

Ambulatory Assessment of Adolescent Coping: It's a Complicated Process

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Scholars have long-called for researchers to treat coping as a process that is measured over an arc of time. Ambulatory assessment (AA) offers an appealing tool for capturing the dynamic process of adolescent coping. However, challenges in capturing the coping process are not altogether circumvented with AA designs. We conducted a scoping review of the AA literature on adolescent coping and draw from 60 studies to provide an overview of the field. We provide critiques of different AA approaches and highlight benefits and costs associated with various types of measurement within AA. We also speak to considerations of participant burden and compliance. We conclude with recommendations for developmental scholars seeking to deploy AA to capture this quintessential process among adolescents.

The transition from childhood to young adulthood is characterized by an upswing in psychosocial vulnerabilities, emotional lability, stressors and challenges (Larson, Moneta, Richards, & Wilson, 2002; Modecki, 2016). In fact, with its physical and cognitive transformations, evolving family and peer relationships, inexpert romantic relationships, and educational demands, the adolescent period is sometimes typified as one of “navigating stressors” (Luciana, 2013; Modecki, Zimmer-Gembeck, & Guerra, 2017). Daily hassles represent a salient source of strain for youth, and research suggests that experiencing these and other relatively minor stressors can have significant explanatory power in predicting later maladjustment (Compas, Davis, & Forsythe, 1985; Sim, 2000). As a result, one major developmental task during adolescence is to acquire the skills needed to respond adaptively to stressors across day to day life.

Given that youth coping has major implications for symptoms of psychopathology in the short term (Grant et al., 2003; Uink, Modecki, & Barber, 2017) as well as for long-term psychosocial development (Frydenberg, 2008), there is a compelling need to better

understand youths' experience of coping across their days. In part, a lack of understanding of adolescents' coping capacity is related to legitimate challenges that exist in tapping this process. Illustratively, a widely accepted coping definition highlights that coping is a fine-grained dynamic progression—that is, coping is a “conscious and volitional effort to regulate emotion, cognition, behavior, physiology, and the environment in response to stressful events or circumstances” (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001, p. 89).

Not surprisingly then, coping scholars were among the earliest adopters of Ambulatory Assessment (AA) in an effort to more fully characterize this process (e.g., Larson & Ham, 1993; Stone, Neale, & Shiffman, 1993). In fact, more than three decades ago, foundational scholars of coping, Lazarus and Folkman (1984) called for “micro-analytic, process-oriented research” to assess the complex interplay between the individual and her/his environment. Since that time, and especially in the last decade, the field has shown mounting enthusiasm for deployment of AA methods for the study of well-being generally (Modecki & Mazza, 2017) for the study of coping (e.g., Serre, Fatseas, Swendsen, & Auriacombe, 2015) and adolescent development (e.g., Heron, Everhart, McHale, & Smyth, 2017) more specifically. Accordingly, what follows is a scoping review and an informed critique of the literature. To lend a clearer sense of the field, we

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audited AA research on child and adolescent coping, and considered major themes and approaches.

We searched Web of Science, Psych Info, and Pub Med with a combination of a range of terms which allowed us to identify studies including a searchable item associated with coping (e.g., *cope*, *coping*, *stress appraisal*, *emotion response*); ambulatory assessment (e.g., *experience sampling*, *daily diary*, *ecological momentary*, *momentary assessment*, *ecological assessment*, *electronic diary*); and youth (e.g., *adolescent*, *pre-adolescent*, *early adolescent*, *youth*, *student*), up through mid-2017. After culling studies which did not meet each of these subject criteria, and those which did not include data, we began our focused review with 413 studies. We extracted abstracts and underwent a closer search for studies which could be conceptualized as coping (loosely defined as including the term *coping* or *emotion regulation* in response to stress or hassles). Two hundred and ten were retained for further review and coding. These were evaluated by four study authors for inclusion criteria including population (e.g., children, adolescents, or college students) whether any type of coping (or closely related construct in response to stress) was measured, and self-report daily diary or momentary assessment. Of these, 60 studies were considered relevant for a systematic discussion, and these are listed in Table S1 in the online Supporting Information. Notably, because the distinction between coping, emotions, and behaviors is not always clear, an expansive set of studies were included (e.g., Skinner & Zimmer-Gembeck, 2007). We draw on these to first provide a broad overview of the adolescent AA coping literature. We then progress to enumerate the challenges, benefits, costs, and advantages of varied AA study designs that are represented within Table S1. Finally, we conclude our scoping review with a series of scholarly recommendations for the field.

AMBULATORY ASSESSMENT AND ADOLESCENTS

As evidenced by this Special Issue, AA methods have grown in fashion in parallel with rapid advances in technology (Singer, 2017). In particular, self-report digital AA (sometimes referred to as ecological momentary assessment [EMA], or experience sampling methodology [ESM]) is facilitated by youths' rapid uptake of new mobile technologies, their native dexterity in navigating digital settings, and their ability in making intuitive use of emerging apps and innovations (Subrahmanyam &

Smahel, 2010). Moreover, a particular strength of AA designs is that youth are treated as their own "control," thus data provide novel insight into how youth deviate from their average, across time and settings. Specific to our focus on adolescent coping, one of the foremost advantages of AA is that youth are able to report processes unfolding across micro-time periods (e.g., hours, days) as they navigate ordinary life, across varied demands and settings. Thus, with AA, we can gauge, and ideally unpack, the micro-progression of adolescents' coping processes in vivo. Importantly, the term "process" is highlighted here intentionally, as scholars widely characterize coping as a sequence, but only more recently have researchers studied it as such.

