaviour change, however this was not statistically significant (p=.07, Figure 2).

Discussion

Adolescents have a reputation for low motivation to change health behaviours (Gayes & Steele, 2014), including those that may improve their sleep health (Cassoff

et al., 2013; Moseley & Gradisar, 2009; Cain, Gradisar, & Moseley, 2011). In the present study, we assessed how adolescents' with DSWPD desire, ability, reasons and need related to their commitment to behaviour change during bright light therapy, as well as their actual changes in behaviour (i.e., treatment compliance). The original readiness to change model proposed that desire, ability, reason and need are predictors of commitment, and this in turn is a pathway for influencing behaviour change (Amrhein, 2003). The present study found desire and ability related to their willingness to make a change, and actually comply with therapy instructions. Although we did not find significant associations with reasons and need to change, this is not to say that these aspects of motivation are not important in this field (as discussed below).

One of the most validated treatments for DSWPD in adolescent populations is bright light therapy (Auger et al., 2015, Van Maanen et al., 2013). Bright light therapy involves the adolescent gradually getting up earlier each day and exposing their vision to bright light, which assists in phase advancing their circadian rhythm and sleep timing (Gradisar et al., 2011; Saxvig et al., 2014; Sharkey et al., 2011; Wilhelmsen-Langeland et al., 2013a). 'Getting up early' is a typically unpleasant behaviour for adolescents who, on the whole, prefer to sleep-in when given the chance (i.e., weekends; Hasler et al., 2012; Crowley, & Carskadon, 2010), and hence delay the timing of such light exposure (or avoid bright light altogether). At the end of the first treatment session, where adolescents were provided psychoeducation and a tailored behavioural change plan, they rated their desire (I *want* to change…), reasons, and need (It is *important* to change…) to change as high, yet these were not ultimately related to their commitment (I *will* change…). Instead, their ability (i.e., confidence) was a significant predictor of commitment and their actual behaviour change (i.e.,

getting up 30-minutes earlier each morning as instructed). Adolescents' rating of their ability was found to be important in terms of both what they say they will do and what they actually do (in terms of complying to a gradually earlier wake-up schedule). Part of motivational interviewing is to explore a client's desire, ability, reasons and need to change their current behaviour (Hettema et al., 2005). Therefore, clinicians working to help adolescents change their behaviours around sleep could initially believe that the adolescent's high ratings of desire, reasons and need will mean they will comply with treatment instructions. However, our findings suggest that clinicians may wish to focus on adolescents' modest ratings of confidence and to a lesser extent, desire. These results are supported by similar clinical research in other areas (e.g., eating disorders and social anxiety disorder), where confidence to change (i.e., self-efficacy) is the strongest motivational predictor of change, when clients are ambivalent toward changing their behaviour (Goldin et al., 2012, Steele, Bergin, & Wade, 2011, Vall & Wade, 2015).

We speculate that up to and including the first treatment session, adolescents had experienced significant consequences of their sleep disorder, which may have boosted their ratings of why it was important to change and why they needed to make a change. Interestingly, previous studies have shown that when adolescents are provided with psychoeducation about sleep, they still voice apprehension about their ability to maintain behavioural sleep changes, and this may be especially so when they feel they need to do this alone (Cain et al., 2011). That is, our previous research has shown that adolescents state that they need support in making changes to their sleep, which could be in the form of assistance from parents, and/or access to bright light (e.g., exercise, Cain et al., 2011). In the present study, we did not perform any adjunct motivational interviewing in conjunction with bright light therapy. However,

treatment session attendance and compliance were good. We posit that the inclusion of a parent in our therapy to support the adolescent in making behavioural changes (Gayes & Steele, 2014) could have overcome their modest ratings of confidence, which in turn led to treatment compliance, and ultimately improved sleep. Likewise, the LED light glasses provided adolescents with access to bright light. Indeed, adolescents enrolled in a motivational interviewing based school intervention obtain improved sleep health when provided access to bright light glasses and/or supported by their parents (compared to controls; Bonnar et al., 2015). Thus, we recommend clinicians attempt to enhance access to bright light and engage parents in sleep interventions in order to address adolescents' moderate confidence in changing their sleep behaviours.

