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Discrimination and sleep mediate ethnic/racial identity and adolescent adjustment: Uncovering change processes with slope-as-mediator mediation

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The impact of ethnicity/race on youth development is both theoretically and empirically documented (Coll et al., 1996). The formation of an ethnic/racial identity (ERI) represents an important avenue through which scholars have studied how ethnicity/race impacts adolescent development (Umaña-Taylor et al., 2014). The general consensus of the literature is that ERI confers psychological and adjustment benefits for adolescents (Rivas-Drake, Seaton, et al., 2014; Rivas-Drake, Syed, et al., 2014). Yet, in the context of ethnic/racial discrimination (ERD), research is beginning to suggest that certain dimensions of ERI confer protection while others invite vulnerabilities (Yip, 2018). Further, there is a growing interest in biopsychosocial investigations of the impact of ERD on youth development (Adam et al., 2015; Goosby, Straley, & Cheadle, 2017; Levy, Heissel, Richeson, & Adam, 2016), with particular interest in the ways in which ERD impacts sleep (Goosby, Cheadle, Strong-Bak, Roth, & Nelson, 2018; Slopen, Lewis, & Williams, 2016; Zeiders et al., 2017). The current study adopts a biopsychosocial approach to build upon the science of how ERI, ERD, sleep and adolescent adjustment are related. To this end, the study utilizes a new analytic approach, referred to as "slope-as-mediator" (SAM) mediation (author citation[a]).

SAM mediation involves considering the *association*, or *relationship*, between two variables as the mediating mechanism. This approach represents a departure from existing mediational techniques such that rather than employing *the mean* value of an intervening variable, we employ *the association between two variables* or strength-of-relationship as the mechanism responsible for how the independent variable is subsequently related to the outcome. Exploring the association between two variables, rather than mean values, will highlight how the correspondence between two variables might be at least partially responsible for the link between predictors and outcomes over time. With its focus on processes and associations rather than static means, this approach is particularly well suited to the application of development theories, processes and mechanisms.

A Biopsychosocial Approach to Ethnic/Racial Minority Youth Development

A biopsychosocial approach (Engel, 1980) maintains that to fully understand the determinants of health, it is necessary to employ perspectives that give equal weight to biological, psychological, and social influences. The biological focus of the current study

includes self-reported measures of daily sleep. Sleep is a particularly important biological process to investigate among adolescents, who are also dealing with pubertal changes. Research finds that mid-pubertal adolescents require more sleep than their younger or older counterparts to achieve the same level of daytime concentration (Dewald et al., 2010). Furthermore, sleep disturbance increases daytime sleepiness, neurologically compromising adolescents' cognitive control and concentration (Telzer, Fuligni, Lieberman, & Galván, 2013). Therefore, sleep disturbance among adolescents is particularly detrimental for developmental outcomes. The psychological focus of the study includes ethnic/racial identity (ERI) development, a critical task during adolescence (Erikson, 1968). Healthy ERI development is associated with better health and academic outcomes throughout adolescence (Chavous et al., 2003; Rowley, Sellers, Chavous, & Smith, 1998). The social component of the study focuses on ethnic/racial discrimination (ERD), which is linked to poor health and academic outcomes (Huynh & Fuligni, 2010; Neblett et al., 2006; Seaton & Yip, 2009). It is especially important to examine the effects of ERD during adolescence because of academic and health consequences; further, discrimination experienced in adolescence has downstream adult health consequences (Adam et al., 2015; Greene, Way, & Pahl, 2006; Hughes, Del Toro, Harding, Way, & Rarick, 2016).

Taken together, the current paper aims to elucidate how the longitudinal association between ethnic/racial identity (ERI) and psychological functioning might be mediated by the daily-level association between ethnic/racial discrimination (ERD) and sleep. Ethnic/racial identity (ERI) is defined as "a multidimensional, psychological construct that reflects the beliefs and attitudes that individuals have about their ethnic-racial group memberships, as well as the processes by which these beliefs and attitudes develop over time" (p. 23; Umaña-Taylor et al 2014). Similarly, we consider ethnic/racial discrimination (ERD) to be differential, typically unfair, treatment due to membership in a marginalized ethnic/racial group which serves to "reinforce relations of dominance and subordination, thereby bolstering privileges conferred to…members of a dominant group" (p. 301, Krieger, 1999).

Ethnic/Racial Identity and Psychological Outcomes

Empirical interest in ethnic/racial identity was arguably born of an inquiry into understanding how marginalized youth are impacted by their socially-undervalued group membership. Starting with the Clarks' seminal doll study research (Clark & Clark, 1939), the study of ERI has stemmed from an interest in how children and youth at once form an identification with a marginalized group and maintain a positive and healthy sense of self. This research continues, and scientists are delving deeper into the nuanced ways in which ERI impacts and is impacted by psychological adjustment. Although ERI research has made significant progress since the Clarks' early research, much is still unknown. In part, the lack of clarity about the association between ERI and outcomes is due to conceptual and methodological inconsistencies (Schwartz et al., 2014).

We focus exclusively on the developmental components of ERI commitment and exploration since there are clear, theory-driven hypotheses related to how these components should be related to psychological outcomes over time and they show the most consistent moderating effects of discrimination in a recent meta-analysis (author citation[b]). ERI commitment refers

to the extent to which one feels attached and personally invested as a member of one's ethnic/racial group (Phinney, 1992). Phinney & Ong (2007) note that commitment is "perhaps the most important component of ethnic identity" (p. 272). According to identity theory, having a strong sense of commitment to one's identity is expected to be associated with positive outcomes (Tajfel & Turner, 2004). The empirical evidence largely supports this prediction observing positive associations between high levels of ERI commitment and emotional stability, self-esteem, clarity, family functioning, mental health, life satisfaction and academic achievement (Phinney & Kohatsu, 1997; Phinney, Lochner, & Murphy, 1990; Rivas-Drake, Seaton, et al., 2014).

ERI exploration refers to the extent to which one seeks information and experiences relevant to one's ethnic/racial group membership (Phinney, 1992). While a strong sense of ERI commitment is expected to be beneficial for well-being, the theory and research on the psychological effects of exploration are more equivocal. In part, the relationship between exploration and psychological outcomes may depend on the impetus for the exploration (Syed et al., 2013). For example, exploration in response to negative experiences such as discrimination may signal distress and be associated with compromised outcomes (Syed & Azmitia, 2010). On the other hand, exploration related to parental socialization and cultural activities may be associated with more optimal outcomes (Syed et al., 2013). Moreover, regardless of the impetus, prolonged periods of exploration, may signal uncertainty or insecurity, which may also be associated with compromised adjustment (Yip, Seaton, & Sellers, 2006). As an illustration, ERI exploration has been observed to have a positive bivariate association with self-esteem among Latinx adolescents, however, this association is negative after adjusting for the effects of discrimination (Romero & Roberts, 2003). Similarly, exploration has been observed to be associated with positive psychological indicators such as agreeableness, purpose in life, and self-esteem (Syed & Azmitia, 2010; Syed et al., 2013). At the same time, exploration has been also observed to be associated with negative adjustment such as emotional instability, internalization, and more distressed responses to discrimination (Syed et al., 2013).

Based on theory, existing research, and a meta-analysis (author citation[b]), we posit an overall benefit of ERI commitment for psychological outcomes; and because the current analyses focus on discrimination, a corresponding compromise for high levels of ERI exploration. More importantly, our substantive and methodological contributions are put forth in the mediating processes that are responsible for the link between ERI and outcomes. Here, we introduce slope-as-mediator (SAM) mediation analysis (author citation[a]) and propose that the association between daily experiences of ethnic/racial discrimination (ERD) and sleep disturbance may at least partially mediate the overall association between ERI and psychological outcomes.

The Association between ERD and Sleep as A Mediator

The literature on the health effects of ethnic/racial discrimination (ERD) is robust and consistent. Indeed, recent meta-analyses and systematic reviews have observed the negative effects of ERD on a host of health outcomes, including recent research on sleep (Goosby et al., 2018; Lewis et al., 2012; Slopen et al., 2016). The negative effects of ERD on

psychological health among adolescents are clear (Schimitt, Branscombe, Postmes, & Garcia, 2014). For example, researchers have found that ERD is associated with more depressive symptoms and psychological distress, lower self-esteem, increased hopelessness and anxiety (Branscombe, Schmitt, & Harvey, 1999; Gee, Spencer, Chen, Yip, & Takeuchi, 2007; Greene et al., 2006; Williams, Neighbors, & Jackson, 2008; Yip, Gee, & Takeuchi, 2008). In a recent meta-analysis, Schmitt et al. (2014) observed that the effects of ERD were particularly detrimental for youth as compared to adults. Moreover, ERD seems to have stronger effects on negative outcome indices (e.g., depressive symptoms, anxiety), compared to positive ones (e.g., self-esteem).

Focusing on sleep, there is a growing body of evidence suggestive of direct effects of ERD on sleep. A recent systematic review found consistent links between discrimination and sleep disturbances for all 17 of the studies included in the analysis (Slopen et al., 2016). Among African American adolescents, recent daily diary and actigraphy research has found a link between daily discrimination and compromised sleep quality (Goosby et al., 2018). In diverse group of adolescents, discrimination has also been observed to compromise sleep duration (Goosby et al., 2018; Huynh & Gillen-O'Neel, 2016). Also recently, a study of Latinx young adults found that ERD was predictive of greater variability in sleep, suggesting disturbances in sleep due to ERD that are not related to duration or quality (Zeiders et al., 2017). Importantly, recent research on sleep among adolescents finds that night-to-night variability is predictive of brain development one year later, over and above the effects of sleep duration (Telzer, Goldenberg, Fuligni, Lieberman, & Gálvan, 2015). In other analyses using the same sample presented here, there was evidence of same-day disturbances in sleep duration and quality on days in which adolescents reported experiencing discrimination (author citation[c]). Extending the current literature, we hypothesize that ERD will have a negative impact on sleep (duration and quality) such that higher levels of ERD will be associated with more disturbance. Among adults, discrimination has been observed to predict sleep disturbances above and beyond effects attributable to more general stressors, moreover, ethnic/racial disparities in sleep have been observed to be mediated by discrimination (Fuller-Rowell et al., 2017; Slopen & Williams, 2014; Tomfohr, Pung, Edwards, & Dimsdale, 2012). In a slope-as-mediator (SAM) approach, the association between ERD and sleep are hypothesized to serve as the mediating mechanism.

Moreover, we believe that the strength of this association - how strong the daily positive association between ERD and sleep disturbance is - will at least in part, explain the association between ERI and outcomes. For the first part of the SAM model (the extent to which ERI is linked to daily ERD-sleep associations), we pose different hypotheses for ERI commitment and exploration. We hypothesize that adolescents who have a strong sense of ERI commitment will report a weaker positive association between ERD and sleep disturbance. This is informed by a recent meta-analysis highlighting a weaker effect of ERD on health outcomes for adolescents with stronger ERI commitment (author citation[b]). On the other hand, it is hypothesized that adolescents who have a high level of ERI exploration will report a stronger positive association between ERD and sleep disturbance. This is informed by meta-analytic research identifying stronger effects of ERD on health outcomes for adolescents with higher levels of ERI exploration (author citation[b]). Because the slope-as-mediator is an association (rather than the typical mean/level of the variable as mediator),

the first part of the SAM model is statistically and conceptually equivalent to a cross-level interaction effect (e.g., how a person-level trait at Level 2 impacts daily-levels processes at Level 1). Yet, the second part of the SAM model (the extent to which daily ERD-sleep associations are linked to well-being) is conceptually distinct from cross-level interactions. We next discuss our hypotheses regarding the second part of the SAM model.

Linking the ERD-Sleep Association to Well-being

Sleep touches nearly all aspects of development including academic, physical, and psychological outcomes. Among adolescents, sleep is particularly important for day-to-day functioning as well as development over time (Shochat, Cohen-Zion & Tzischinshy, 2014; Wolfson & Carskadon, 1998). Although the impact of sleep and sleep deprivation is far-reaching, in the current study, we focus on psychological outcomes including daily mood states (Lofthouse, Gilchrist, & Splaingard, 2009). Sleep disturbances including poor quality sleep, shortened sleep duration, and high sleep variability have been observed to be related to increased depressive symptoms, anxiety, and psychological distress (Beatty et al., 2011; Gregory & Sadeh, 2012; Haack & Mullington, 2005; Hamilton et al., 2007, Kelly & El-Sheikh, 2014; McMakin & Alfano, 2015). In research on Latinx communities, sleep accounted for 26% of the variance in depressive symptoms (Steffen & Bowden, 2006). In a sleep manipulation study, where adolescents were randomly assigned to sleep deprivation conditions, adolescents in the restricted condition reported more anxiety, anger, hostility, confusion, and fatigue (Baum et al., 2014). Moreover, adolescents with restricted sleep also reported more difficulty regulating their emotions (Baum et al., 2014). Informed by the deleterious effects of ERD and sleep disturbance for well-being, we hypothesize that the daily association between ERD and sleep disturbance also has an impact on well-being (i.e., second part of the SAM model). Adolescents who have a strong, positive association between ERD and sleep disturbance are also expected to report compromised well-being.