COPING THEORIES AND THE IMPORTANCE OF PROCESS

Developmental, clinical, and health scientists have a rich tradition of considering coping in children and adolescents, as part of their field's attention on factors that can promote positive outcomes or that can protect against long-term mental and physical difficulties. Coping is of particular interest for scholars assessing youths' exposure to adversity, including challenge in the form of daily stressors (e.g., victimization or exclusion by peers; Zimmer-Gembeck, 2016) or major adverse life events (e.g., poverty or loss of a parent; Cicchetti & Rogosch, 2009; Masten, 2001). Thus, coping is often viewed as a promotive or protective factor (e.g., Modecki et al., 2017). Yet, considering coping as a static "factor" is not very satisfying in developmental science. Instead, coping responses are often described with terms that suggest a process of adaptive regulation, such as descriptions of "managing" or "dealing" with stressors. A major challenge, then, in deploying AA to assess youthful coping is how to extract essential elements of this process of managing real-life stressors in a well-timed, brief, and reliable manner.

Furthermore, as with any research agenda, design is incumbent upon the theoretical framework. Theoretical frameworks of coping are varied—these include Carver, Scheier, and Kumari Weintraub (1989), Compas et al. (2001), Lazarus and Folkman (1984), Sandler, Tein, Mehta, Wolchik, and Ayers (2000), Skinner and Zimmer-Gembeck (2007), Taylor and Stanton (2007), and others; however, throughout a core emphasis on *process* remains. Specifically, across these and other varied perspectives on coping, scholars speak to a collection of regulatory processes which play out across

a span of time, such as initiating a coping process, mobilizing resources, and coordinating goals and responses. Thus notionally, capturing coping should entail tapping aspects of the wider process, beginning with stress detection, encapsulating various coping responses, and subsequent outcomes (Folkman & Moskowitz, 2004).

Beyond conceptualizing coping as a micro-longitudinal process, coping is also widely characterized as engaging multiple levels of experience (i.e., including factors which occur within an individual, such as unique circumstances and events, and across individuals, such as health and demographic risks). For instance, Skinner and Zimmer-Gembeck (2016) proposed a multilevel framework that described coping as dynamic, and involving multiple subsystems (e.g., physiological, emotional, attentional). Their model considers coping as occurring at three time intervals: “on the scale of developmental time; ... as an episodic process across days and months; (and) in real time as an interactive regulatory process” (p. 10). Thus, this model speaks to multiple between-person and within-person elements which interact to influence how youth cope with stressors across multiple spans of time.

Bearing this in mind, through the lens provided by AA, scholars might characterize between-person factors in terms of trait or dispositional qualities (e.g., psychopathology, developmental stage). These factors, in turn, likely influence within-person variation in appraisals (e.g., process of appraising the stressor as a challenge or a threat) and the subsequent retrieval of possible coping responses. Likewise, within AA, we might expect within-person variation in terms of different stressors (including severity of stressors) and different circumstances. Finally, scholars might tap coping outcomes in terms of short-term relief from stressors within AA or by linking AA response to measures of longer term well-being.

TRADITIONAL TRAIT-BASED STUDY OF COPING

Traditionally, scholars have employed retrospective measures in an effort to characterize adolescent stress and coping, soliciting adolescents’ own reflections of their affective well-being and coping responses *in general*, or over a certain period of time (e.g., during the past month; Folkman & Moskowitz, 2004). In response to such assessments, adolescents must combine remembered affective and behavioral responses into a given global outcome measure (e.g., Adolescent Coping Scale:

Frydenberg & Lewis, 1993; Ways of Coping: Folkman & Lazarus, 1980; The COPE Inventory: Carver et al., 1989). These methods and measures have provided the essential groundwork for our conceptualizations of youthful coping (e.g., Ayers, Sandler, West, & Roosa, 1996), and offer useful evidence for how youth generally cope with stressful events across given situations. However, these methods do have several shortcomings, many of which AA methods are well-posed to address.

One of the most widely cited drawbacks to retrospective responding using trait psychometric scales is recall biases (e.g., participants tend to recall stressful events which are consistent with their current affective state; Trull & Ebner-Priemer, 2009). Ambulatory assessment offers advantages of tapping emotions, motives, events, and behavior on a far shorter time scale (e.g., over the day, over the last few hours, or even over the last hour) relative to psychometric scales (Scollon, Kim-Prieto, & Diener, 2003) and thus reducing such recall biases. Also problematic is that trait questionnaires of coping risk imprecision and possible inaccuracy because they assess context-dependent constructs (i.e., coping) by querying about *general* tendencies across settings and contexts (O’Toole, Jensen, Fentz, Zachariae, & Hougaard, 2014). Furthermore, trait-based approaches have additionally asked youth to envision how they believe they would cope within a given situation (e.g., use of hypothetical vignettes). However, a critical issue with such methodology is that projections of behavior consistently differs from actual behavior (Dunning, Heath, & Suls, 2004). Consequently, trait-based measures, even those based on past behaviors or hypothetical vignettes, may not accurately tap adolescents’ actual experiences or behaviors.

AA DESIGN CONSIDERATIONS

Although AA methods can help minimize or circumvent these drawbacks found in traditional trait-based studies, AA is not without its own challenges. As with any research method, researchers wishing to utilize AA to study youthful coping are confronted with a range of considerations, starting from questions of study design. Likewise, as with any theoretically driven study question, scholars must match their design with the coping process that is being conceptualized. Because AA has primarily been deployed to examine coping as an episodic process, that is, as a process that is initiated by the experience of a stressor, that includes an adolescents’ deployment of a coping strategy, and

that ends with emotion relief or a behavioral outcome, this lends itself to two main designs. When focused on this micro-process of coping, researchers have elected to tap youthful coping responses by either relying on time-based or event-based designs.

Time-Based Designs

In time-based AA designs, which include signal-contingent (whenever the device “beeps”) and interval-contingent (at specific time points) designs (e.g., Khor, Melvin, Reid, & Gray, 2014) youth report on phenomena of interest at specific, predetermined time points (as opposed to events). Taking the view that coping is a continually unfolding, dynamic, and cumulative process (Lazarus & Folkman, 1984), time-based designs represent a strong fit for the assessment of adolescent coping. That is, this design allows for the repeated sampling of stressful events, coping responses, appraisals, emotions, or behavioral reactions, as they unfold. Thus, researchers can glean needed insight into the process of coping. However, the question becomes: how frequently, and for how long, do adolescents need to report on their stress experiences and coping responses to adequately capture this process?