DSWPD clients' lower conscientiousness scores on personality measures relative to controls (Wilhelmsen et al., 2013b; Micic et al., 2017), suggest that they may be less motivated to deal with issues or may prioritise enjoyment and leisure (prolonging evening activities; sleeping-in, etc.) over necessary behaviour change (Cassoff et al., 2013). Motivational Interviewing (MI) has been found to be effective in motivating behaviour change especially when used in conjunction with another intervention (Hettema et al., 2005; Lundahl et al., 2010). MI is aimed at stimulating and reinforcing clients' motivation by reducing resistance and encouraging commitment to change (Hettema et al., 2005). Five therapeutic guidelines that govern MI rely on collaboration, and include: (a) expressing empathy; (b) guiding clients to identify discrepancies between current behaviour and ambitions or life goals (c) avoiding argument and confrontation (d) "rolling with resistance" (i.e., seeking to reinforce accurate perceptions versus correcting misperceptions); and (e) supporting self-efficacy (Miller & Rollnick, 2002). While all five components are equally

important for MI, findings of the present study suggest that 'supporting self-efficacy' should be an initial focus for clinicians treating adolescents with DSPWD, in order to augment beliefs in their ability to succeed and accomplish their goals. It is reasonable to assume that clients with persistent behaviours that negatively impact their lives have previously attempted to change (i.e., prior to help-seeking) and have been unsuccessful. Clinicians who express dependable belief in their clients' capability to change and highlight client strengths, are likely to foster the clients' confidence thus improving therapy outcomes (Hall et al., 2012).

It is important to note that while the total shared variance of ability and desire individually predicted behaviour change, the direct and indirect effects of these factors separately were not predictors of behaviour change. It is likely that other factors may impact on clients' desire and ability to change their behaviour and not necessarily mediated by clients' commitment to therapy. Nevertheless, commitment to therapy may still predict clients' eventual behaviour change. Hence, our study showed significant variance is shared between desire, ability and commitment in determining clients' behaviour to change and together these three factors are important for gauging clients' efficacy to treatment. Moreover, due to the design of the study, it is slightly unclear how changes in aspects in motivation affect commitment and behaviour change. Whilst temporal precedence is an important factor in mediation models. Technically, adolescents reported on their desire, ability, reasons and need to change their sleep behaviours, moments before rating their commitment to change – and these ratings occurred within 24 hours of them performing their first prescribed behaviour (i.e., waking up the following day). Hayes (2017) stipulates that mediation analyses can be conducted even if causality cannot be clearly established, so long as a strong theoretical reason exists for testing in the given

direction. This holds true in the present study, given the limitations of the research design. Nevertheless, future studies in this area will likely need to measure DARN, commitment and behavioural compliance within a 24-hour period, therefore we recommend attempting to space out the timing of these measurements (e.g., measure commitment to change after the treatment session).

Potential ceiling effects for some variables (i.e., desire, reason, need) and an absence of using a validated scale to measuring adolescents' motivation to change their sleep behaviour are further limitations that should be considered when interpreting the findings of the present study. For ceiling effects, we assume adolescents who engage in help-seeking behaviour (i.e., attending weekly sessions) are highly motivated (i.e., high desire, need and reason), but usually have tried several approaches without success (relatively lower ability). We predict that the levels of motivation in the present study are likely to be replicated in future studies with such a subsample of this population, yet will likely differ with other samples (i.e., those involved in school-based sleep interventions; Bonnar et al., 2015). Future research is needed to validate measurement in this specific field. To the authors' knowledge, such validated questionnaires do not exist.

A randomised control trial delivering sleep treatment, with or without MI, to adolescents is warranted to examine if motivational enhancement leads to more favourable outcomes. Future work in this area will benefit from evaluating other factors that contribute to sleep-disordered adolescents' response to therapy. For example, supports and barriers in the teenagers' lives may augment or hinder their commitment and progress during therapy, respectively (Rollnick et al., 2008). In addition, clients are often expected to come already prepared with sufficient

motivation for change. This may not be the case for adolescents in general, who may be guided by their parents' motivation to seek treatment, and not their own.

Conclusion

Adolescence is a turbulent developmental stage, marked by significant changes across psychological, behavioural, and physiological domains. Paradoxically, it is also a time when young clients may be most resistant to change (Gayes & Steele, 2014). Results of the present study have important implications for sleep therapy, suggesting that adolescents' subjective reports of 'motivation' may not predict compliance. What we know from the present study is that adolescents' confidence can predict the likelihood of their sleep treatment compliance. Evidence for the use of MI in therapies for adolescents has only recently begun emerging. Our findings may support the use of motivational strategies in therapies for sleep-disordered adolescents, to enhance their commitment and compliance to therapy, ultimately leading to favourable outcomes in sleep and other well-being domains.