Slope-as-Mediator (SAM) Mediation: An Introduction

Baron and Kenny's 1986 publication is often cited for its contributions to the study and applications of mediation analysis, particularly as it distinguishes mediation from another third-variable association, moderation. Baron and Kenny's (1986) paper has been cited well over 20,000 times (PsycINFO) and is the most-cited article ever published in the *Journal of Personality and Social Psychology*. Baron and Kenny describe a mediating variable as "the generative mechanism through which the focal independent variable is able to influence the dependent variable of interest" (p. 1173). Mediating variables "intervene", "account for", and "speak to how or why" independent variables are related to the outcome of interest (p. 1176). More recently, Kenny (2008) wrote "mediation is important because it allows us to conduct scientific investigations; that is, the interesting part of science is to explain how something comes about…mediational analyses provide the researcher with a story about a sequence of events that leads to something" (p. 354). The ability to explore the impact of predictors on distal outcomes through proximal processes may be one of the key reasons for the appeal of mediation analyses to developmental science (Dearing et al., 2006).

Baron and Kenny (1986) propose that a mediating variable is a third, explanatory variable, that at least partially explains the association between the independent and dependent variables. Shrout and Bolger (2002) discuss one of the most notable ways in which mediation analyses have been misspecified: overlooking the temporal and causal assumption underlying the analysis (Imai, Keele, & Tingley, 2010; Maxwell & Cole, 2007). At its core, mediation models make inferences about causal processes. That is, changes in the predictor, lead to subsequent changes in the mediator, which result in changes in the outcome. Mediation analysis is an important analytical tool and there have been recent advances in their application (see Preacher, 2015 for review).

Adding to current elaborations of Baron and Kenny's (1986) original conceptualization, we propose the concept of slope-as-mediator (SAM) mediation, an analytical approach where *the association between two variables* serves in a mediating capacity (author citation[a], Figure 1). In this section, we introduce the general concept of slope-as-mediator mediation and offer an illustration with multilevel, experience sampling data and propose that the day-to-day association between two variables can be considered as the mediating link responsible for outcomes over time. In this multilevel framework, daily-level associations are modeled at level 1 and person-level changes over time are modeled at level 2. A similar notion of strength-of-relationship has recently been used in research assessing individuals' affective responses to stress in daily lives (Charles et al., 2013; Mandel, Dunkley, & Moroz, 2015; Wichers et al., 2009). By linking the person-level (level 2) association between daily stress and affect (i.e., stress reactivity; level 1) to long-term psychological well-being, this line of work shows that higher levels of stress reactivity are associated with increased depressive and anxious symptoms over time (Charles et al, 2013). These findings highlight the significance of investigating cumulative affective responses in daily lives. Exploring the relationship between two variables, rather than mean values, highlights how the correspondence between two variables might be at least partially responsible for the link between predictors and outcomes. With its focus on processes and relationships rather than static means, this approach is well suited to the application of developmental and intervention-focused theories and questions.

Why does focusing on the association between daily processes (rather than a static mean) uniquely elucidate developmental processes? Developmental theory often focuses on the importance of daily processes, and repeated experiences of daily processes, for longer term development (Barker, 1968; Gallimore, Goldenberg, & Weisner, 1993). However, few analytic methods are able to approximate and reflect the theoretical underpinnings of these developmental theories. Development occurs as an accumulation of daily experiences and often these daily experiences extend beyond just average levels, and move in to the association between two constructs. The slope-as-mediator approach provides a conceptual and analytical tool to investigate and model these associated experiences. For example, intervention research is predicated on the idea that an intervention (the predictor variable) may change the relationship between two variables, which in turn, results in changes in the outcome. As an illustration, an educational intervention may target student-teacher relationships aiming to improve academic outcomes. The intervention might focus on improving the quality of student-teacher interactions such that students feel better about themselves after having interacted with a teacher, which in turn, lead to academic

improvement over time. Focusing on daily-level associations provides a more dynamic and nuanced depiction of how everyday processes are involved in development over time.

The Current Study

Taking a biopsychosocial approach, the current study aims to contribute to the science of how ethnic/racial minority adolescents experience the daily impact of ERD, with a particular focus on sleep disturbances. Moreover, the daily-level *association* between ERD and sleep (i.e., level 1) is implicated as a *mediating mechanism* linking ERI to adolescent adjustment outcomes over time (i.e., level 2). Consistent with research, we hypothesize that ERI commitment will be associated with overall positive psychological adjustment. In part, however, we believe that this positive association will be mediated by positive association between ERD and sleep disturbance. Based on existing research, we hypothesize that adolescents who have a strong sense of ERI commitment a). will report a weaker positive association between ERD and sleep disturbance (i.e. cross-level interaction where ERI commitment buffers the positive association between ERD and sleep disturbance), and b). that the association between ERD and sleep disturbance will at least partially mediate the positive association between ERI commitment and psychological adjustment (i.e., slope-as-mediator mediation). On the other hand, we hypothesize that ERI exploration will be associated with compromised psychological outcomes. And again, we hypothesize an explanatory pathway through the association between ERD and sleep disturbance. Specifically, we predict that adolescents who have a strong sense of ERI exploration will: a). report a stronger positive association between ERD and sleep disturbance (i.e., cross-level interaction where ERD exploration exacerbates the positive association between ERD and sleep disturbance), and b). that the association between ERD and sleep disturbance will at least partially mediate the negative association between ERI and psychological adjustment (i.e., slope-as-mediator mediation).

Methods

Participants

The data of the current study were from the first year of a four-year longitudinal study on stress, sleep, and daily activities in ninth-grade adolescents. The sample had a total of 264 adolescents with 70% females and 30% males (M_{age} = 14.3 years old, SD = .66). The majority of the sample (76%) was born in the United States, while modal birthplaces included Jamaica (23%) and the Dominican Republic (15%). The sample was 43% Latinx, 32% Asian Americans, and 25% African Americans. Among adolescents who identified as Latinx: 28% identified as Dominican, 22% as Mexican, 21% South American, 16% Puerto Rican, 5% Central American, and 8% other. Among the adolescents who identified as Asian Americans: 79% identified as Chinese, 8% as Korean, 2% as Indian, and 11% other. A considerable proportion of the adolescents reported their parents' highest level of education as high school or below (35% mothers, 37% fathers). Slightly fewer adolescents reported their parents' education as beyond high school (32% mothers, 21% fathers). Many adolescents reported not knowing their parents' highest level of education (33% mothers,

42% fathers). Latinx, African American, and Asian American adolescents did not differ by age, gender, nativity, mother's and father's education level.

Procedures

Participants were recruited from five public New York City high schools that were selected for their racial diversity - diversity at the schools had a mean of 46% Latinx (ranging from 21% to 50%), 31% African Americans (ranging from 4% to 63%), 15% Asian Americans (ranging from 3% to 57%), and 6% Whites (ranging from 2% to 16%). The Simpson's diversity index (ranging from zero to one, one indicates the highest diversity) for the schools' racial compositions had the mean of .47 (ranging from .29 to .62), indicating that the probability of randomly selecting two students from different ethnic/racial groups was .47 on average. All Latinx, African American, and Asian American ninth-grade students in these schools were invited to participate in a study focused on stress and sleep. Invitation letters were mailed to the parents of these students, and only students with parental consents participated. Online data from the Department of Education website (2016–2017) reports that students in these five schools had mean SAT = 925 (SD = 101) and attendance rates = 87% (SD = 6%; city's average = 89%), and four-year graduation rates = 76% (ranging from 60% to 89%; city's average = 74%). The response rate ranged from 6% to 31% across the five schools likely because active parental consent was required and each of the schools had 52% to 86% of students who were socioeconomically disadvantaged. Parents often work multiple jobs and may not see their kids regularly. In addition, it is possible that not all parents received the consent forms since some families use addresses that are not their own. As such, data were collected in three successive cohorts (cohort 1: n = 88, cohort 2: n = 87, cohort 3: n = 89) collected across successive school years from 2015 to 2017. The cohorts did not differ on age, gender, race, mother's and father's education level.

In the first wave of data collection (referred to as T1 hereafter), participants met in groups of one to ten students after dismissal and were assented to the study and completed an online demographic questionnaire including questions about ERI. After that, participants were given a data-enabled electronic tablet to access the five- to seven-minute daily web-based survey, which they completed each night before bed for 14 days. Because the daily diary survey was hosted online, research assistants monitored compliance. Participants were compliant with their daily diary completion (M = 10.4 diaries completed, SD = 3.7, maximum = 14). About half of the participants (54%) reported sharing a room with at least one other person (M = 1.45, SD = .76), while the others reported sleeping alone at night. At the end of the 14 days, participants returned the tablet, completed another online survey (referred to as T2), and were compensated $20. This longitudinal design increases the internal validity of the mediation effects (Imai et al., 2010; Maxwell & Cole, 2007).

Measures

Ethnic/Racial Identity (ERI) Exploration and Commitment.—ERI exploration and commitment were assessed at T1 using the Multigroup Ethnic Identity Measure (MEIM; Phinney, 1992). The exploration subscale consisted of five items (e.g., "I have spent time trying to find out more about my own ethnic/racial group, such as history, traditions, and customs.") and the commitment subscale consisted of seven items (e.g., "I have a strong

sense of belonging to my own ethnic/racial group.") Participants responded to all items using a four-point scale (1 = "strongly disagree" to 4 = "strongly agree"). Both subscales showed good internal consistency (exploration: α = .71; commitment: α = .84). Means and standard deviations for all measures are presented in Table 1.

Daily Ethnic/Racial Discrimination (ERD).—We developed a discrimination scale to assess adolescent's daily ERD. The scale consists of six daily hassles related to respondents' ethnicity/race ("I was treated unfairly because of my race/ethnicity," "I felt stress because of my race/ethnicity," "others treated me poorly because of my race/ethnicity," "I was teased because of my race/ethnicity," "I felt uncomfortable because of my race/ethnicity," "I felt unsafe because of my race/ethnicity"). Adolescents reported the extent to which each item was a problem using a four-point scale (0 = "did not happen/was not a problem today" to 3 = "very much a problem today"). To maintain a temporal ordering between discrimination and sleep, the analyses investigate the same-day effects of discrimination on sleep (i.e., today's discrimination predicting tonight's sleep). This scale had good internal consistency at daily level (α = .90) and adolescent level (α = .98; Geldhof, Preacher, & Zyphur, 2014). Consistent with other indicators of daily ERD, adolescents also reported low frequencies of daily ERD on the six items (Torres & Ong, 2010). On average across the six items, 71% of students reported that they did not experience ERD. To conceptualize ERD as a low frequency and high impact experience, we calculated a binary indicator (i.e., 0 = no ERD experience on a given day, 1 = at least one ERD experience on a given day; M = .09). The intraclass correlation of this indicator showed that there was variation in ERD across days among the adolescents (ICC = .47). At the daily level, ERD was significantly correlated with angry mood (r = .10), rumination (r = .13), somatic symptoms (r = .16) and daily hassles (e.g., academic pressures, friendship stress, family stress; r = .19), ps < .001, supporting its criterion-related validity.

Daily Sleep.—Sleep was assessed using an adapted daily measure of the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1988). PSQI is an 18-item self-reported scale measuring multiple dimensions of sleep. The data presented here include sleep latency, sleep efficiency, sleep disturbance, daytime dysfunction, and duration. All sleep quality indicators were coded such that higher scores indicate the presence of more disturbance (e.g., longer sleep latency, poorer efficiency, etc.). Sleep latency was assessed with "last night, how long did it take you to fall asleep?" with responses including "less than 15 minutes, 16–30 minutes, 31–60 minutes, more than an hour", such that higher scores indicate a longer transition from wake to sleep. Sleep efficiency was computed using a combination of sleep duration and time in bed. Time in bed was computed from: "what time did you go to sleep last night?" and "what time did you wake up today?". Sleep efficiency is a ratio of proportion of time asleep out of time in bed, higher scores indicate worse sleep efficiency. Sleep quality disturbance was assessed with 9 items listing common issues "last night, how much did you have trouble sleeping due to the following reasons? …felt too cold, felt too cold, had bad dreams, had pain, coughed or snored loudly etc…" on a scale from 0 = not at all to 3 = a lot, with higher scores indicating more disturbance. Daytime dysfunction was assessed with two items, for example, "today, how much trouble did you have staying awake while doing homework, while in class, eating meals, or spending time with friends" and responses

included 0 = no trouble at all, 1 = a little bit of trouble, 2 = some trouble, and 3 = a whole lot of trouble. Finally, duration was computed based on adolescents' responses to "last night how many hours of actual sleep did you get" where 0 = less than 5 hours, 1 = 5–6 hours, 2 = 6–7 hours, 3 = greater than 7 hours. In contrast to sleep quality, sleep duration was coded such that lower scores were associated with shorter sleep and more disturbance. With the exception of daytime dysfunction, adolescents responded to all items referring to the prior day. The means of the various sleep dimensions (Table 1) were on the lower end of the continuum. For example, the mean values for scales ranging from 0 to 3 were: sleep latency = .45 (higher score indicates longer time to fall asleep), sleep efficiency = .90 (higher score means lower efficiency), sleep disturbance = .42 (higher score means more disrupted sleep), daytime dysfunction = .41 (higher score means more dysfunction), sleep duration = 1.97 (higher score means longer duration). The intraclass correlations (ICC) across days indicated daily variation in sleep (sleep latency =.36, sleep efficiency = .30, sleep disturbance = .31, daytime dysfunction = .29, sleep duration = .39).