Time-based designs: How often? On the one hand, researchers may wish to adopt a sampling schedule that allows for as many repeated assessments as possible. Indeed, more sampling moments across the day or week would be assumed to increase the chance of capturing “coping in action.” Furthermore, with greater sampling moments comes the possibility of measuring coping across a larger variety of social contexts which youth inhabit (e.g., the classroom, the family, with peers). Such contextual information is especially helpful for understanding adolescents’ coping responses, given that coping is expected to be differently constrained or supported within different social settings (Mesquita & Boiger, 2014). As an example, Waller, Silk, Stone, and Dahl (2014) phoned depressed and non-depressed adolescents 42 times over 3 weeks, to assess differences in two coping behaviors—co-rumination and co-problem solving—in two different social contexts, when with peers and when with family. In so doing, the authors were able to compare co-rumination that occurred with peers versus parents and show that contextual effects were dependent on youths’ depression status.

Yet, the need to sample youths’ coping behaviors frequently enough to capture the process unfolding,

and across multiple contexts, must be balanced with considerations of participant burden. Thus, scholars must contend with the possibility that sampling too frequently, or not frequently enough, may result in missing out on core elements of the coping process (Ebner-Priemer & Sawitzki, 2007). As outlined in the Length and Timescale section within Table S1 in the online Supporting Information, within the studies we examined sampling frequency differed substantially, ranging from once per day (e.g., Hema et al., 2009; Johnson & Swendsen, 2015) to 25–30 times per day (e.g., Henker, Whalen, Jamner, & Delfino, 2002), making precise recommendations for the “ideal” number of sampling moments unclear. What is clear, though, is that the number of sampling moments within time-contingent studies need to be approached as a cost-benefit analysis. Indeed, as Nesselroade and Featherman (1991) fittingly convey, “choosing an interval for repeated measurements is something like selecting a sieve or a strainer for use; you may lose some pieces you would like to keep because the holes (intervals between measurements) are too large or retain some that you don’t want because the holes are too small” (p. 48).

Whatever the size of one’s scholarly sieve, time-based designs will not always be ideal for capturing coping processes. Specifically, the majority of AA coping studies that utilize time-based designs ask youth to report on whether a stressful event occurred since they were last contacted (e.g., Khor et al., 2014) before asking about coping responses. Yet, in most studies, many adolescents do not report encountering a stressful event on any given day, and thus, do not report coping responses. For example, adolescents in the Johnson and Swendsen (2015) study reported a maximum of one peer, family, and school-related stressor across 28 sampling moments, and just under a quarter of adolescents (24%) in Low, Matthews, and Hall (2013) reported having an argument with their parents at *every* sampling moment (each day across a 7-day sampling period). Hence, stressful events can be too infrequent for this design. Hence, a possible alternative is to ask youth to initiate the reporting process themselves when they encounter a stressful experience.

Event-based designs. Event-based designs (also known as event-contingent designs) offer a potential solution for tailoring AA to more closely monitor when stressful events are perceived, and when coping responses are initiated. Instead of predetermined sampling times, event-based designs ask adolescents to complete AA reports whenever a

specific event occurs. As an example, in examining the link between stressors, negative affect, and eating, Kubiak, Vögele, Siering, Schiel, and Weber (2008) asked obese adolescent girls to make an AA report of negative affect and rumination whenever they experienced a hassle. Likewise, event-based designs can be used to sample specific coping behaviors. For instance, Goldstein, Stewart, Hoaken, and Flett (2014) and Goldstein, Vilhena-Churchill, Stewart, Hoaken, and Flett (2015) asked late adolescents to report whenever they gambled, and Gorka, Hedeker, Piasecki, and Mermelstein (2017) asked adolescents to report whenever they had smoked or craved a cigarette.

Event-based designs can be particularly useful for measuring relatively low-frequency coping behaviors, or those that require a specific context or setting (Piasecki, Richardson, & Smith, 2007). Examples of such (problematic) coping behaviors include nonsuicidal self-injury (e.g., Nock, Prinstein, & Sterba, 2009), bingeing and purging (Karr et al., 2013), or drinking alcohol (Hussong, 2007; Hussong, Galloway, & Feagans, 2005). Illustratively, Karr et al. (2013), though in a sample including adults, used event-based reports of bingeing and purging to show that women diagnosed with bulimia nervosa plus post-traumatic stress disorder exhibited faster increases in negative affect before a binge/purge episode, as well as faster decreases in negative affect after an episode, compared to women with a sole diagnosis of bulimia nervosa. Arguably, such nuanced data on bingeing and purging as maladaptive coping behavior could be overlooked in time-based designs.

Importantly, among the AA studies of adolescent coping reviewed here, none relied exclusively on event-based designs (e.g., Goldstein et al., 2014; Gorka et al., 2017; Kubiak et al., 2008). Rather, event-contingent designs were included alongside the time-based sampling. Indeed, in the Karr et al. (2013) study, across 14 days women reported an additional 1,006 episodes of bingeing and purging not picked up within the time-based prompts. This suggests that time-based designs may not fully capture the frequency of certain coping behaviors, and that for behavioral coping responses, for example, time-based designs may be best paired with event-contingent methods.

COPING MEASUREMENT IN AMBULATORY ASSESSMENT

Outside of one's design strategy, one thorny challenge that AA researchers face lies in their

measurement of coping. The difficulty here being that coping is a complex and interactive process, and in the context of AA, characterizing "coping" can be nebulous.

The prospect of quantifying a construct characterized as "coping" in situ can lead scholars to seek the more familiar havens of person-level psychometric scales (e.g., at pre-test). Alternatively, some scholars seek to adapt coping measures to a select number of ambulatory items in an effort to adequately account for the time and situation-dependent nature of the coping process. As another option, other scholars elect to operationalize coping through specific behaviors (e.g., smoking, avoidance, self-harm), which can be assessed as both trait and state-level constructs.