Author Contributions: GM was involved with recruitment, therapy delivery, data analysis, and write-up of the manuscript. CR (2) had responsibility for day-to-day administration and supervision of the entire project, recruitment, screening and scheduling of participants, participation in data collection, data management, and drafting of this manuscript. MG had primary supervisory role for the project, overall planning, supervision of therapists and students, and manuscript preparation. KB, NZ, CR (5) were involved with recruitment, therapy delivery, and drafting of this manuscript. BM assisted with data collection and quality, as well as drafting of this manuscript.

Conflict of Interests: The authors declare no personal or financial conflicts of interest relating to the subject matter of this paper, with the exception of Michael Gradisar who has received consultancies from the Australian Psychological Society, Johnson & Johnson, Little Brown Book Company, is a shareholder in ResMed, and previously received partial project funding from Re-Time Pty Ltd (Bonnar et al., 2015). No industry sponsorship (funding, equipment) was provided for the present study.

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Table 1
Outcomes of sleep variables at pre-treatment relative to post-treatment in adolescents with DSWPD.

N = 56					
	Mean [95 % CI]		ME [95 % CI]		
	Pre-treatment	**Post-treatment**	**Pre to Post treatment**	**Cohen's *d*[a]**	***p* value**
Bedtime	23:17 [22:54, 23:52]	22:46 [22:19, 23:13]	31m [0.14, 0.89]	0.31	.008
Lights out time	23:56 [23:26, 24:28]	23:29 [23:01, 23:57]	28m [0.06, 0.85]	0.26	.024
Sleep onset latency	98m [72, 123]	52m [37, 66]	45m [26.87, 64.73]	0.61	<.001
Sleep onset time	01:35 [01:20, 02:41]	00:21 [23:56, 01:00]	1h 14m [0.93, 2.17]	0.59	<.001
Wake up time	09:07 [08:37, 09:37]	08:20 [07:22, 08:58]	47m [0.33, 1.24]	0.39	.001
Out of bedtime	09:35 [07:43, 08:58]	08:38 [08:00, 09.28]	57m [0.52, 1.39]	0.45	<.001
Time in bed	9h 38m [9h 14m, 10h 3m]	9h 10m [8h 40m, 9h 38m]	29m [-0.01, 0.98]	0.29	.056
Total sleep time	7h 11m [6h 41m, 7h 41m]	7h 52m [7h 26m, 8h 17]	41m [-1.12, -0.25]	0.41	.003
Sleep Efficiency (%)	75 [70, 80]	86 [83, 89]	11 [-14.13, -8.00]	0.77	<.001
Wake after sleep onsetASO	16m [10, 22]	7m [1, 14]	9m [2.23, 15.63]	0.40	.010

Notes: **ME**: Mean Error; **CI**: Confidence Interval

[a] Cohen's d Size of effect: $d > 0.20$ = small; $d > 0.50$ = medium; $d > 0.80$ = large.

Table 2

Zero-order correlation analyses of desire, ability, reason, need, verbal commitment and behaviour change.

	1	2	3	4	5	6
1. Desire		-.07	-.21	**.37****	.12	**.30***
2. Ability			-.26	.02	**.66****	.26
3. Reason ^				.15	.30	.30
4. Need					.12	.18
5. Commitment						**.30***
6. Behaviour Change						

**< 0.001, *$p < 0.05$

^ $n = 16$ valid cases as the terminology of this question was invalid for the first 40.