Well-being.—Adolescent well-being was assessed by six constructs at T1 and T2: self-esteem, positive mood, negative mood, anxious mood, and depressive symptoms. Self-esteem was assessed by Rosenberg Self-esteem Scale (Rosenberg, 1965), which had ten items using a four-point scale (1 = "strongly disagree" to 5 = "strongly agree"). This scale had satisfactory internal consistency at T1 (α = .86) and T2 (α = .84). Positive mood (i.e., happy, calm, joyful, excited), negative mood (i.e., sad, hopeless, discouraged, blue) and anxious mood (i.e., anxious, nervous, unable to concentrate, on edge/uneasy) were assessed using a short form of Profile of Mood States (POMS; McNair et al., 1971). Adolescent's feelings during the past week at T1 and during the past two weeks at T2 were rated on a five-point scale (1 = "not at all" to 5 = "extremely"). All three scales had satisfactory internal consistency at T1 (positive mood: α = .78; negative mood: α = .84; anxious mood: α = .72) and T2 (positive mood: α = .80; negative mood: α = .89; anxious mood: α = .85). Depressive symptoms were assessed by Center for Epidemiological Studies-Depression (CES-D; Radloff, 1977), which had ten items using a four-point scale to assess respondent's depressive feelings during the past month at T1 and during the past two weeks at T2 (1 = "never" to 5 = "all of the time"). This scale had satisfactory internal consistency at T1 (α = .88) and T2 (α = .89).

Analysis and Results

Analytic Procedures

Table 1 shows the means, *SD*s, intraclass correlations (*ICC*s), and correlations of the primary study variables. Although adolescents were nested within schools by design, the ICCs of the study variables at the school level were considered small (mean = .01, ranging from .00 to .03; Hedges & Hedberg, 2007); suggesting none to negligible amounts of the variability in daily sleep indices were attributable to adolescents' schools. Therefore, school-level variability was not included in the multilevel analyses.

Figure 1 shows the conceptual path diagram of the SAM mediation models. In the model, ERI exploration/commitment (*Path a*) predicts the slope-as-mediator (the daily association

between ERD and sleep indicated by a black dot) and well-being (*Path c*'), and the slope-as-mediator predicts well-being (*Path b*). Each slope-as-mediator with different sleep indicators was tested in separate models because of the computational difficulties associated with estimating several random slopes in one model. All the well-being indicators (self-esteem, positive mood, negative mood, anxious mood, depressive symptoms) were included in every model, thus adjusting for any covariance between the outcomes. Of note, analyses were also conducted with each well-being outcome tested in separate models and the results were consistent with those in Table 1. As depicted in Figure 2, covariates were included to facilitate causal inference in the mediation analysis. At the daily level, we included day of the study (i.e., 1–14) which adjusts for method artifacts of daily diary studies, day of the week (1 = weekend, 0 = weekday; Lee et al., 1999) and previous-day sleep to adjust for sleep. At the adolescent level, we included ERI (commitment adjusting for exploration, and vice versa), gender (0 = female, 1 = male), age (continuous), race (two dummy variables with Asian Americans as the reference group), mother's and father's education levels (dummy variables for high school or below, beyond high school, and do not know), and T1 well-being as covariates (Borders & Liang, 2011). Adolescent's nativity was not included as a covariate because of high missing data rate (26%).

Multilevel structural equation modeling was used to estimate the SAM mediation model. Simulation study found that this method can produce unbiased mediation effect estimate and satisfactory statistical power when there are more than 14 level 1 observations per every level 2 in a balanced design (i.e., equal number of level 1 observations for all level 2 observations; author citation[a]). Using the notations by Preacher, Zyphur, and Zhang (2010), the SAM mediation model in Figure 1 can be expressed in equations 1 to 3:

Measurement Model:

$$\mathbf{Y}_{ij} = \boldsymbol{\Lambda}\boldsymbol{\eta}_{ij}$$

$$\begin{pmatrix} D_{ij} \\ E_{ij} \\ X_j \\ Y_j \end{pmatrix} = \begin{pmatrix} 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \eta_{Dij} \\ \eta_{Eij} \\ \eta_{Dj} \\ \eta_{Ej} \\ \eta_{Xj} \\ \eta_{Yj} \end{pmatrix}$$

Structural Model at Level 1:

$$\boldsymbol{\eta}_{ij} = \boldsymbol{\alpha}_j + \mathbf{B}_j\boldsymbol{\eta}_{ij} + \boldsymbol{\zeta}_{ij}$$

$$\begin{pmatrix} \eta_{Dij} \\ \eta_{Eij} \\ \eta_{Dj} \\ \eta_{Ej} \\ \eta_{Xj} \\ \eta_{Yj} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ \alpha_{\eta Dj} \\ \alpha_{\eta Ej} \\ \alpha_{\eta Xj} \\ \alpha_{\eta Yj} \end{pmatrix} + \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ B_{EDj} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} \eta_{Dij} \\ \eta_{Eij} \\ \eta_{Dj} \\ \eta_{Ej} \\ \eta_{Xj} \\ \eta_{Yj} \end{pmatrix} + \begin{pmatrix} \zeta_{Dij} \\ \zeta_{Eij} \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

Structural Model at Level 2:

$$\boldsymbol{\eta}_j = \boldsymbol{\mu} + \boldsymbol{\beta}\boldsymbol{\eta}_j + \boldsymbol{\zeta}_j$$

$$\begin{pmatrix} \mathrm{vec}(\mathbf{B}_j) \\ \mathrm{vec}(\boldsymbol{\alpha}_j) \end{pmatrix} = \boldsymbol{\mu} + \boldsymbol{\beta}\begin{pmatrix} \mathrm{vec}(\mathbf{B}_j) \\ \mathrm{vec}(\boldsymbol{\alpha}_j) \end{pmatrix} + \boldsymbol{\zeta}_j$$

$$\begin{pmatrix} B_{EDj} \\ \alpha_{\eta Dj} \\ \alpha_{\eta Ej} \\ \alpha_{\eta Xj} \\ \alpha_{\eta Yj} \end{pmatrix} = \begin{pmatrix} \mu_{BEDj} \\ \mu_{\eta Dj} \\ \mu_{\eta Ej} \\ \mu_{\eta Xj} \\ \mu_{\eta Yj} \end{pmatrix} + \left(\begin{array}{ccccc} 0 & 0 & 0 & \beta_{BEDX} & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ \beta_{YBED} & 0 & 0 & \beta_{YX} & 0 \end{array}\right)\begin{pmatrix} B_{EDj} \\ \alpha_{\eta Dj} \\ \alpha_{\eta Ej} \\ \alpha_{\eta xj} \\ \alpha_{\eta Yj} \end{pmatrix} + \begin{pmatrix} \zeta_{BEDj} \\ \zeta_{\eta Dj} \\ \zeta_{\eta Ej} \\ \zeta_{\eta Xj} \\ \zeta_{\eta Yj} \end{pmatrix}$$

where i and j means level 1 and level 2 units, respectively. In the measurement model, $\mathbf{Y}_{ij}$ is a column vector of measured variables at both levels. In $\mathbf{Y}$, D is ERD, E is Sleep, X is ERI, and Y is well-being. $\boldsymbol{\eta}_{ij}$ is a column vector of latent variables at both levels and $\boldsymbol{\Lambda}$ is the factor loading matrix. The measurement model separates each level 1 variable (e.g, D) into two latent variables that capture the level 1 (η_{Dij}) and level 2 (η_{Dj}) information. The dash lines in the matrices separates the level 1 and level 2 information. In the level 1 structural model, $\boldsymbol{\alpha}_j$ is the vector of level 2 unit's intercepts of each variable. $\mathbf{B}_j$ is the vector of level 2 unit's slopes of the relationships between level 1 latent variables. $\boldsymbol{\zeta}_{ij}$ is the vector of level 1 disturbances. Here we model the relationship between the two level 1 variables D and E, producing the random slope B_{EDj}. In the level 2 structural model, $\boldsymbol{\eta}_j$ is the vector of level 2 unit's slope and intercepts. $\boldsymbol{\mu}$ is the vector of intercept coefficients. $\boldsymbol{\beta}$ is the vector of path coefficients. β_{BEDX} is the path coefficient of predictor X to level 2 unit's slope. β_{YBED} is the path coefficients of slope (mediator) to outcome Y. β_{YX} is the path coefficient of X to Y. $\boldsymbol{\zeta}_j$ is the vector of level 2 disturbances.

These model specifications allow SAM approaches to make unique conceptual contributions compared to traditional mediation models, cross-level interactions, and conditional indirect effect models. We use the SAM mediation pathway from ERI commitment to the slope between daily ERD and sleep to adolescent self-esteem as an example. Compared to the traditional mediation (e.g., ERI commitment to daily ERD to self-esteem), SAM mediation also tests for the mechanisms through which a predictor influences an outcome variable. The mediator in a SAM model is a random slope between two level 1 latent variables, rather than a variable. Although the SAM mediation is equivalent to cross-level interactions in its first part (i.e., predictor to slope-as-mediator), it provides additional information by highlighting the developmental implications of linking the slope-as-mediator to the outcome variables (i.e., slope between daily ERD and sleep to self-esteem). Finally, the SAM mediation shares some similarities with conditional indirect effect models (e.g., ERI commitment conditioning the effect of daily ERD on daily sleep, daily sleep in turn related to self-esteem), as both methods could test the same set of variables. The key contrast between the two methods is that while the conditional indirect effect model draws conclusions on the mediating effect of a variable (i.e., daily sleep), the SAM mediation draws conclusions on the mediating role of a slope (i.e., slope between daily ERD and sleep).

Mediation analyses were conducted in M*plus* 7.2, using the Bayesian estimator that allows for incorporating prior distributions of parameters. The Gibbs sampler algorithm with random walk was selected because prior distributions of parameters from past studies can be

incorporated into model estimations, resulting in more precise posterior distributions of the parameters and mediation effects (Yuan & MacKinnon, 2009). For each model, the prior distributions of the path from predictor to slope-as-mediator, and from slope-as-mediator to outcome was inputted. Prior distribution estimates were based on studies that are conceptually and methodologically similar to this study (Table 2). For the prior distributions of the path from predictor to slope-as-mediator (*Path a*), the effect of (ERI exploration/commitment → [the daily association between ERD and daily sleep]) was equivalent to a cross-level interaction between ERI exploration/commitment and daily ERD for daily sleep. As a result, using estimates from a recent meta-analysis on the interactions between ERI and daily ERD for daily adjustment (author citation[b]); six published studies and one unpublished study provided the estimates for the predictive effects of ERI exploration and commitment. Rows A and B in Table 2 present the parameter estimates and standard errors from these studies. Effects were listed in order of the ratio of the parameter estimates to standard errors (i.e., *z* scores). We chose the set of the parameter estimate and standard error closest to the third quartile of the *z* scores as the prior mean and prior *SD* for each effect. We chose the third quartile of the *z* scores because these effects are equivalent to moderation effects, which often have smaller effect sizes (Chapin, 1991). The prior distributions were set to be normally distributed.

For the prior distributions of the path from slope-as-mediator to outcome (*Path b*), we searched for the studies investigating the effects of individuals' stress reactivity on well-being. Two studies of depression, one study of anxiety, and two studies of other well-being constructs (affective disorder, affective diagnosis, distress) were identified (Table 2). Row C in Table 2 presents the parameter estimates and standard errors from these studies. We included the prior distributions according to their respective outcomes (e.g., depression estimates for the depression outcome). Similarly, the effects were listed in order of the ratio of the parameter estimates to standard errors (i.e., *z* scores). We chose the set of the parameter estimate and standard error closest to the median of the *z* scores as the prior mean and prior *SD* for each effect. Median was chosen to provide the average effects using Bayesian analysis. The prior distributions were set to be normally distributed.

At the adolescent level, the average percentage of missing data at T1 and T2 was 1% and 7%, respectively. Missing data rates less than 10% are unlikely to affect statistical analyses (Dong & Peng, 2013). The daily diary reports had an average missing data rate = 12%. To examine whether the daily diary variables were missing completely at random, we calculated the correlations between the compliance of the daily diary reports and the variables at T1 (Enders, 2010). The average correlations (ignoring directions) was small (*r*s = .07, *SD* = .06), supporting the conclusion that daily ERD and sleep were missing completely at random. M*plus* omitted participants with missing values on any predictors and covariates from analyses, resulting in a final analytic sample of 255 adolescents with an average of 9.3 daily reports.