Although psychometric scales provide a sound basis for external and internal validity, they are typically too burdensome for multiple repeated assessments in a short time frame. Thus, as described below, psychometric scales tend to be reserved for pre-AA coping assessments. However, those scholars assessing coping at a daily or momentary level have mainly sought to adapt trait self-report scales to their state equivalencies (e.g., Bentall et al., 2011). Yet, approaches have been inconsistent; some scholars have relied on one item per coping response type, whereas others have used multiple items, and still others have combined items from different scales in an attempt to capture a wider range of coping responses (e.g., Massey, Garnefski, Gebhardt, & Van Der Leeden, 2009). As a result, rarely do researchers fully explore the full extent of possible coping responses in situ, or consider how different stressful events might elicit different coping responses. Hence, there is no gold standard measure, as of yet, for assessing state coping within AA. Below, we briefly describe these different approaches to measuring coping, moving from the trait to the momentary level, along with their associated benefits and limitations.

Trait, Daily, or Momentary Assessment of Coping

Trait coping in ambulatory assessment. Despite the promise of AA for measuring the coping process, trait-level measurement of coping is still used within these designs, as found in four of the studies (6.7%) included this review. For example, Cleveland and Harris (2010) investigated the moderating role of trait coping strategies, specifically problem-solving and avoidance, between daily negative affect and daily substance cravings in college students in substance abuse

recovery. The study found that students who reported trait-level avoidance coping, experienced higher levels of cravings on days where their negative affect was also high. As another example, Low et al. (2013) investigated the role of trait coping, stress and inflammation in adolescents. This study measured both daily stressors and negative life events and found trait positive engagement coping, as opposed to disengagement coping, to be a protective factor for youth with high stress. While both studies provide novel insight in tying coping to key aspects of health, they and many others still rely on broad brush-strokes to characterize coping. These broad themes of “avoidance is harmful” and “approach is adaptive” have appeared in the coping literature since the field’s inception. Yet recall that trait or dispositional reports of coping have been found to correlate only weakly with AA reports of coping (Todd, Tennen, Carney, Armeli, & Affleck, 2004). Thus, despite the use of AA methods, without a measure of coping embedded within the ambulatory design, findings cannot fully clarify “what works” for youth, and when.

Measuring daily coping. As an alternative, some researchers have begun to tap coping processes on a daily basis. Indeed, one-fifth of studies reviewed in Table S1 in the online Supporting Information fall under this rubric. Daily coping has most often been measured through end-of-day reports (sometimes referred to as daily diaries), whereby youth are asked to reflect upon their day and nominate the degree to which they have engaged in specific cognitive or behavioral coping strategies (e.g., Aldridge-Gerry et al., 2011; Hema et al., 2009). For example, Aldridge-Gerry et al. (2011) used a daily diary design to explore the relations between ethnicity, the experience of daily stress, coping strategies and alcohol consumption. This study is a notable example of a thoughtfully designed AA approach for determining interrelations among focal between- and within-person factors, here assessing cognitive and behavioral methods of coping and how these differ based on one’s reported ethnicity.

Daily measures in AA offer the distinct advantage of reducing participant burden while still allowing for the possibility of a more thorough assessment of the coping process. For instance, daily AA measures can still include multiple facets of the coping process (e.g., Hoggard, Byrd, & Sellers, 2012). That said, sampling adolescents’ experiences on a daily basis may still not tap the intricacies of the coping process in its entirety.

Specifically, as with trait self-report measures, end-of-day reports may be colored by participants’ affect at the time of reporting, and so may not provide a fully accurate recollection of the stressors experienced, the coping responses or even the outcomes of the coping process (Stone, Shiffman, Atienza, & Nebeling, 2007).

Perhaps the most notable limitation of using daily measures within AA is that often the direction of causality cannot be accurately tested, given emotions and behaviors experienced across the day are reported simultaneously (Aldridge-Gerry et al., 2011; Ham & Larson, 1990). However, we note some useful work-arounds in the literature. For example, Weiss, Bold, Sullivan, Armeli, and Tennen (2017) investigated the bidirectional associations between daily emotion regulation strategies and substance use in daily diary design. To do so, they simultaneously enquired about the current day’s emotion regulation strategies (e.g., “since waking until the time of the report”), and substance use during the previous evening (e.g., “since completing yesterday’s survey”), thus, allowing for lagged models to test these relations. Although this type of design is still subject to potential bias from retrospective recall, it does at least allow for the inference of causal effects.

Measuring coping in situ. As an alternative, a smaller subset of studies (15% in this review) have measured coping on a within-day basis, hence implementing AA designs to their full effect (e.g., Allen et al., 2016; South & Miller, 2014; Tan et al., 2012). These designs vary considerably in the number of sampling moments, ranging from 3 (Ranzenhofer et al., 2014) to a substantial 30 assessments (Henker et al., 2002) within a single day. The benefit of these momentary assessments is that they can help paint a more detailed picture of youths’ coping processes, and thus equip scholars with a deeper, more nuanced understanding of what promotes or prevents adaptation in the face of stress. For example, Tan et al. (2012) employed an AA design to investigate anxious youths’ emotion reactivity and emotion regulation strategies in response to micro-stressors. They found that, compared to a healthy control group, anxious youth did not show greater reliance on maladaptive emotion regulation strategies (e.g., avoidance), or less reliance on adaptive strategies (e.g., acceptance). Rather, the efficacy of certain strategies heavily depended on the severity of the stressor, which specific negative emotion youth were attempting to manage, and how much simultaneous

physiological arousal they experienced. Scholars cannot tap this level of detail (i.e., the conditioning effects of stressor severity, discrete emotions, and level of physiological arousal) and hence uncover this type of nuanced information, without repeated assessments of these constructs across the day.