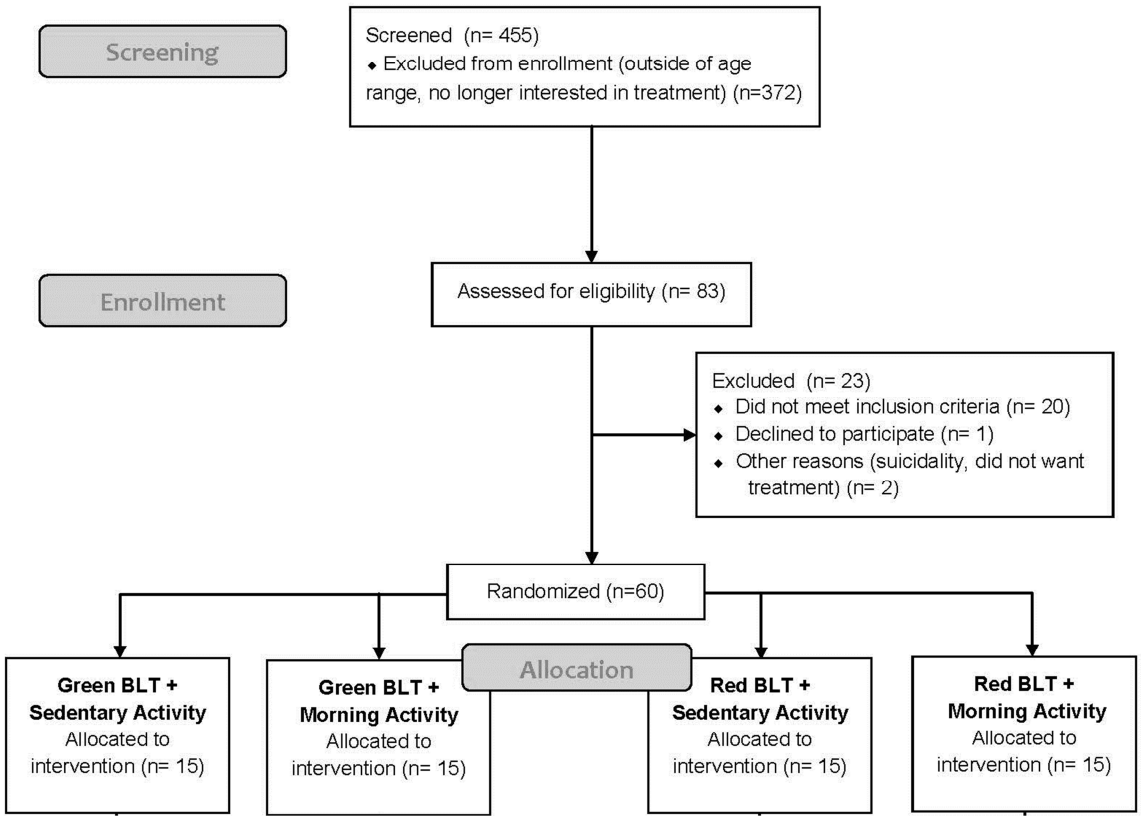

Figure 1. Participant flow through the randomised controlled trial, taken from Richardson et al., 2018.

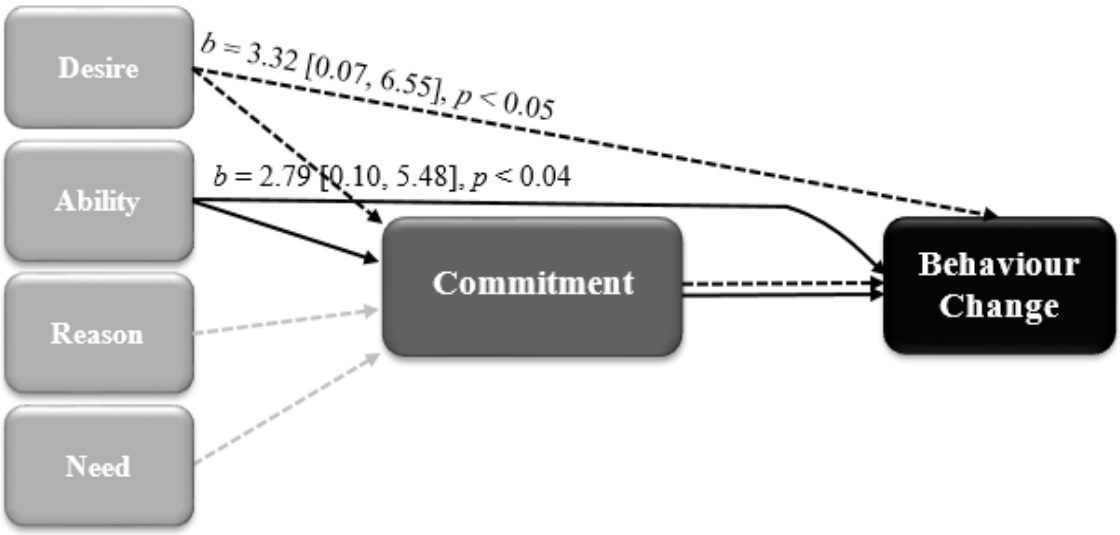

Figure 2. The "DARN Model" for adolescents with DSWPD. Desire, Ability, Reason and Need as predictors of commitment and behaviour change. Desire predicted behaviour change directly and indirectly through commitment (black perforated lines). Ability predicted behaviour change directly and indirectly through commitment (black solid lines).

Supplement

Table 1

Zero-order correlation analyses of age, gender, DSWPD severity and chronicity as potential co-variates of behaviour change.