Results

Table 3 presents the full set of results from the SAM mediation analysis. The posterior medians and 95% credible intervals (CI) of the adjusted mean of the slope-as-mediator

(daily ERD to sleep), the direct effect of ERI exploration/commitment to well-being (*Path c'*), the effect of ERI exploration/commitment to the slope-as-mediator (*Path a*), the effect of the slope-as-mediator to well-being (*Path b*), presented from left to right. Consistent with other research, effects whose 95% credible intervals that did not include zero between the lower limit (*LL*) and upper limit (*UL*) were regarded as statistically significant (Yuan & MacKinnon, 2009). Only significant mediated results are discussed in the text, but the complete set of results can be found in Table 3.

Sleep Latency.—The results for sleep latency are presented in Table 3, Row A. First, analyses focused on ERI commitment observed that, consistent with hypotheses, adolescents who were higher on commitment reported a weaker effect of ERD on sleep latency (i.e., ERD had a weaker positive effect on sleep latency, posterior *Mdn* = −.07, 95% CI = [−.12, −.01]; *Path a*). Next, turning to the association between the slope-as-mediator (i.e., the association between ERD and sleep latency) and the outcome, results suggested that the daily association between ERD and sleep latency was positively related to anxious mood (posterior *Mdn* = .58, 95% CI = [.38, .79]; *Path b*) such that a strong, positive associations between ERD and sleep latency lead to higher levels of anxious mood. Further, this mediation effect was significant (posterior *Mdn* = −.04, 95% CI = [−.08, −.01]) and there was evidence of full mediation as the direct effect of ERI commitment to anxious mood was not significant (i.e., slope-as-mediator).

Sleep Efficiency.—The results for sleep efficiency are presented in Table 3, Row B. A pattern different from sleep latency emerged; consistent with hypotheses, ERI exploration predicted a stronger effect of ERD on sleep efficiency (i.e., ERD was associated with poorer sleep efficiency, posterior *Mdn* = .65, 95% CI = [.19, 1.10]; *Path a*). Adolescents who reported high levels of exploration reported a stronger positive association between ERD and poor sleep efficiency. Next, the daily association between ERD and poor sleep efficiency was observed to be positively related to anxious mood (posterior *Mdn* = .06, 95% CI = [.04, .07]; *Path b*) such that stronger positive associations between ERD and poor sleep efficiency were in turn related to higher levels of anxious mood. Further, this mediation effect was significant (posterior *Mdn* = .04, 95% CI = [.01, .07]) and there was evidence of full mediation (i.e., direct effect of ERI exploration to anxious mood was not significant; slope-as-mediator).

Sleep Disturbance.—The results for sleep disturbance are presented in Table 3, Row C and all results were marginally significant (90% CI). First, consistent with hypotheses, ERI commitment predicted a weaker association of ERD on sleep disturbance (i.e., ERI commitment buffered the association between ERD and sleep disturbance). Adolescents with higher levels of ERI commitment reported a weaker positive association between ERD and sleep disturbance, such that ERD was associated with *less* sleep disturbance (posterior *Mdn* = −.26, 95% CI = [−.46, −.05]; *Path a*). Next, turning to the association between the slope-as-mediator (i.e., the association between ERD and sleep disturbance) and the outcome (*Path b*), results suggested that the daily association between ERD and sleep disturbance was positively related to anxious mood (posterior *Mdn* = .06, 95% CI = [.04, .08]), meaning that stronger associations between ERD and sleep disturbance were in

turn related to higher levels of anxious mood. Further, this mediation effect was marginally significant (posterior *Mdn* = −.02, 90% CI = [−.03, −.01]) and this effect seemed to be fully mediated (i.e., slope-as-mediator).

Daytime Dysfunction.—The results for daytime dysfunction are presented in Table 3, Row D. First, ERI commitment predicted a weaker impact of ERD on daytime dysfunction (i.e., ERI commitment buffered the association between ERD and daytime dysfunction). Consistent with hypotheses, adolescents with higher levels of ERI commitment reported a more negative association between ERD and daytime dysfunction, such that ERD was associated with *less* daytime dysfunction (posterior *Mdn* = −.10, 95% CI = [−.18, −.02]; *Path a*). Next, turning to the association between the slope-as-mediator (i.e., the association between ERD and daytime dysfunction) and the outcome (*Path b*), the daily association between ERD and daytime dysfunction was negatively related to positive mood (posterior *Mdn* = −.47, 95% CI = [−.73, −.20]), suggesting that stronger negative associations between ERD and daytime dysfunction were in turn related lower positive mood. Moreover, the daily association between ERD and daytime dysfunction was positively related to negative mood (posterior *Mdn* = .46, 95% CI = [.19, .73]), anxious mood (posterior *Mdn* = .87, 95% CI = [.57, 1.17]), and depressive symptoms (posterior *Mdn* = .39, 95% CI = [.18, .59]), suggesting that stronger negative associations between ERD and daytime dysfunction were in turn related higher negative and anxious mood, and depressive symptoms. Further, all mediation effects were significant (positive mood: posterior *Mdn* = .04, 95% CI = [.01, .10]; negative mood: posterior *Mdn* = −.04, 95% CI = [−.10, −.01]; anxious mood: posterior *Mdn* = −.08, 95% CI = [−.17, −.01]; and depressive symptoms: posterior *Mdn* = −.04, 95% CI = [−.08, −.01]) and there was evidence of full mediation (i.e., the direct effect of ERI commitment to outcomes was not significant; slope-as-mediator).

Sleep Duration.—The results for sleep duration are presented in Table 3, Row E. First, analyses focused on ERI exploration observed that exploration exacerbated the effect of ERD on sleep duration such that adolescents who were higher on exploration reported a stronger negative effect of ERD on sleep duration (posterior *Mdn* = −.08, 95% CI = [−.14, −.02]; *Path a*). Consistent with hypotheses, adolescents who reported high levels of ERI exploration reported shorter sleep duration when they experienced ERD. Next, turning to the association between the slope-as-mediator (i.e., the association between ERD and sleep duration) and the outcome (*Path b*), results suggested that the daily association between ERD and sleep duration was positively related to positive mood (posterior *Mdn* = .34, 95% CI = [.15, .53]) and negatively related to negative (posterior *Mdn* = −.36, 95% CI = [−.56, −.17]) and anxious mood (posterior *Mdn* = −.64, 95% CI = [−.86, −.42]), suggesting a less negative daily associations between ERD and sleep duration were in turn related to higher positive mood and lower negative and anxious mood. Further, these mediation effects were significant (positive mood: posterior *Mdn* = −.03, 95% CI = [−.06, −.01]; negative mood: posterior *Mdn* = .03, 95% CI = [.01, .06]; anxious mood: posterior *Mdn* = .05, 95% CI = [.01, .10]) and there was evidence of full mediations as the direct effects of ERI exploration to these outcomes were not significant (i.e., slope-as-mediator).

Discussion

The current study advances development science on a few fronts. First, the study contributes to the science of the inter-relations between ERI, ERD, sleep and psychological outcomes. Second, the use of SAM mediation techniques contributes to methodological and analytic advances by illustrating an application of mediation analyses that uniquely elucidates how developmental processes unfold over time. In doing so, the current study concludes that the association between ERI and psychological outcomes is in part explained by the daily association between ERD and sleep. Consistent with a recent meta-analysis (author citation[b]), ERI exploration was observed to exacerbate the negative effects of ERD on sleep efficiency, disturbance, and duration, while ERI commitment was observed to buffer the negative effects of ERD on sleep latency, efficiency, disturbance, and daytime dysfunction. Below, the results are discussed by *Path* (i.e., *a, b, c'*) and overarching themes are presented. Finally, the utility and application of SAM mediation techniques to developmental science are discussed.

First exploring *Path a*, the association between ERI and the slope-as-mediator; because the slope-as-mediator is an association (rather than the typical mean), *Path a* is equivalent to a cross-level moderated effect (i.e., ERI = Level 2, ERD → Sleep = Level 1). Consistent with theoretical foundations and a recent meta-analysis (author citation[b]), the data suggested that ERI mitigated the negative impact of ERD on sleep. Specifically, for adolescents who reported high levels of ERI commitment, ERD had a weaker negative impact on sleep. Results were observed for sleep latency, sleep efficiency, sleep disturbance, and daytime dysfunction. Adding to the literature that finds ERI commitment shields youth from the mental and physical health impact of discrimination, this study contributes to a gap related to physical health outcomes such as sleep.

Also consistent with theoretical views and meta-analytical conclusions, ERI exploration exacerbated the negative effects of ERD for sleep efficiency, disturbance, and duration. That is, for adolescents reporting high levels of ERI exploration, ERD was associated with more compromised sleep efficiency, disturbance, and duration. Sleep efficiency is a ratio of the proportion of time an adolescent is asleep from the time they go to bed to the time they get out of bed. When adolescents who are unsure about their ERI experience ERD, they are asleep for a smaller proportion of the time that they are in bed. It is possible that high levels of ERI exploration are also associated with ruminative processes triggered by ERD experiences. That is, for adolescents who have not yet come to terms with their ERI, experiencing ERD may be particularly confusing and disturbing, resulting in possible ruminatory behaviors at bedtime. As a result, adolescents who are unsure about their ERI also sleep less when they encounter ERD as part of their daily experience.

Why might ERI commitment help to buffer the negative effects of ERD on various sleep indices while ERI exploration exacerbate effects? ERI commitment conceptually, and as it is measured in the current study, assesses feelings of comfort and resolution with one's membership in an ethnic/racial group. This sense of connection likely reflects a sense of common or shared fate with similar others which likely confers protective effects (Mayeri, 2000). It is also probable that the developmental journey and process to arrive at

commitment also includes accompanying tools for coping with discrimination. For example, research on ethnic/racial socialization finds that parents often prepare their children for the realities of discrimination and bias (Hughes et al., 2006). On the other hand, ERI exploration assess seeking behavior related to wanting to know more about one's ethnic/racial group. High levels of exploration have been associated with uncertainty with respect to one's ethnic/racial group membership and research finds that exploration exacerbates the effects of discrimination (Phinney, 1992; Torres & Ong, 2010). Being the target of unfair treatment directed as a group for which an adolescent is still uncertain, seems to have especially deleterious effects for a host of developmental outcomes (author citation[b]), including sleep as evidenced in the current study.

Turning to *Path b,* results suggested that the association between ERD and sleep (i.e., the slope-as-mediator) had implications for psychological outcomes. For example, adolescents who reported a stronger positive association between ERD and compromised sleep (i.e., latency, efficiency) in turn reported higher levels of anxious mood. These results point to an important developmental pathway and mechanism through which the impact of ERD on sleep results in compromised mental health outcomes. In fact, the associations between ERI commitment and exploration with anxious mood, were fully accounted for by the associations between ERD and sleep disturbance (i.e., the slope-as-mediator). The results were more nuanced, yet conceptually consistent, when daytime dysfunction was considered. For example, the more ERD was associated with daytime dysfunction, the lower levels of self-esteem and positive mood were reported. Conversely, a strong association between ERD and daytime dysfunction was associated with higher levels of negative outcomes such as negative and anxious mood, and depressive symptoms. For all paths, the association between ERI and outcomes were fully explained by the association between ERD and daytime dysfunction. What is so unique about daytime dysfunction that it explains both positive and negative mental health outcomes? Although sleep is a biological need, there are individual differences in how long and how well individuals sleep (Buckelmuller et al., 2006; Mezick et al., 2009). However, daytime dysfunction assesses the *impact* of sleep disturbances on daytime functioning. By querying how much trouble an adolescent has staying awake, or gathering enthusiasm to complete their daily tasks, daytime dysfunction is a better indicator of how problematic sleep disturbances are for everyday tasks and functioning.

Turning to sleep duration, while ERD was associated with shorter sleep duration, this association was stronger (i.e., more negative) for adolescents who are still making sense of their ERI. In turn, shorter sleep duration attributed to ERD was related to lower levels of positive mood and higher levels of negative and anxious mood. In other words, compromising adolescent's sleep duration was another pathway through which ERI impacted positive and negative mood. While assessing quality and duration as separate constructs is an important advance for teasing apart various dimensions of sleep, it is also important to acknowledge that there is a fundamental association between quality and duration. For the current sample, there was an overall negative association between duration and quality such that shorter duration was associated with poorer quality. Nevertheless, the results for duration suggest that similar to quality, the extent to which an adolescent's sleep is compromised by ERD has explanatory power linking ERI to psychological adjustment. Of note, the current study assessed self-reported duration using an ordinal scale, therefore

future research should further interrogate this association with other samples and with actigraphy-assessed indicators.

