Title: Grit-related profiles predict polysubstance use in youth with a history of childhood maltreatment

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Abstract

Childhood maltreatment (CM) is a significant impediment to normative developmental trajectories and consistently predicts increased risk for a range of adverse outcomes, including substance misuse and polysubstance use (polySU). Yet, a subset of individuals who experience CM exhibit successful adaptations across the lifespan. Though there is an expansive literature on social, emotional, and cognitive protective factors that mitigate impacts of CM, less is known about non-social and non-cognitive protective factors such as 'grit' (i.e., determination to achieve long-term goals). Grit has been shown to predict adaptive functioning in a variety of domains. Using a person-centered statistical approach (i.e., latent profile analysis), we examined heterogeneity in grit in maltreated youth from the LONGSCAN sample as it related to maltreatment characteristics and substance use (SU) patterns during adolescence. We uncovered 3 latent profiles based on participants' grit-related traits (i.e., Low Grit, Average Grit, and High Grit). Those in the High Grit profile were least likely to engage in polySU during adolescence. These findings highlight the promise of grit as a protective factor against polySU following CM and one that is not necessarily contingent upon environmental supports and/or cognitive ability. As such, this work represents a promising avenue for future preventative intervention efforts.

Keywords: child maltreatment, resilience, polysubstance use, grit, latent profile analysis

Introduction

Childhood maltreatment (CM) is distressingly common in the US, with 1 in 7 children having experienced some form of abuse or neglect in the past year and more than 670,000 substantiated cases annually (Fortson, Klevens, Merrick, Gilbert, & Alexander, 2016; U.S. Department of HHS, Administration for Children and Families, 2020). Importantly, CM represents a significant risk factor for an array of physical and mental health sequelae across the life span, including substance misuse (Buckingham & Daniolos, 2013). Youths who experience CM are more likely to initiate substance use (SU) earlier, escalate SU more rapidly, meet criteria for a substance use disorder (SUD), and experience relapse following SU treatment compared to their non-maltreated peers (Alvarez-Alonso et al., 2016; Dube, et al., 2006; Mills et al., 2014; Shin et al., 2013; Van Dam et al., 2014). A burgeoning literature has also demonstrated that youth who experience CM are at greater risk of engaging in polysubstance use (polySU; Alvarez-Alonso et al., 2016; Rivera, Bray, Guastaferro, Kugler, & Noll, 2018; Snyder & Smith, 2015), a SU pattern that is itself associated with amplified risk of experiencing an SUD (Moss, Chen, & Yi, 2014). Moreover, polySU also represents a significant risk factor for a number of mental and physical health issues (Hakansson, Schlyter, Berglund, 2011; Jones et al., 2017; Smith et al., 2011; Timko, Han, Woodhead, Shelley, & Cucciare, 2018), making it a pertinent SU pattern to investigate in a population already at elevated risk for poor health outcomes.

Critically, not all maltreated individuals go on to develop poor outcomes; in fact, some individuals appear to be “resilient” to the impacts of CM and achieve an adaptive level of functioning (for review, see Meng, Fleury, Xiang, Li, & D’Arcy, 2018). Although efforts have been made to characterize resilience following CM, there are still significant gaps in the literature regarding which factors contribute to mitigating SU outcomes in this population. There is a dearth of literature delineating contributing factors to resilience and how they may influence developmental pathways preventing CM-exposed youths from substance misuse and/or

developing SUD. Identifying these contributing factors is likely crucial for understanding successful adaptation to life following CM. Moreover, bolstering resilience-promoting characteristics in those who are less likely to be resilient may represent an opportunity for preventative intervention efforts to combat substance misuse in those who are highly at risk of developing SUDs and other comorbid psychopathologies.