	1	**2**	**3**	**4**	**5**
1. Behaviour Change		-.09	.20	.15	.09
2. Age			-.07	-.05	-.17
3. Gender				.18	.14
4. Severity					.23
5. Chronicity					

*$p < 0.05$

Table 2

Total and direct effects of desire, ability, reason and need (DARN) on behaviour change.

	Total effect of DARN on Behaviour Change					
	b	**SE_b**	**LLCI**	**ULCI**	***t***	***p***
Desire	**3.32**	**1.61**	**0.07**	**6.55**	**2.05**	**0.045***
Ability	**2.79**	**1.34**	**0.10**	**5.48**	**2.08**	**0.04***
Reason	6.53	5.86	-6.54	19.60	1.11	0.29
Need	0.74	1.66	-.2.59	4.07	0.45	0.66
	Direct effect of DARN on Behaviour Change					
Desire	3.05	1.66	-0.29	6.40	1.84	0.07
Ability	1.95	1.83	-1.74	5.63	1.06	0.29
Reason	7.51	7.27	-8.94	23.97	1.03	0.33
Need	0.66	1.67	-2.70	4.01	0.39	0.70

Notes: **SE_b**: Standard error of *b*; **LLCI**: Lower limit confidence interval; **ULCI**: Upper limit confidence interval; *$p<0.05$

Table 3

Indirect effects of desire, ability, reason and need (DARN) on behaviour change, mediated by commitment.

	b	**BootSE$_b$**	**BootLLCI**	**BootULCI**
Desire	0.25	0.53	-0.53	1.72
Ability	0.84	1.37	-1.55	3.95
Reason	-0.99	17.35	-16.87	8.32
Need	0.08	0.34	-0.27	1.14

Notes: **BootSE$_b$**: Bootstrapped standard error of *b*; **BootLLCI**: Bootstrapped lower limit confidence interval; **BootULCI**: Bootstrapped upper limit confidence interval

Appendix

Diagnostic Criteria

Criteria A-E must be met

A. There is a significant delay in the phase of the major sleep episode in relation to the desired or required sleep time and wakeup time, as evidenced by a chronic or recurrent complaint by the patient or a caregiver of inability to fall asleep and difficulty awakening at a desired or required clock time.

B. The symptoms are present for at least three months.

C. When patients are allowed to choose their ad libitum schedule, they will exhibit improved sleep quality and duration for age and maintain a delayed phase of the 24-hour sleep wake pattern.

D. Sleep log and, whenever possible, actigraphy monitoring for at least seven days (preferably 14 days) demonstrate a delay in the timing of the habitual sleep period. Both work/school days and free days must be included within this monitoring.

E. The sleep disturbance is not better explained by another current sleep disorder, medical or neurological disorder, mental disorder, medication use, or substance use disorder.

Notes

1. Standardized chronotype questionnaires are useful tools to assess the chronotype of eveningness and morningness. Individuals with this disorder typically score as evening types. This tool can also be useful in determining whether an eveningness circadian preference contributes to -sleep initiation difficulties among those who do not meet full criteria for the disorder.

2. Demonstration of a delay in the timing of other circadian rhythms, such as melatonin (measured by dim light melatonin onset or urinary 6-sulfatoxymelatonin sampled across a 24-hour period), is desirable to confirm the delayed circadian phase.

Essential Features

Delayed sleep-wake phase disorder (DSWPD) is characterized by habitual sleep wake timing that is delayed, usually more than two hours, relative to conventional or socially acceptable timing. Affected individuals complain of difficulty falling asleep at a socially acceptable time, as required to obtain sufficient sleep duration on a school or work night. Once sleep onset occurs, it is reportedly of normal duration. These individuals also experience difficulty arising at a socially acceptable wake time, as required to prepare for school or work. When allowed to follow his or her preferred schedule, the patient's timing of sleep is delayed.

American Academy Of Sleep Medicine. (2014). *International classification of sleep disorders: Diagnostic and coding manual* (3rd ed.). Westchester, IL: Author

Highlights

- This is the first study to investigate associations between adolescents' readiness to change at the outset of a sleep therapy and subsequent behaviour change (i.e., therapy compliance).
- Results show that adolescents with a sleep-related disorder indicated strong desire, reasons and need to advance their sleep-wake patterns, however their reported ability and commitment was relatively lower.
- Adolescents' commitment to therapy was associated with their perceived ability and desire to change sleep-wake patterns.
- Overall, ability and commitment to change are the best predictors of adolescents' behavioural changes, hence these components should be the focus of intervention when working with adolescents with a sleep disorder.