Notably, the association between ERD and all of the daily sleep indicators was predictive of anxious mood during a two-week period (assessed at T2). What this suggests is that the more an adolescent's sleep was negatively impacted by ERD, the more anxious mood the adolescent reported over the past two weeks. Discrimination is associated with a host of negative feelings (Benner et al., 2018; Park, Wang, Williams, & Alegría, 2017), but the link between ERD and anxiety has been well cited in the literature (Soto, Dawson-Andoh, & BeLue, 2011). Similarly, there is also empirical support for links between sleep disturbances and anxiety (Alfano, 2018; Uhde, Cortese, & Vedeniapin, 2009). This current study integrates these literatures by showing that one way in which ERD, sleep, and anxious mood are related is through the daily-level association between ERD and sleep, which has subsequent impact on feelings of anxiety. This discovery suggests a potential point of intervention for interrupting the mechanistic chain between these constructs may be to focus on alleviating experiences of anxiety.

While anxiety was most consistently related to the association between ERD and sleep, other outcomes such as self-esteem, positive and negative mood, and depressive symptoms were also related to the daily links between ERD and sleep. In part, these associations underscore the far-reaching impact of ERD, sleep, and their association on the socioemotional states of adolescents. With the exception of sleep efficiency, all other sleep indicators were associated with all of the socioemotional outcomes. While the current data are longitudinal, the design is a short-term longitudinal design focusing on the associations between daily experiences and socioemotional outcomes over a two-week period. Over time, these associations have the potential to elucidate developmental patterns related to associations between ERD and sleep with overall socioemotional development. Indeed, recent meta-analytic reviews have noted robust links between ERD with socioemotional outcomes as well as ERD and sleep (Benner et al., 2018; Slopen, Lewis, & Williams, 2016). Together, this literature has the potential to contribute to growing research on ethnic/racial disparities in health and youth development (Goosby, Straley, & Cheadle, 2017; Levy, Heissel, Richeson, & Adam, 2016).

Taken together, these analyses suggest that part of the reason that ERI (exploration and commitment) are related to psychological outcomes is through the association between ERD and sleep. That is, the extent to which ERD impacts adolescents' sleep and daytime dysfunction seems to serve as an explanatory mechanism linking ERI to outcomes. This study therefore adds to the growing literature elucidating the mechanisms underlying the overall positive benefits of ERI (Rivas-Drake, Seaton, et al., 2014). So why might ERD and sleep, and more specifically, their daily-level association play such an important role in ERI and adjustment? The extent to which an adolescent has engaged with and committed to one's ethnic/racial group membership has implications for the impact of ERD on a host of psychological and physical health outcomes (author citation[b]), including the current study's focus on sleep. In turn, sleep has far-reaching developmental implications including cognition, health, academics, and overall adjustment (Bub, Buckhalt, & El-Sheikh, 2011; Carskadon, 1999; Dahl, 1999; Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010; Philbrook,

Hinnant, Elmore-Stanton, Buckhalt, & El-Sheikh, 2017; Wolfson & Carskadon, 2008). Indeed, with the exception of just a few pathways, the results suggest the *Path b* (the path between the slope-as-mediator and the outcome) was significant; underscoring the importance of how adolescent's sleep is impacted by ERD for overall health and development. Identifying the association between ERD and sleep as an important mediating pathway also points to areas of intervention. For example, disrupting the pathway between ERD and sleep may help mitigate the effects of ERD on health overall. Fortunately, sleep behavior and hygiene have been shown to be responsive to intervention efforts and may provide a reasonable point of intervention to mitigate the effects of ERD (David, 2016). In addition, the data also suggest that increasing ERI may lead to more positive developmental outcomes. Recent research finds that interventions focused on helping adolescents to explore the history, symbols and traditions of their ethnic group have resulted in higher levels of ERI (Umana-Taylor et al., 2018).

Notably, the results also point to the importance of considering sleep quality indicators in developmental science. While national agencies including the National Sleep Foundation (Hirshkowitz, et al. 2015) and the National Institutes of Health (2006) make recommendations for how much people should sleep as a function of age, there are wide individual differences (Buckelmuller et al., 2006; Mezick et al., 2009). These results are consistent with literature that finds related, yet distinct, associations between sleep quality and duration with developmental outcomes (Galambos, Dalton, & Maggs, 2009; Galambos, Howard, & Maggs, 2011). Although more subjective, research does support the predictive utility of sleep quality (Buysse, Reynolds III, Monk, Berman, & Kupfer, 1989; Willis & Gregory, 2015). While individuals may have a more difficult time agreeing on the optimal amount of sleep, it may be easier to agree on what constitutes a "good night's sleep". The current study is consistent with this view that sleep quality, although subjective and self-reported, is indicative of adjustment and developmentally relevant. Indeed, consistent with existing research (Tu, Marks & El-Sheikh, 2017), the bivariate correlations indicate significant associations between subjective sleep problems and mood, anxiety, depressive symptoms and self-esteem.

Slope-As-Mediator (SAM) Mediation – Applications and Future Directions

In addition to contributing to the substantive literature on ERI, ERD, sleep and adolescent adjustment, the current study also make methodological contributions with the application of SAM models. Although we are the first to coin the term "slope-as-mediator" and "SAM" mediation, the concept is not new to the social and behavioral sciences. For example, intervention research is predicated on the idea that an intervention (the predictor variable) may change the relationship between two variables, which in turn, results in changes in the outcome. MacKinnon (2012) observed that mediator variables are often chosen precisely for their malleable nature. We extend this logic by suggesting that not only are meditators themselves malleable and subject to change, but that *their relationships with other variables are also subject to change*. It is precisely the change in the relationship between the mediator and its immediate outcome (i.e., the "co-mediator"), which results in a "co-mediated association" that becomes the target of the intervention. This approach contrasts the conventional mediation models or conditional mediation models that draw conclusions

regarding a particular variable (compared to the *association between variables*) as the intervention target.

Although the current study makes significant advances in understanding the links between ERI, ERD, sleep, and adolescent adjustment, the study is not without limitations. First, the sample was collected in a large and diverse urban area where adolescents may be more prone to consider issues of ethnicity/race, identity, and discrimination (McMahon & Watts, 2002; Semons, 1991; Williams, Aiyer, Durkee, & Tolan, 2014). Second, research has found that sleep may be generally compromised in urban settings (Street et al., 2016), leaving open the question how these processes may be different for adolescents residing in non-urban areas. As well, the data here represent only the first year of an ongoing longitudinal study; therefore, it is imperative to explore how these associations are related over time and for older adolescents. The current study also did not consider cognitive functioning and academic outcomes which have been linked to ERI, ERD, and sleep (Benner et al., 2018; Brown & Chu, 2012; Buckhalt & Staton, 2011; Chavous et al., 2003; El-Sheikh, Buckhalt, Keller, Cummings, & Acebo, 2007; Philbrook et al., 2017), therefore, future research should consider outcomes beyond psychological adjustment. Finally, the current study focused on multiple indices of self-reported sleep, and adolescent research is increasingly touting the benefits of multiple indicators of sleep, including wrist actigraphy which provides more objective measures of sleep (Sadeh, 2008, 2011).

Despite the limitations, the current study makes important contributions to appreciating the role of ethnicity/race in the daily lives of adolescents who are tasked with forming an identity, coping with unfair treatment, and balancing the biological need for sleep with the social pressures of school and family. The current data suggest that the impact that discrimination has on adolescent sleep depends upon how much they have explored and committed to their ethnic/racial group; in turn, this association is associated with downstream psychological adjustment. The unique combination of a biopsychosocial approach is important for developmental scientists who wish to understand the synergy of multiple levels of influence on child and adolescent development. Embracing a more holistic approach to developmental influences on adolescent health not only provides a broader conceptualization of health and development, but also suggests new avenues for intervention and health promotion.

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References

Adam EK, Heissel JA, Zeiders KH, Richeson JA, Ross EC, Ehrlich KB, … Malanchuk O (2015). Developmental histories of perceived racial discrimination and diurnal cortisol profiles in adulthood: A 20-year prospective study. Psychoneuroendocrinology, 62, 279–291. 10.1016/j.psyneuen.2015.08.018 [PubMed: 26352481]

Alfano CA (2018). (Re) Conceptualizing Sleep Among Children with Anxiety Disorders: Where to Next?. Clinical child and family psychology review, 21(4), 482–499. [PubMed: 30136070]

Author citationa. Mechanisms of change via relationships between variables (slope-as-mediator): A multilevel structural equation modeling framework.

Author citationb. (in press). Moderating the association between discrimination and adjustment: A Meta-analysis of ethnic/racial identity. Developmental Psychology.

Author citationc. Racial disparities in sleep: Associations with discrimination among ethnic minority adolescents.

Author citationd. (2019). Parental cultural socialization and adolescent private regard: Exploring mediating pathways through daily experiences. Child Development.

Barker RG (1968). Ecological psychology: Concepts and methods for studying the environment of human behavior. Stanford, CA: Stanford University Press.

Baron RM, & Kenny DA (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. Journal of Personality and Social Psychology, 51, 1173–1182. [PubMed: 3806354]

Baum KT, Desai A, Field J, Miller LE, Rausch J, & Beebe DW (2014). Sleep restriction worsens mood and emotion regulation in adolescents. Journal of Child Psychology and Psychiatry, 55(2), 180–190. [PubMed: 24889207]

Benner AD, Wang Y, Shen Y, Boyle AE, Polk R, & Cheng Y-P (2018). Racial/ethnic discrimination and well-being during adolescence: A meta-analytic review. American Psychologist. doi:10.1037/amp0000204

Branscombe N, Schmitt M, & Harvey R (1999). Perceiving pervasive discrimination among African Americans: Implications for group identification and well-being. Journal of Personality and Social Psychology, 77, 135–149.

Brown CS, & Chu H (2012). Discrimination, ethnic identity, and academic outcomes of Mexican immigrant children: The importance of school context. Child development, 83(5), 1477–1485. [PubMed: 22966916]

Bub KL, Buckhalt JA, & El-Sheikh M (2011). Children's sleep and cognitive performance: A cross-domain analysis of change over time. Developmental Psychology, 47(6), 1504–1514. doi:10.1037/a0025535 [PubMed: 21942668]

Buckelmüller J, Landolt HP, Stassen HH, & Achermann P (2006). Trait-like individual differences in the human sleep electroencephalogram. Neuroscience, 138(1), 351–356. [PubMed: 16388912]

Buysse DJ, Reynolds CF III, Monk TH, Berman SR, & Kupfer DJ (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry research, 28(2), 193–213. [PubMed: 2748771]

Carskadon M (1999). When worlds collide: Adolescent need for sleep versus societal demands. Phi Delta Kappan, 80, 348–353.

Charles ST, Piazza JR, Mogle J, Sliwinski MJ, & Almeida DM (2013). The wear and tear of daily stressors on mental health. Psychological science, 24(5), 733–741. [PubMed: 23531486]

Chavous TM, Bernat DH, Schmeelk-Cone K, Caldwell CH, Kohn-Wood L, & Zimmerman MA (2003). Racial identity and academic attainment among African American adolescents. Child development, 74(4), 1076–1090. [PubMed: 12938705]

Clark KB, & Clark MK (1939). The development of consciousness of self and the emergence of racial identification in Negro preschool children. The Journal of social psychology, 10(4), 591–599.

Coll CG, Crnic K, Lamberty G, Wasik BH, Jenkins R, Garcia HV, & McAdoo HP (1996). An integrative model for the study of developmental competencies in minority children. Child development, 67(5), 1891–1914. [PubMed: 9022222]

Dahl RE (1999). The consequences of insufficient sleep for adolescents. Phi Delta Kappan, 80(5), 354–359.

David L (2016). How Did You Sleep?: Effects of an Individualized Sleep Hygiene Intervention Program on College Students' Sleep.

Dewald JF, Meijer AM, Oort FJ, Kerkhof GA, & Bögels SM (2010). The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: a meta-analytic review. Sleep Medicine Reviews, 14(3), 179–189. [PubMed: 20093054]

Dunbar M, Mirpuri S, & Yip T (2017). Ethnic/racial discrimination moderates the effect of sleep quality on school engagement across high school. Cultural Diversity and Ethnic Minority Psychology, 23(4), 527. [PubMed: 28394166]

El-Sheikh M, Buckhalt JA, Keller PS, Cummings EM, & Acebo C (2007). Child emotional insecurity and academic achievement: the role of sleep disruptions. Journal of Family Psychology, 21(1), 29. [PubMed: 17371107]

Fuller-Rowell TE, Curtis DS, El-Sheikh M, Duke AM, Ryff CD, & Zgierska AE (2017). Racial discrimination mediates race differences in sleep problems: A longitudinal analysis. Cultural Diversity and Ethnic Minority Psychology, 23(2), 165. [PubMed: 27429065]

Galambos NL, Dalton AL, & Maggs JL (2009). Losing sleep over it: Daily variation in sleep quantity and quality in Canadian students' first semester of university. Journal of Research on Adolescence, 19(4), 741–761.

Galambos NL, Howard AL, & Maggs JL (2011). Rise and fall of sleep quantity and quality with student experiences across the first year of university. Journal of Research on Adolescence, 21(2), 342–349.