Thus, momentary coping measures offer the advantage of finer detail, and arguably increased ecological validity of reports. However, AA designs that tap coping at a momentary level can place considerable demands on youthful participants—which may be reflected in high drop out and/or low compliance rates (McCabe, Mack, & Fleeson, 2012). Indeed, small sample sizes can be an issue with momentary coping approaches (e.g., Kubiak et al., 2008; Pavlickova, Turnbull, Myin-Germeys, & Bentall, 2015). As an alternative, by sampling more intensively over the day, or extending the sampling period, which generally run between 5 (Tan et al., 2012) to 14 days (Ranzenhofer et al., 2014), researchers can increase their power to detect effects. Longer time frames also make sense in that the likelihood of capturing the coping process is arguably diminished within shorter sampling frames, at least among normative samples. To address this concern, some AA designs have usefully executed AA assessments across a much longer sampling period (e.g., 30 days; O'Hara, Armeli, & Tennen, 2016), with the sacrifice here being the likely omission of core aspects of the coping process (e.g., stressors, affect, or other outcomes).

The combination of trait, daily or state measurement. A scoping of the literature makes clear the flexibility of AA methods for capturing coping at different time-levels. Some of these useful possibilities are highlighted within Table S1 in the online Supporting Information. Indeed, the vast majority of studies in this review sought to combine either trait and daily measurements (35%) or trait and momentary measurements of coping (23.3%). In several cases, studies have used a combination of trait and daily/AA coping scales, which have helped expand upon cross-sectional findings. For example, Waller et al. (2014) compared trait and momentary reports of rumination in youth with major depressive disorder (MDD) and healthy controls. Consistent with prior research, youth with MDD reported higher levels of trait rumination. However, through AA measurement, it was also found that depressed youth engaged in rumination almost three times more often as controls in vivo.

As another example, and pointing to the immense potential of AA to deepen scholarly understanding of youthful coping, the inclusion of AA measures has helped to debunk long-held beliefs in the coping sphere. For instance, cross-sectional research has widely suggested that suppressing the expression of emotion is maladaptive (Pepping, Duvenage, Cronin, & Lyons, 2016). However, Chapman, Rosenthal, and Leung (2009) measured trait experiential avoidance (e.g., emotional suppression) among late adolescents, and then instructed them to either suppress or observe their negative emotions throughout the day. At the momentary level, youth reported their emotion and urges to engage in impulsive behaviors (e.g., self-injury). Among youth who exhibited features of borderline personality disorder, positive affect was higher and urges to engage in impulsive behaviors were diminished on days where they suppressed their emotions. Thus, this study design provides evidence that expressive suppression may actually be adaptive within specific populations, at least in the short term.

Furthermore, studies that incorporate both trait and AA measures of coping have made clear that there is often poor correspondence between momentary assessment and trait-coping measures. For instance, Hussong et al. (2005) investigated the association between college students' trait reports of "drinking to cope" with their actual experience of daily negative affect and alcohol use. They found that students who indicated that they drank alcohol as a means to cope consistently reported daily mood experiences that were not linked to their drinking. These findings could be taken to suggest that using alcohol is an ineffective means to manage negative affect among college students, or that the assessment of coping motives at the trait level provides imprecise information with regard to the in situ relation between negative affect and alcohol use.

As another example, in a study of coping motives for smoking cigarettes among late adolescents, Piasecki et al. (2007) found that trait-based responses measured pre-AA did not correlate with in vivo reports of coping. In this case, the relative importance of particular coping motives differed by assessment method (retrospective reports versus daily diary). Retrospective reports of coping motives appeared to measure subjective importance of different smoking to cope outcomes, rather than the probability or incidence of outcomes (Piasecki et al., 2007). These and other studies are suggestive of the idea that momentary assessment and

retrospective recall are perhaps assessing different features of experience (Conner & Barrett, 2012).

THE PROCESS OF COPING: THE TRIGGER AND THE OUTCOME

What's the Problem? Measuring Stressors

Beyond the challenges of operationalizing and measuring coping in a theoretically meaningful way (i.e., whether at a trait, daily, or state level), challenges exist in measuring its triggers—stressful events. There are numerous possibilities for assessing stressors, and thus not surprisingly, the literature is highly variable with regard to how stressful events have been measured. This variability is important, because from a theoretical perspective, the nature of the stressor can arguably be deemed just as important as the coping response itself (Carver & Connor-Smith, 2010). Indeed, scholars have repeatedly argued that that a specific coping strategy might be effective in one situation, but less productive in another (Folkman & Moskowitz, 2004). Furthermore, effectiveness will depend on how well a coping strategy matches the stressor itself (Carver & Connor-Smith, 2010). Thus, facets that might usefully be measured include how severe the youth rates the stressor severity (e.g., Khor et al., 2014), how much a youth perceives that they have control over the stressor occurrence or resolution (e.g., Allen et al., 2016), whether the youth expected the stressor (e.g., Ham & Larson, 1990), and the context in which the stressor occurred (e.g., Shrier, Rhoads, Burke, Walls, & Blood, 2014).

In fact, a critical oversight within the AA literature (found in 32% of studies we detailed) has been failure to measure stressful events, let alone the nature of specific stressors. This may be due to a heavy focus on coping behaviors, rather than potential triggers of a coping process. That is, some studies have measured trait-level coping and their subsequent AA-level behaviors (e.g., alcohol or cannabis use) but failed to measure the occurrence of stressors (Kuntsche & Cooper, 2010; O'Hara et al., 2016). Thus, within these designs, it could be argued that coping responses were not actually measured but rather, behaviors which could be attributed to other motivations such as socializing or enhancement of positive emotion.