Gallimore R, Goldenberg CN, & Weisner TS (1993). The social construction and subjective reality of activity settings: Implications for community psychology. American Journal of Community Psychology, 21(4), 537–559. [PubMed: 8192122]

Gee GC, Spencer M, Chen J, Yip T, & Takeuchi DT (2007). The association between self-reported racial discrimination and 12-month DSM-IV mental disorders among Asian Americans nationwide. Social Science & Medicine, 64(10), 1984–1996. doi:10.1016/j.socscimed.2007.02.013 [PubMed: 17374553]

Goosby BJ, Cheadle JE, Strong-Bak W, Roth TC, & Nelson TD (2018). Perceived Discrimination and Adolescent Sleep in a Community Sample. RSF.

Goosby BJ, Straley E, & Cheadle JE (2017). Discrimination, Sleep, and Stress Reactivity: Pathways to African American-White Cardiometabolic Risk Inequities. Population Research and Policy Review, 36(5), 699–716.

Greene ML, Way N, & Pahl K (2006). Trajectories of Perceived Adult and Peer Discrimination among Black, Latino and Asian American Adolescents: Patterns and Psychological Correlates. Developmental Psychology, 42(2), 218–238. [PubMed: 16569162]

Gregory AM, & Sadeh A (2012). Sleep, emotional and behavioral difficulties in children and adolescents. Sleep medicine reviews, 16(2), 129–136. [PubMed: 21676633]

Hayes AF, Preacher KJ, & Myers TA (2011). Mediation and the estimation of indirect effects in political communication research. Sourcebook for political communication research: Methods, measures, and analytical techniques, 23, 434–465.

Hedges LV, & Hedberg EC (2007). Intraclass correlation values for planning group-randomized trials in education. Educational Evaluation and Policy Analysis, 29, 60–87. 10.3102/0162373707299706

Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, ... & Neubauer DN (2015). National Sleep Foundation's sleep time duration recommendations: methodology and results summary. Sleep Health, 1(1), 40–43. [PubMed: 29073412]

Hughes DL, Del Toro J, Harding JF, Way N, & Rarick JRD (2016). Trajectories of Discrimination Across Adolescence: Associations With Academic, Psychological, and Behavioral Outcomes. Child Development, 87(5), 1337–1351. [PubMed: 27684390]

Hughes DL, Rodriguez J, Smith EP, Johnson DJ, Stevenson HC, & Spicer P (2006). Parents' ethnic-racial socialization practices: A review of research and directions for future study. Developmental Psychology, 42(5), 747–770. [PubMed: 16953684]

Huynh VW, & Gillen-O'Neel C (2016). Discrimination and sleep: The protective role of school belonging. Youth & Society, 48(5), 649–672.

Imai K, Keele L, & Tingley D (2010). A general approach to causal mediation analysis. Psychological methods, 15(4), 309. [PubMed: 20954780]

Kelly RJ, & El-Sheikh M (2014). Reciprocal relations between children's sleep and their adjustment over time. Developmental Psychology, 50, 1137–1147. doi: 10.1037/a0034501 [PubMed: 24188035]

Levy DJ, Heissel JA, Richeson JA, & Adam EK (2016). Psychological and biological responses to race-based social stress as pathways to disparities in educational outcomes. American Psychologist, 71(6), 455. [PubMed: 27571526]

Lewis TT, Troxel WM, Kravitz HM, Bromberger JT, Matthews KA, & Hall MH (2012). Chronic Exposure to Everyday Discrimination and Sleep in a Multiethnic Sample of Middle-Aged Women. Health Psychology. doi:10.1037/a0029938

Lofthouse N, Gilchrist R, & Splaingard M (2009). Mood-related sleep problems in children and adolescents. Child and Adolescent Psychiatric Clinics, 18(4), 893–916.

MacKinnon D (2012). Introduction to statistical mediation analysis: Routledge.

Mandel T, Dunkley DM, & Moroz M (2015). Self-critical perfectionism and depressive and anxious symptoms over 4 years: The mediating role of daily stress reactivity. Journal of Counseling Psychology, 62(4), 703. [PubMed: 26191980]

Maxwell SE, & Cole DA (2007). Bias in cross-sectional analyses of longitudinal mediation. Psychological methods, 12(1), 23. [PubMed: 17402810]

Mayeri S (2000). A Common Fate of Discrimination: Race-Gender Analogies in Legal and Historical Perspective. Yale LJ, 110, 1045.

McMahon SD, & Watts RJ (2002). Ethnic identity in urban African American youth: Exploring links with self-worth, aggression, and other psychosocial variables. Journal of Community Psychology, 30, 411–431.

McMakin DL, & Alfano CA (2015). Sleep and anxiety in late childhood and early adolescence. Current opinion in psychiatry, 28(6), 483. [PubMed: 26382163]

Mezick EJ, Matthews KA, Hall M, Kamarck TW, Buysse DJ, Owens JF, & Reis SE (2009). Intra-individual variability in sleep duration and fragmentation: associations with stress. Psychoneuroendocrinology, 34(9), 1346–1354. [PubMed: 19450933]

National Institutes of Health (2006, 3 23). NIH offers new comprehensive guide to health sleep. Retrieved from https://www.nih.gov/news-events/news-releases/nih-offers-new-comprehensive-guide-healthy-sleep

Park IJ, Wang L, Williams DR, & Alegría M (2017). Does anger regulation mediate the discrimination–mental health link among Mexican-origin adolescents? A longitudinal mediation analysis using multilevel modeling. Developmental Psychology, 53(2), 340. [PubMed: 27893238]

Philbrook LE, Hinnant JB, Elmore-Staton L, Buckhalt JA, & El-Sheikh M (2017). Sleep and cognitive functioning in childhood: Ethnicity, socioeconomic status, and sex as moderators. Developmental Psychology, 53(7), 1276. [PubMed: 28414509]

Phinney JS (1992). The Multigroup Ethnic Identity Measure: A new scale for use with diverse groups. Journal of Adolescent Research, 7(2), 156–176.

Phinney JS, & Kohatsu EL (1997). Ethnic and racial identity development and mental health In Hurrelman K (Ed.), Health Risks and Developmental Transitions in Adolescence. New York: Cambridge University Press.

Phinney JS, Lochner BT, & Murphy R (1990). Ethnic identity development and psychological adjustment in adolescence: Sage Publications, Inc.

Rivas-Drake D, Seaton EK, Markstrom C, Quintana S, Syed M, Lee RM, … Racial Identity in the 21st Century Study, G. (2014). Ethnic and Racial Identity in Adolescence: Implications for Psychosocial, Academic, and Health Outcomes. Child development, 85(1), 40–57. doi:10.1111/cdev.12200 [PubMed: 24490891]

Rivas-Drake D, Syed M, Umaña-Taylor A, Markstrom C, French S, Schwartz SJ, … Racial Identity in the 21st Century Study, G. (2014). Feeling Good, Happy, and Proud: A Meta-Analysis of Positive Ethnic–Racial Affect and Adjustment. Child development, 85(1), 77–102. doi:10.1111/cdev.12175 [PubMed: 24490893]

Sadeh A (2008). Commentary: Comparing actigraphy and parental report as measures of children's sleep. Journal of Pediatric Psychology, 33(4), 406–407. [PubMed: 18310663]

Sadeh A (2011). Sleep assessment methods In El-Sheikh M (Ed.), Sleep and development: Familial and socio-cultural considerations. (pp. 355–371). New York, NY US: Oxford University Press.

Schimitt MT, Branscombe NR, Postmes T, & Garcia A (2014). The consequences of perceived discrimiantion for psychological well-being: A Meta-analytic review. Psychological bulletin.

Schwartz SJ, Syed M, Yip T, Knight GP, Umaña-Taylor AJ, Rivas-Drake D, … Racial Identity in the 21st Century Study, G. (2014). Methodological Issues in Ethnic and Racial Identity Research With

Ethnic Minority Populations: Theoretical Precision, Measurement Issues, and Research Designs. Child development, 85(1), 58–76. doi:10.1111/cdev.12201 [PubMed: 24490892]

Sellers RM, Smith MA, Shelton JN, Rowley SAJ, & Chavous TM (1998). Multidimensional model of racial identity: A reconceptualization of African American racial identity. Personality and Social Psychology Review, 2(1), 18–39. [PubMed: 15647149]

Semons M (1991). Ethnicity in the urban high school: A naturalistic study of student experiences. Urban Review, 23(3), 137–158.

Shochat T, Cohen-Zion M, & Tzischinsky O. (2014). Functional consequences of inadequate sleep in adolescents: A Systematic review. Sleep Med Rev, 18(1), 75–87. [PubMed: 23806891]

Shrout PE, & Bolger N (2002). Mediation in experimental and nonexperimental studies: new procedures and recommendations. Psychological Methods, 7(4), 422. [PubMed: 12530702]

Slopen N, Lewis TT, & Williams DR (2016). Discrimination and sleep: a systematic review. Sleep medicine, 18, 88–95. [PubMed: 25770043]

Slopen N, & Williams DR (2014). Discrimination, other psychosocial stressors, and self-reported sleep duration and difficulties. Sleep, 37(1), 147–156. [PubMed: 24381373]

Soto JA, Dawson-Andoh NA, & BeLue R (2011). The relationship between perceived discrimination and generalized anxiety disorder among African Americans, Afro Caribbeans, and non-Hispanic Whites. Journal of anxiety disorders, 25(2), 258–265. [PubMed: 21041059]

Steffen PR, & Bowden M (2006). Sleep disturbance mediates the relationship between perceived racism and depressive symptoms. Ethnic Groups, 5(6), 8–11.

Street NW, McCormick MC, Austin SB, Slopen N, Habre R, & Molnar BE (2016). Sleep duration and risk of physical aggression against peers in urban youth. Sleep Health, 2(2), 129–135. doi:10.1016/j.sleh.2016.03.002 [PubMed: 28923255]

Syed M, & Azmitia M (2010). Narrative and ethnic identity exploration: A longitudinal account of emerging adults' ethnicity-related experiences. Developmental Psychology, 46(1), 208. [PubMed: 20053018]

Syed M, Walker LH, Lee RM, Umaña-Taylor AJ, Zamboanga BL, Schwartz SJ, … Huynh Q-L (2013). A two-factor model of ethnic identity exploration: Implications for identity coherence and well-being. Cultural Diversity and Ethnic Minority Psychology, 19(2), 143. [PubMed: 23647328]

Tajfel H, & Turner JC (2004). The Social Identity Theory of Intergroup Behavior.

Telzer EH, Goldenberg D, Fuligni AJ, Lieberman MD, & Gálvan A (2015). Sleep variability in adolescence is associated with altered brain development. Developmental cognitive neuroscience, 14, 16–22. [PubMed: 26093368]

Tomfohr L, Pung MA, Edwards KM, & Dimsdale JE (2012). Racial differences in sleep architecture: The role of ethnic discrimination. Biological Psychology, 89(1), 34–38. doi:10.1016/j.biopsycho.2011.09.002 [PubMed: 21925567]

Torres L, & Ong AD (2010). A daily diary investigation of latino ethnic identity, discrimination, and depression Cultural Diversity and Ethnic Minority Psychology (Vol. 16, pp. 561–568). [PubMed: 21058819]

Tu KM, Marks B, & El-Sheikh M (2017). Sleep and mental health: The moderating role of perceived adolescent-parent attachment. Sleep Health, 2, 90–97. doi.org/10.1016/j.sleh.2016.12.003

Uhde TW, Cortese BM, & Vedeniapin A (2009). Anxiety and sleep problems: emerging concepts and theoretical treatment implications. Current psychiatry reports, 11(4), 269–276. [PubMed: 19635234]

Umaña-Taylor AJ, Douglass S, Updegraff KA, & Marsiglia FF (2018). A small-scale randomized efficacy trial of the Identity Project: Promoting adolescents' ethnic–racial identity exploration and resolution. Child development, 89(3), 862–870. [PubMed: 28321839]

Umaña-Taylor AJ, Quintana SM, Lee RM, Cross WE, Rivas-Drake D, Schwartz SJ, … Seaton E (2014). Ethnic and racial identity during adolescence and into young adulthood: An integrated conceptualization. Child development, 85(1), 21–39. [PubMed: 24490890]

Wichers M, Geschwind N, Jacobs N, Kenis G, Peeters F, Derom C, ... & van Os J (2009). Transition from stress sensitivity to a depressive state: longitudinal twin study. The British Journal of Psychiatry, 195(6), 498–503. [PubMed: 19949197]

Williams DR, Neighbors HW, & Jackson JS (2008). Racial/ethnic discrimination and health: Findings from community studies. American Journal of Public Health, 98(Suppl 9), S29–S37. [PubMed: 18687616]

Williams JL, Aiyer SM, Durkee MI, & Tolan PH (2014). The protective role of ethnic identity for urban adolescent males facing multiple stressors Journal of youth and adolescence (Vol. 43, pp. 1728–1741). [PubMed: 24318745]

Willis TA, & Gregory AM (2015). Anxiety disorders and sleep in children and adolescents. Sleep medicine clinics, 10(2), 125–131. [PubMed: 26055860]

Wolfson AR, & Carskadon MA (1998). Sleep schedules and daytime functioning in adolescents. Child development, 875–887. [PubMed: 9768476]

Wolfson AR, & Carskadon MA (2008). Sleep schedules and daytime functioning in adolescents. Child development, 69(4), 875–887.

Yip T (2015). The effects of ethnic/racial discrimination and sleep quality on depressive symptoms and self-esteem trajectories among diverse adolescents. Journal of youth and adolescence, 44(2), 419–430. [PubMed: 24682960]

Yip T (2018). Ethnic/racial identity—A double-edged sword? Associations with discrimination and psychological outcomes. Current Directions in Psychological Science, 27(3), 170–175. [PubMed: 30581253]

Yip T, Gee GC, & Takeuchi DT (2008). Racial discrimination and psychological distress: The impact of ethnic identity and age among immigrant and United States-born Asian adults. Developmental Psychology, 44(3), 787–800. doi:10.1037/0012-1649.44.3.787 [PubMed: 18473644]

Yip T, Seaton EK, & Sellers RM (2006). African American Racial Identity Across the Lifespan: Identity Status, Identity Content, and Depressive Symptoms. Child development, 77(5), 1504–1517. doi:10.1111/j.1467-8624.2006.00950.x [PubMed: 16999814]

Zeiders KH, Updegraff KA, Sally I, Kuo C, Umaña-Taylor AJ, & McHale SM (2017). Perceived discrimination and Mexican-origin young adults' sleep duration and variability: the moderating role of cultural orientations. Journal of youth and adolecence, 46(8), 1851–1861.

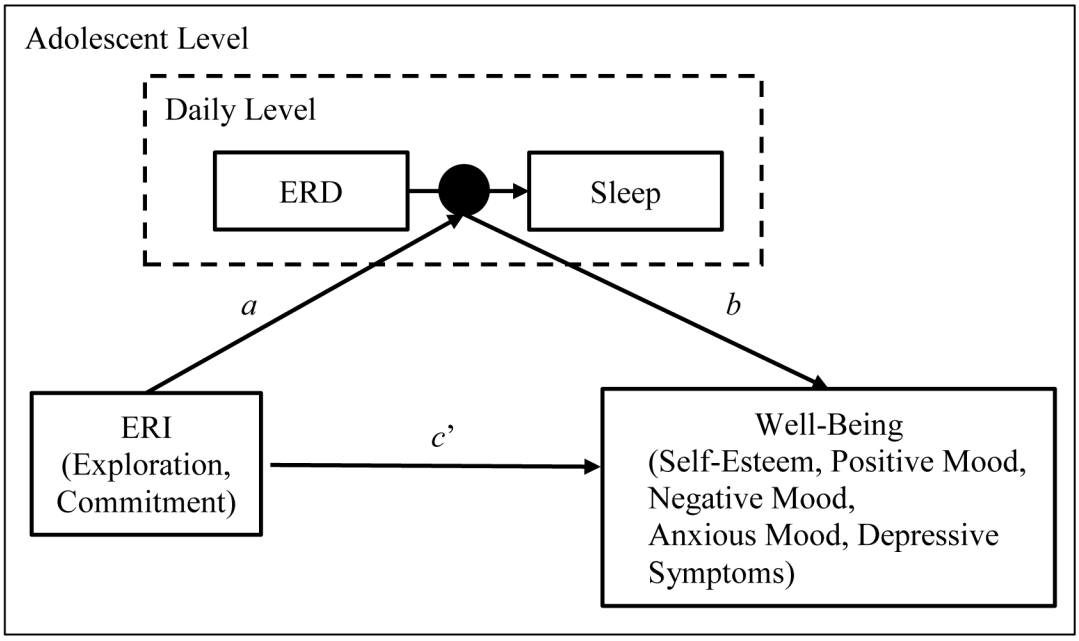

Figure 1.

Conceptual path diagram of the slope-as-mediator (SAM) mediation model. ERI = ethnic/racial identity, ERD = ethnic/racial discrimination. Outer solid box represents adolescent-level processes. Inner dashed box represents daily-level processes. The black circle between ERD and sleep represents adolescents' daily-level random slope.

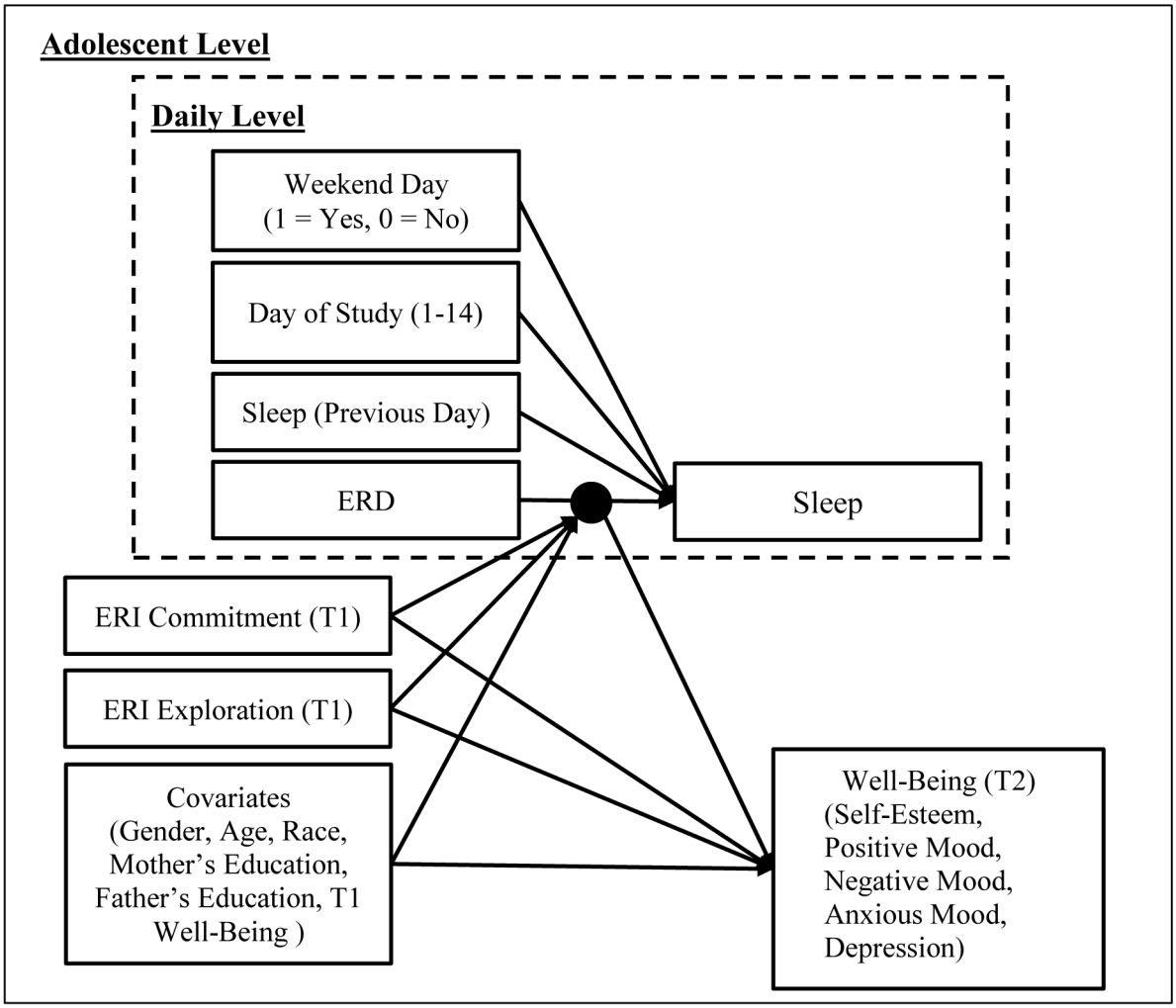

Figure 2.

Path diagram of the SAM mediation model testing adolescent's ERI commitment/exploration to well-being via adolescents' associations between daily ethnic/racial discrimination (ERD) and sleep. Outer solid box represents adolescent-level processes. Inner dashed box represents daily-level processes. The black circle between ERD and sleep represents adolescents' daily-level random slope. At daily level, covariates included previous day sleep, day of the study, day of the week (1 = weekend, 0 = weekday). At adolescent level, covariates included gender (0 = female, 1 = male), age (continuous), race (two dummy variables with Asian Americans as the reference group), mother's and father's education levels (dummy variables for high school or below, beyond high school, and do not know), and well-being indicators at baseline (T1). All predictors and covariates were freely correlated in the model (not shown in figure).

Table 1

Means, SDs, Intraclass Correlations (ICC), and Correlations for Primary Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Exploration (T1)	1																	
2. Commitment (T1)	.68***	1																
3. Self-Esteem (T1)	.06	.19**	1															
4. Positive Mood (T1)	.16*	.27***	.50***	1														
5. Negative Mood (T1)	.02	−.05	−.64***	−.32***	1													
6. Anxious Mood (T1)	.06	−.04	−.48***	−.14*	.64***	1												
7. Dep. Symptoms (T1)	.00	−.09	−.71***	−.46***	.80***	.58***	1											
8. Self-Esteem (T2)	.04	.22***	.66***	.43	−.44***	−.39***	−.53***	1										
9. Positive Mood (T2)	.09	.20***	.32***	.46***	−.21**	−.16*	−.28***	.48***	1									
10. Negative Mood (T2)	−.02	−.11	−.43***	−.30***	.57***	.42***	.58***	−.50***	−.09	1								
11. Anxious Mood (T2)	−.03	−.10	−.39***	−.28***	.45***	.49***	.48***	−.43***	−.01	.79***	1							
12. Dep. Symptoms (T2)	−.04	−.16*	−.47***	−.34***	.51***	.38***	.59***	−.61***	−.28***	.80***	.67***	1						
13. Discrimination (D)	−.11	−.25***	−.16*	−.19**	.17**	.16*	.22*	−.23***	−.12	.31***	.22**	.35***	1					
14. Sleep Latency (D)	.01	.00	−.15*	−.06	.15**	.17**	.16*	−.14*	−.15*	.15*	.10	.19**	.04	1				
15. Sleep Efficiency (D)	−.07	−.10	−.09	−.10	.20**	.14*	.20**	−.14*	−.05	.23***	.15*	.25***	.04*	−.01	1			
16. Sleep Disturb. (D)	.06	−.02	−.15*	−.10	.16*	.18**	.20**	−.11	−.12	.24***	.21**	.35***	.08***	.39***	.03	1		
17. Daytime Dysfun. (D)	−.01	−.04	−.27***	−.26***	.20**	.27***	.17**	−.26***	−.25***	.29***	.35***	.30***	.02	.26***	−.06*	.30***	1	
18. Sleep Duration (D)	.07	.12	.16*	.15*	−.24***	−.20**	−.27***	.24***	.00	−.37***	−.34***	−.33***	−.05**	−.12***	−.02	−.06**	−.18***	1

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
M	2.65	3.01	3.54	3.36	2.05	2.52	2.21	3.40	3.20	1.86	2.15	2.18	.09	.45	.90	.42	.41	1.97
SD	.56	.51	.73	.94	.97	.89	.63	.70	.98	.98	.99	.65	.20	.58	.84	.46	.54	.96
ICC (Adolescent Level)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	.50	.36	.30	.31	.29	.39
ICC (School Level)	.02	.02	.00	.10	.03	.00	.02	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.00
N	258	257	258	260	259	260	259	243	246	246	246	248	2750	3696	2757	3696	3696	2772

Note.

*
$p < .05$.

**
$p < .01$.

***
$p < .001$. N/A = not available. T1 = Time 1. T2 = Time 2. D = Daily Assessment. The *SD*s and correlations of discrimination and sleep were assessed at the daily level.