An interesting alternative to omitting the assessment of stressors entirely, is to provide a checklist of stressors that could arise throughout the day (Ham & Larson, 1990; Reeves, Nicholls, & McKenna, 2011; White & Shih, 2012). As an

example, White and Shih (2012) developed an 18-item daily stressful events measure in which youth could nominate multiple types of stressors they encountered each day. Yet, although useful for the measurement of typical stressors (e.g., social exclusion, academic stress), this method may limit reporting of less common and more unique experiences. Importantly too, not all stressors need be external. Youth commonly cope with stressors in the form of negative cognitions (regarding the present or the future) or the recollection of past negative experiences. As such, a smaller subset of studies has measured adolescents coping responses to unpleasant internal experiences (Mori, Takano, & Tanno, 2015; Shahar & Herr, 2011; Weiss et al., 2017).

Among those coping studies that did include an assessment of stressful events, most (62%) have measured the most salient stressor of the day, or since the last sampling period (e.g., Kubiak et al., 2008; Low et al., 2013). Although this method may capture the most varied, and the most naturalistic measurement of stress, it also brings with it increased variability. Put another way, coping responses and their effectiveness will depend in part on the characteristics of the context (Folkman & Moskowitz, 2004). Thus, measuring youths' "biggest stressor" as part of the coping process can mean that scholars are left with a wide array of coping responses, emotional reactions, and behavioral responses from which to detect a coherent pattern. Thus, to reduce the "noise" in youths' reports of salient stressors, one useful alternative is to ground coping assessments by tapping only specific stressors (e.g., experience of racially stressful events; Hoggard et al., 2012). Anchoring the coping process to one type of stressor allows for a more tailored (and arguably more accurate) measurement of appraisals and coping responses, though can limit generalizability to other types of stressors or other populations.

Finding What Works: Measuring Outcomes of Coping in Ambulatory Assessment

Yet, another challenge scholars face in seeking to measure the coping process is how to establish a meaningful endpoint, or tangible coping outcome (Sommerfield & McCrae, 2000). Relatedly, depending on where scholars delineate their coping "outcome," this will necessarily affect what constitutes an adaptive (or maladaptive) coping response. That is, when measuring the coping process on a micro-longitudinal basis, what might be considered to be

an adaptive coping outcome (e.g., lower negative affect or emotional recovery), may not be at all adaptive over the long term. As an example, past empirical evidence suggests that youth use particular coping behaviors (for instance, emotion-focused coping) to attain short-term emotional relief, but that these behaviors can lead to increased distress in the longer term; whereas problem-focused coping can lead to short-term peaks in distress but longer term positive outcomes (Gross & John, 2003).

Given challenges in identifying “what works” in relation to adolescent coping more broadly, and in defining coping’s “endpoint” within AA designs more specifically, our scoping review revealed several alternative options. First, some studies are able to circumvent this issue by anchoring the coping process to a tangible, specific experience, such as a headache (Massey et al., 2009), binge eating (Freeman & Gil, 2004), or alcohol craving (Cleveland & Harris, 2010). Thus, these researchers were able to track “outcomes” of coping at one- and two-time intervals later, to assess whether specific ways of coping lead to diminished problematic outcomes. Another option is to track mental health symptoms on the same time scale as stressors. Thus, stress, coping, and well-being can be examined sequentially to better characterize how different ways of coping, with different forms of stress, help to manage mental health difficulties (Hankin, Fraley, & Abela, 2005).

That said, some studies take a different tack and assess affect as an outcome, in which case, assessing “what works” becomes less clear. As noted above, short-term emotional relief does not necessarily equate with an adaptive coping outcome. Although several studies seek to bypass this conundrum by predicting affect at the next adjacent time point (e.g., Pavlickova et al., 2015), moving the time scale one interval beyond the trigger may not be far enough to tap longer term emotional outcomes. Further shifting out the time scale means that any number of external factors may also be influencing mood, thus adding inevitable noise in outcome measurement.

In addition, a number of studies suggest that coping effectiveness does not solely depend on which coping strategy was enacted, but rather an individual’s perception of the efficacy of their coping attempts (Sandler et al., 2000). Helpfully, some AA research has incorporated this idea into study design. One noteworthy example is a study conducted by Massey et al. (2009), in which youth were asked to report on their perceptions of how

they believed they managed their emotions and experiences encountered that day, while measuring the occurrence of daily headaches. Results suggested that such coping efficacy beliefs were significantly related to the next day’s headache occurrence, regardless of which cognitive coping strategies the youth employed. As another example of how scholars have tapped youths’ experience of coping effectiveness, Piasecki et al. (2014) asked youth whether their engagement in specific coping strategies resulted in either pleasure or relief, or increased discomfort. These approaches to assessing coping efficacy, and approaches that otherwise provide alternative options for considering coping outcomes, are helpful examples of how scholars might better characterize the successfulness of coping strategies.

That said, although the field has made considerable headway toward measuring outcomes of coping within AA, it is also not surprising that some scholars have evaded this challenge altogether by defining their focal outcome in terms of engagement in specific coping strategies (e.g., Aldridge-Gerry et al., 2011; Shahar & Herr, 2011). Specifically, Hema et al. (2009) explored which coping responses among adolescents with Type 1 diabetes were endorsed in the context of daily stressors. Furthermore, Hoggard et al. (2012) investigated whether coping appraisals and responses differed depending on the nature of the stressor, in this case, whether the stressor was race-related. While these designs are valuable in helping to describe coping responses within certain populations or in response to specific stressors, the field stands to benefit from researchers widening their AA lens to encompass the full coping process and include coping outcomes.

Moving Toward a More Complete Picture of Coping

Given the nature of stress and coping, the coping literature has more commonly focused on the negative aspects of daily life, thus overlooking day-to-day upsides and uplifts. In fact, within our scoping review, only four studies (6.7%) accounted for the impact of momentary positive events during the coping process (Bentall et al., 2011; Klipker, Wrzus, Rauters, & Riediger, 2017; McHale, Clark, & Tramoto, 2015; Wang, Shih, Hu, Louie, & Lau, 2010). More broadly, there has been an over-reliance on the sole measurement of negative affect in the field (e.g., Armeli, Conner, Cullum, & Tennen, 2010; Turner, Wakefield, Gratz, & Chapman, 2017; White

& Shih, 2012). Naturally, positive experiences are not necessarily intuitive when conceptualizing the coping process. However, positive events and affect do play a significant, distinct role in this process. Specifically, positive affect has been found to be a substantial buffer against stressors (Gilbert, 2012). Taken a step further, one might argue that the aim of coping research should not be solely to establish ways in which youth can feel *less bad*. Thus, scholars should ideally seek to uncover the ways in which coping processes can bolster, or at least maintain, positive outcomes in youth.

COMPLIANCE IN AA COPING RESEARCH

Traditionally, compliance rates have been considered an Achilles' heel of the in vivo process using self-report data (Wen, Schneider, Stone, & Spruijt-Metz, 2017). That said, in Wen et al.'s (2017) meta-analysis of compliance rates with mobile AA among children and adolescents, the average compliance rate was 78% (among 36 studies which reported compliance). Of course, a caveat here is that many studies do not report compliance. Encouragingly, in terms of the coping specific AA literature, 67% ($n = 40$) of the 60 studies reviewed here reported some form of compliance to AA protocol. Among these, the average reported rate was 73.6%, suggesting coping studies may not be uniquely susceptible to lower compliance rates relative to the broader AA literature.

However, among the studies that did report compliance within our review, a subset (7%) report lower compliance than what is typically found in AA designs. Illustratively Kenny, Dooley, and Fitzgerald (2016) report a compliance rate of 18% and Reeves et al. (2011) report a compliance rate of 54%. These studies are unlikely to be exceptions, and studies that fail to report compliance may well suffer from difficulties of low compliance rates. Of course, benchmarks for compliance also vary, and are sometimes set at very low levels. For instance, thresholds have been set as low as 25% (South & Miller, 2014) and 33% (Pavlickova et al., 2015). In addition, compliance rates do not tell the whole story in terms of rates of missing data. That is, dropped participants with low rates of compliance can artificially inflate the picture of data completeness. Specifically, retained participants will result in reported rate of missed AA reports that is considerably lower than the original sample. While this is not a scenario unique to AA, given its potential burden on participants,

difficulties with compliance and susceptibility to missing data, youths' engagement needs to be monitored and reported, and reasons for potential missingness should be considered in study design (Enders, 2013).

Compliance When Stressed: Might It Matter?

Scholars who have attempted to implement AA to assess youthful coping are likely familiar with an added complexity emerging from the intersection of coping and AA methodology—that is, the process being measured may simultaneously interfere with adolescents' likelihood of completing an AA report. Put simply, youth may be too busy coping, or not coping as the case may be, to report on their experiences. Specifically, momentary emotions and overall mood profiles have been shown to predict responding rates, though the role of positive versus negative emotions in compliance remains unclear. For example, Sokolovsky, Mermelstein, and Hedeker (2013) found that adolescents who had higher overall negative affect, or who had increased positive affect (relative to their average mood) at the "moment" level showed lower compliance. These authors posit that mood effects on compliance may be due to various underlying causal factors at play. Specifically, for youth who exhibit consistently high levels of negative affect, lower response rates may be due to a general lack of motivation. Although for youth with increased positive affect, low compliance may be due to participants being over-stimulated and subsequently having fewer cognitive resources available to devote to responding. That said, findings tying positive affect and compliance, in particular, are inconsistent. Illustratively, Shiyko, Perkins, and Caldwell (2017) found that youth with consistently high, stable positive affect profiles demonstrated higher adherence rates. Furthermore, findings linking emotional experiences to compliance have further implications for AA studies of youth coping, because emotional intensity of negative and positive affect have been found to relate to adolescent psychopathology (Gilbert, 2012; Silk, Steinberg, & Morris, 2003). Thus, for youth with psychopathology, exposure to stressors throughout the day may prompt fluctuations in affect, but such emotional lability may also reduce the likelihood of an adolescent completing an AA report. Hence, it is important to acknowledge that AA methods may still beget an underrepresentation of coping strategies in adolescent populations, especially those at-risk for psychopathology.

Does Context Affect Compliance?

Of course, adolescents experience stressors across a range of contexts, and a major advantage of using AA is the ability to tap coping across these varied settings. Yet contexts themselves may play a role in adolescents' responding to their AA prompts. As one example, social contexts have been linked to adolescents' emotional states (Uink et al., 2017) with peers providing a palliative effect on adolescents' stress responses. Thus, whom youth are spending time with when they are "beeped" may factor into their affective experiences and thus their reporting. More directly, context in and of itself has been shown to be predictive of youthful compliance with AA protocols (Sokolovsky et al., 2013). Specifically, youth may be less likely to respond to prompts that occur outside of the home compared to prompts that occur inside the home. Similarly, Shiyko et al. (2017) showed that youths' compliance rates are higher at the end of the day, arguably because this is when adolescents are most likely to be at home. Yet school-based stressors (e.g., bullying, problems with teachers), are among the most common stressors that youth face (Zimmer-Gembeck & Skinner, 2008), which means that developmental scholars should proceed with caution. Specifically, tapping school-based stressors may be particularly challenging as adolescents are often not permitted to use phones during school hours. This has prompted some researchers to avoid signaling participants during school hours altogether (e.g., Ranzenhofer et al., 2014). Furthermore, Henker et al. (2002) actively instructed participants to ignore their study protocol during activities that were incompatible with responding, which included being in class. Thus, scholars should pay close attention to potential complications with youthful compliance across the varied social and physical settings adolescents encounter in a given day.

Further Compliance Challenges and Potential Solutions

More broadly, frequent and repeated assessments within AA can represent an imposition for youth. Illustratively, Ebner-Priemer and Sawitzki (2007) show that when prompted too frequently, participant compliance rates decrease overall. As a result, it may be tempting to decrease the frequency of prompts sent to youth in an effort to increase likelihood of compliance. However, reductions in frequency bring two marked disadvantages. First, if

time between sampling is too long, youth may be prone to disengage from the device or forget to attend to the study protocol (Sokolovsky et al., 2013), reducing compliance regardless. Second, and arguably more importantly, reducing frequency of prompts results in a loss of detail within the coping processes, which AA methods are well-placed to capture.