Table 2

Prior Information for the Effects of ERI Commitment and Exploration on Well-Being Mediated by Adolescent's Relationship between Ethnic/Racial Discrimination (ERD) and Sleep Across Days

Study	Effect	*β*	*SE*
(A) Priors for the Effect of ERI Exploration to (ERD to Sleep)			
Jones (2009)	(Exploration × ERD) → Social Functioning	.13	.06
Lee, Lee, Hu, & Kim (2015)	(Exploration × ERD) → Internalizing Problem	.06	.03
Torres & Ong (2010)	(Exploration × ERD) → Depression	.10	.04
Torres, Yznaga, & Moore (2011)	(Exploration × ERD at Work) → Distress	.12	.05
Torres, Yznaga, & Moore (2011)	(Exploration × ERD in Public) → Distress	.11	.05
Authors' Unpublished Study	(Exploration × ERD) → Negative Mood	.06	.03
Authors' Unpublished Study	(Exploration × ERD) → Anxious Mood	.04	.03
Authors' Unpublished Study	(Exploration × ERD) → Sleep Quality	.00	.07
(B) Priors for the Effect of ERI Commitment to (ERD to Sleep)			
Lee (2005)	(Commitment × ERD) → Depression	−.15	.09
Lee (2005)	(Commitment × ERD) → Self-esteem	−.04	.08
Lee, Lee, Hu, & Kim (2015)	(Commitment × ERD) → Internalizing Problem	−.06	.03
Romero & Roberts (2003)	(Commitment × ERD) → Self-esteem	−.45	.17
Torres & Ong (2010)	(Commitment × ERD) → Depression	−.08	.04
Torres, Yznaga, & Moore (2011)	(Commitment × ERD) → Distress	−.10	.05
Authors' Unpublished Study	(Commitment × ERD) → Negative Mood	−.01	.04
Authors' Unpublished Study	(Commitment × ERD) → Anxious Mood	.00	.03
Authors' Unpublished Study	(Commitment × ERD) → Sleep quality	.00	.10
(C) Priors for the Effect of (ERD to Sleep) to Well-Being			
Charles, Piazza, Mogle, Sliwinski, & Almeida (2013)	Stress Reactivity → Affective Disorder	.12	.04
Charles, Piazza, Mogle, Sliwinski, & Almeida (2013)	Stress Reactivity → Distress	.13	.04
Charles, Piazza, Mogle, Sliwinski, & Almeida (2013)	Stress Reactivity → Affective Diagnosis	.06	.04
Mandel, Dunkley, & Moroz (2015)	Stress Reactivity → Anxiety	.23	.04
Mandel, Dunkley, & Moroz (2015)	Stress Reactivity → Depression	.20	N/A
Mandel, Dunkley, & Moroz (2015)	Stress Reactivity → Distress	.28	NA
Wichers (2009)	Stress Reactivity → Affective Diagnosis	.08	.04

Note. *β* is the standardized path coefficient estimate, *SE* is the standard error estimate of *β*. N/A = not available.

Table 3

Posterior Medians and 95% Credible Intervals for the Effects of ERI Commitment and Exploration on Well-Being Mediated by Adolescent's Relationship between Ethnic/Racial Discrimination (ERD) and Sleep Across Days

		Adjusted Mean of Slope-as-Mediator			(Predictor → Outcome) *Path c'*			(Predictor → Slope-As-Mediator) *Path a*			(Slope-As-Mediator → Outcome) *Path b*			Mediation Effect		
Predictor	**Outcome**	***β***	**LL**	**UL**	***β***	**LL**	**UL**	***β***	**LL**	**UL**	***β***	**LL**	**UL**	***β***	**LL**	**UL**
(A) ERD → Sleep Latency																
Exploration	Self-Esteem	.16	−.01	.35	***−.20***	***−.37***	***−.03***	.05	.00	.10	***−.22***	***−.35***	***−.10***	−.01	−.03	.00
Exploration	Pos. Mood	.16	−.01	.35	−.15	−.43	.14	.05	.00	.10	***−.32***	***−.49***	***−.14***	−.02	−.04	.00
Exploration	Neg. Mood	.16	−.01	.35	−.02	−.27	.25	.05	.00	.10	***.33***	***.15***	***.51***	.02	.00	.04
Exploration	Anx. Mood	.16	−.01	.35	−.07	−.36	.21	.05	.00	.10	***.58***	***.38***	***.79***	.03	.00	.06
Exploration	Depression	.16	−.01	.35	.09	−.09	.26	.05	.00	.10	***.24***	***.11***	***.38***	.01	.00	.03
Commitment	Self-Esteem	.16	−.01	.35	***.22***	***.02***	***.41***	***−.07***	***−.12***	***−.01***	***−.22***	***−.35***	***−.10***	.02	.00	.03
Commitment	Pos. Mood	.16	−.01	.35	.17	−.18	.51	***−.07***	***−.12***	***−.01***	***−.32***	***−.49***	***−.14***	.02	.00	.05
Commitment	Neg. Mood	.16	−.01	.35	−.11	−.41	.19	***−.07***	***−.12***	***−.01***	***.33***	***.15***	***.51***	−.02	−.05	.00
Commitment	Anx. Mood	.16	−.01	.35	−.05	−.38	.28	***−.07***	***−.12***	***−.01***	***.58***	***.38***	***.79***	***−.04***	***−.08***	***−.01***
Commitment	Depression	.16	−.01	.35	−.18	−.38	.02	***−.07***	***−.12***	***−.01***	***.24***	***.11***	***.38***	−.02	−.03	.00
(B) ERD → Sleep Efficiency																
Exploration	Self-Esteem	.18	−.15	.50	***−.20***	***−.38***	***−.03***	***.65***	***.19***	***1.10***	−.02	−.04	.00	−.01	−.03	.00
Exploration	Pos. Mood	.18	−.15	.50	−.14	−.43	.16	***.65***	***.19***	***1.10***	***−.03***	***−.05***	***−.01***	−.02	−.04	.00
Exploration	Neg. Mood	.18	−.15	.50	−.03	−.30	.23	***.65***	***.19***	***1.10***	***.03***	***.01***	***.05***	.02	.00	.04
Exploration	Anx. Mood	.18	−.15	.50	−.10	−.38	.17	***.65***	***.19***	***1.10***	***.06***	***.04***	***.07***	***.04***	***.01***	***.07***
Exploration	Depression	.18	−.15	.50	.09	−.09	.26	***.65***	***.19***	***1.10***	.02	.00	.04	.01	.00	.03
Commitment	Self-Esteem	.18	−.15	.50	***.23***	***.03***	***.43***	***−.49***	***−.97***	***−.02***	−.02	−.04	.00	.01	.00	.03
Commitment	Pos. Mood	.18	−.15	.50	.18	−.16	.52	***−.49***	***−.97***	***−.02***	***−.03***	***−.05***	***−.01***	.01	.00	.03
Commitment	Neg. Mood	.18	−.15	.50	−.11	−.42	.20	***−.49***	***−.97***	***−.02***	***.03***	***.01***	***.05***	−.01	−.03	.00
Commitment	Anx. Mood	.18	−.15	.50	−.03	−.36	.29	***−.49***	***−.97***	***−.02***	***.06***	***.04***	***.07***	−.03	−.06	.00
Commitment	Depression	.18	−.15	.50	−.18	−.37	.02	***−.49***	***−.97***	***−.02***	.02	.00	.04	−.01	−.03	.00
(C) ERD → Sleep Disturbance																
Exploration	Self-Esteem	.10	−.07	.28	***−.20***	***−.37***	***−.03***	***.23***	***.04***	***.42***	−.02	−.04	.00	−.01	−.01	.00
Exploration	Pos. Mood	.10	−.07	.28	−.12	−.41	.17	***.23***	***.04***	***.42***	***−.03***	***−.05***	***−.01***	−.01	−.02	.00

		Adjusted Mean of Slope-as-Mediator			(Predictor → Outcome) *Path c'*			(Predictor → Slope-As-Mediator) *Path a*			(Slope-As-Mediator → Outcome) *Path b*			Mediation Effect		
Predictor	**Outcome**	***β***	**LL**	**UL**	***β***	**LL**	**UL**	***β***	**LL**	**UL**	***β***	**LL**	**UL**	***β***	**LL**	**UL**
Exploration	Neg. Mood	.10	−.07	.28	−.03	−.28	.21	***.23***	***.04***	***.42***	***.04***	***.02***	***.05***	.01	.00	.02
Exploration	Anx. Mood	.10	−.07	.28	−.08	−.35	.19	***.23***	***.04***	***.42***	***.06***	***.04***	***.08***	.01	.00	.03
Exploration	Depression	.10	−.07	.28	.07	−.09	.23	***.23***	***.04***	***.42***	***.03***	***.01***	***.05***	.01	.00	.01
Commitment	Self-Esteem	.10	−.07	.28	***.23***	***.03***	***.42***	***−.26***	***−.46***	***−.05***	−.02	−.04	.00	.01	.00	.01
Commitment	Pos. Mood	.10	−.07	.28	.15	−.19	.50	***−.26***	***−.46***	***−.05***	***−.03***	***−.05***	***−.01***	.01	.00	.02
Commitment	Neg. Mood	.10	−.07	.28	−.07	−.36	.22	***−.26***	***−.46***	***−.05***	***.04***	***.02***	***.05***	−.01	−.02	.00
Commitment	Anx. Mood	.10	−.07	.28	−.02	−.33	.30	***−.26***	***−.46***	***−.05***	***.06***	***.04***	***.08***	−.02[+]	−.03	.00
Commitment	Depression	.10	−.07	.28	−.15	−.34	.04	***−.26***	***−.46***	***−.05***	***.03***	***.01***	***.05***	−.01	−.02	.00
(D) ERD → Daytime Dysfunction																
Exploration	Self-Esteem	−.02	−.17	.14	***−.18***	***−.35***	***−.01***	.08	.00	.15	***−.33***	***−.52***	***−.14***	−.02	−.06	.00
Exploration	Pos. Mood	−.02	−.17	.14	−.13	−.42	.16	.08	.00	.15	***−.47***	***−.73***	***−.20***	−.03	−.08	.00
Exploration	Neg. Mood	−.02	−.17	.14	−.04	−.29	.21	.08	.00	.15	***.46***	***.19***	***.73***	.03	.00	.08
Exploration	Anx. Mood	−.02	−.17	.14	−.09	−.37	.18	.08	.00	.15	***.87***	***.57***	***1.17***	.07	.00	.14
Exploration	Depression	−.02	−.17	.14	.07	−.11	.23	.08	.00	.15	***.39***	***.18***	***.59***	.03	.00	.07
Commitment	Self-Esteem	−.02	−.17	.14	.19	−.01	.38	***−.10***	***−.18***	***−.02***	***−.33***	***−.52***	***−.14***	.03	.00	.07
Commitment	Pos. Mood	−.02	−.17	.14	.14	−.20	.48	***−.10***	***−.18***	***−.02***	***−.47***	***−.73***	***−.20***	***.04***	***.01***	***.10***
Commitment	Neg. Mood	−.02	−.17	.14	−.06	−.36	.23	***−.10***	***−.18***	***−.02***	***.46***	***.19***	***.73***	***−.04***	***−.10***	***−.01***
Commitment	Anx. Mood	−.02	−.17	.14	.01	−.31	.32	***−.10***	***−.18***	***−.02***	***.87***	***.57***	***1.17***	***−.08***	***−.17***	***−.01***
Commitment	Depression	−.02	−.17	.14	−.14	−.33	.06	***−.10***	***−.18***	***−.02***	***.39***	***.18***	***.59***	***−.04***	***−.08***	***−.01***
(E) ERD → Sleep Duration																
Exploration	Self-Esteem	−.12	−.34	.10	***−.20***	***−.38***	***−.03***	***−.08***	***−.14***	***−.02***	***.25***	***.11***	***.38***	−.02	−.04	.00
Exploration	Pos. Mood	−.12	−.34	.10	−.12	−.41	.17	***−.08***	***−.14***	***−.02***	***.34***	***.15***	***.53***	***−.03***	***−.06***	***−.01***
Exploration	Neg. Mood	−.12	−.34	.10	−.01	−.27	.24	***−.08***	***−.14***	***−.02***	***−.36***	***−.56***	***−.17***	***.03***	***.01***	***.06***
Exploration	Anx. Mood	−.12	−.34	.10	−.08	−.35	.19	***−.08***	***−.14***	***−.02***	***−.64***	***−.86***	***−.42***	***.05***	***.01***	***.10***
Exploration	Depression	−.12	−.34	.10	.08	−.09	.24	***−.08***	***−.14***	***−.02***	***−.28***	***−.43***	***−.13***	.02	.00	.05
Commitment	Self-Esteem	−.12	−.34	.10	***.21***	***.02***	***.41***	.06	−.01	.13	***.25***	***.11***	***.38***	.01	.00	.04
Commitment	Pos. Mood	−.12	−.34	.10	.18	−.17	.52	.06	−.01	.13	***.34***	***.15***	***.53***	.02	.00	.05
Commitment	Neg. Mood	−.12	−.34	.10	−.09	−.39	.21	.06	−.01	.13	***−.36***	***−.56***	***−.17***	−.02	−.05	.00

		Adjusted Mean of Slope-as-Mediator			(Predictor → Outcome) *Path c'*			(Predictor → Slope-As-Mediator) *Path a*			(Slope-As-Mediator → Outcome) *Path b*			Mediation Effect		
Predictor	**Outcome**	***β***	**LL**	**UL**	***β***	**LL**	**UL**	***β***	**LL**	**UL**	***β***	**LL**	**UL**	***β***	**LL**	**UL**
Commitment	Anx. Mood	−.12	−.34	.10	−.01	−.33	.30	.06	−.01	.13	***−.64***	***−.86***	***−.42***	−.04	−.09	.01
Commitment	Depression	−.12	−.34	.10	−.16	−.35	.04	.06	−.01	.13	***−.28***	***−.43***	***−.13***	−.02	−.04	.00

Note. Pos. Mood = positive mood. Neg. Mood = negative mood. Anx. Mood = anxious mood. *β* = the posterior median of the effect. LL is the lower limit of the 95% credible interval of the effect. UL is the upper limit of the 95% credible interval of the effect. Bold estimates indicate effects with 95% credible interval excluding zero.

$^{+}$indicates effects with 90% credible interval excluding zero.