Rather than seeking to dramatically diminish the frequency of AA prompts, scholars may be better off seeking to reduce participants' burden. One practical approach is to reimburse youth for their time and effort associated with their participation. Research shows that compliance rates are higher in studies that offer incentives (Dubad, Winsper, Meyer, Livanou, & Marwaha, 2018). Notably, methods of compensation in the studies we reviewed were wide-ranging, with some studies offering entry into a competition (e.g., McHale et al., 2015; O'Hara et al., 2016) and others offering incentives for baseline and each ambulatory response separately (e.g., Hoggard et al., 2012; Schatz et al., 2015). Providing youth with additional incentives for achieving benchmark levels of compliance also seems to be a promising strategy (Sokolovsky et al., 2013). Illustratively, studies offering bonus incentives for high levels of compliance (e.g., Karr et al., 2013; Turner et al., 2017) reported compliance levels within 90% of responses. That said, some studies report admirable compliance rates even without providing incentives for participation. For instance, Weiss et al. (2017) reported an impressive 88% compliance without incentives. However, participants within this study could respond to missed prompts up to 3 days later, which naturally would have reduced missing data points, but at the cost of reducing the reliability of their responses.

While we fall in favor of compensating youth for their contributions and offer payments for their time and effort wherever possible, it is also the case that researchers may need to adjust their assessments to reduce participant burden. Designs that allow the order of questions to be contingent upon participants' responses are one way to decrease response load. For example, within time-based designs, if a youth responds that they have not experienced a stressor in the current sampling period, then stressor-related questions may be omitted (e.g., Reid et al., 2009; Waller et al., 2014). Of course, the concern then becomes whether youth then opt against reporting a "cascade"-type behavior (e.g., that they have experienced a stressor) in order to avoid further assessment.

Finally, it is worth mentioning potential developmental considerations with regard to compliance in AA. We found that studies have successfully utilized AA methods with individuals as young as 10, with good compliance (Allen et al., 2016; Tan et al., 2012). These studies used phone calls to contact participants, and further, Tan et al. offered to recontact participants if timing was inconvenient, and attempted to contact multiple times in the event of a missed call. This adjustment in design is a prime example of how researchers can adapt research methods to accommodate youth to increase compliance in AA. Other noteworthy methods of investment in youth compliance include contacting and problem solving with youth in the event of a missed report (e.g., Schatz et al., 2015), or even asking parents to help remind youth to complete reports (e.g., Hema et al., 2009).

PARTING THOUGHTS AND RECOMMENDATIONS

While we have outlined in considerable detail a number of considerations and challenges associated with AA research on adolescent coping, we do so while continuing to endorse AA's promise for informing developmental understanding. Overall, we recommend that scholars take a cautionary approach to the study of adolescents' coping with AA, and readily acknowledge that "the weakest ink is more powerful than the strongest memory." As momentum for AA coping research with adolescents continues to grow, below we take a parting opportunity to offer practical recommendations.

Recommendations

- 1 *Treat coping as a process.* One of the more disappointing outcomes of AA coping research occurs when fine-grained, repeated assessments of stressors, coping strategies and outcomes are, in the end, converted to aggregate measures. Thus, micro-processes are examined through an increasingly macro lens, as scholars collapse across categories in an effort to reduce many data points and many different types of responses into something more manageable. We urge researchers to delve into the nuanced and fine-grained information that AA methods can provide (Modecki & Mazza, 2017), to unpack coping process that occur within (and between) adolescents.
- 2 *Consider including both trait and state measures.* We recommend including both trait and state measures of coping constructs, where possible. When responding to trait-level reports, to some extent we rely on conjecture, hypothesizing what we would *usually* do to cope. Although state measures necessarily highlight one or a few possible coping options. Given that trait and state coping measures likely tap different elements of experience (Conner & Barrett, 2012) we believe that both are important.
- 3 *Measure the positives.* To gather a more complete picture of adolescents' experience, consider the good with the bad and do not exclusively focus on hassles or negative affect. Uplifts and positive affect may play a beneficial role within the coping process, and at the very least need to be accounted for in causal models. Better still, we press the field to move beyond the sole focus on reducing negative affect, and instead conceptualize beneficial coping as simultaneously increasing positive affect, even in the face of stress.
- 4 *Be specific.* As we are sampling experience, anchoring the coping process to either a specific type of stressor or a clearly defined outcome will help reduce "noise" in the data. This will come with the potential cost of lack of generalizability but will bring much needed clarification regarding which coping strategies offer more beneficial or adaptive outcomes, in regards to specific types of stress.
- 5 *Consider reasons for missing data before data collection:* Acknowledge that AA coping designs place demands on youth during potential times of stress. Although this recommendation is by no means unique to AA methods, here, missing data are critical because of AA's focus on gathering a representative snapshot of adolescent life. When studying coping, the challenges of missing data can become especially burdensome, given that reasons for nonresponse can be tied to experiences of stress, turbulence of emotion, and/or deployment of maladaptive coping behaviors (e.g., drinking). With more AA reports completed, scholars can be increasingly confident that they are sampling *life as it is lived*. That said, methods for handling missing AA data are advancing and use of modern methods (e.g., Full Information Maximum Likelihood) and sensitivity checks help lend credibility to AA findings. Here, we recommend turning to previous AA studies to identify factors relating to noncompliance (e.g., unstable mood profiles; Sokolovsky et al., 2013). Researchers should be proactive in this regard and seek to include measures that may be related to subsequent missingness (e.g., youths' perceived likelihood of their own compliance, psychopathology

symptoms) that can be part of an inclusive strategy for data analysis (Enders, 2013).

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Summary of studies included in review.