Resilience is most commonly conceptualized as successful adaption to life despite adverse circumstances (e.g., Masten, 2001). It is multidimensional in nature (Walsh, Dawson, & Mattingly, 2010), with a variety of domains (e.g., social, cognitive, physiological, genetic) and contextual factors (e.g., family, peer, neighborhood) contributing to whether individuals follow developmental trajectories toward or away from adaptive functioning. Specifically, with respect to SU outcomes, adaptive psychological functioning (e.g., good coping skills; Goldstein, Faulkner, & Wekerle, 2013), high-levels of certain cognitive factors (e.g., executive functioning, cognitive flexibility; Burt & Paysnick, 2012; Wingo, Ressler, Bradley, 2014), plus social functioning and support factors (e.g., social competence, parent-child relationship quality; Domhardt, Munzer, Fegert, & Goldbeck, 2015; Shin et al., 2019) are all protective against substance misuse following CM and, therefore, may be critical indicators of resilience.

Despite an abundance of work examining protective effects of socioemotional and cognitive functioning following CM (Burt & Paysnick, 2012; Domhardt et al., 2015), less is known about non-social and non-cognitive factors as potential protective factors against maladaptive outcomes. Grit, or the “perseverance and passion for long-term goals” (Duckworth, 2007, pp. 1087), may be a potentially important non-cognitive resilience factor that is not necessarily contingent upon environmental supports and/or cognitive ability (e.g., SES and IQ), which are potentially less modifiable by preventative interventions. Although self-control is tightly coupled with everyday successes, grit is linked to more substantial, longer-term accomplishments (Duckworth & Gross, 2016). As such, grit may be an ideal trait to examine when considering long-

term resilience outcomes, especially in populations who may be at risk of impairments in self-control due to early life stress (Duckworth, Kim, & Tsukayama, 2013). In addition, grit has been shown to be a robust predictor of adaptive functioning in a number of domains, including social functioning (e.g., marriage), academic achievement, and work success (Eskreis-Winkler et al., 2014). For example, even in the context of situational and individual factors that predict thwarted academic success (e.g., poor test scores, low levels of school-related motivation, lack of school safety, lower SES, race, decreased parental involvement), adolescents higher in grit are more likely to graduate from high school (Eskreis-Winkler et al., 2014; Huang et al., 2015). In addition, grit is predictive of academic success above and beyond self-regulation skills, IQ, aptitude, and personality (e.g., conscientiousness; Duckworth et al., 2007; Duckworth & Gross, 2016; Eskreis-Winkler et al., 2014; Huang & Zhu, 2015).

While much of the work examining grit has focused on academic outcomes, a burgeoning literature has begun to highlight its relevance to health-related behaviors and mental health outcomes. Those higher in grit are less likely to have mental health issues such as anxiety, depression, and substance abuse (Guerrero et al., 2016; Maddi, et al., 2013; Musumari et al., 2018). Adolescents with higher levels of grit are less likely to engage in alcohol or marijuana use or to engage in delinquent behaviors (Guerrero et al., 2016). For those at especially high risk of psychopathology, grit may, therefore, be an important mitigating factor against poor mental health outcomes, such as SU. This is of particular relevance to the current study, which considered individual characteristics thought to contribute to grit in a sample of youths who had experienced CM in order to delineate whether an increase in grit-related traits predicts a decreased risk of SU during adolescence.

Here, we focused on how grit-related traits relate to patterns of SU in adolescents with a history of CM from the LONGSCAN dataset (Runyan et al., 2014). Although grit has been shown to be related to SU risk in samples that did not oversample for developmental adversity (e.g., Guerrero et al., 2016), to the authors' knowledge, no studies to date have examined SU

outcomes as they relate to grit in samples who have experienced adversity. Thus, the present study sought to determine whether and to what extent grit-related characteristics may mitigate SU risk in a cohort with a history of adversity (i.e., CM). To delineate the potential heterogeneity in grit-related profiles in youths with a history of CM, we conducted a latent profile analysis (LPA). LPA is a form of mixture modeling using continuous indicator variables that contribute to a latent categorical construct (i.e., an unobservable construct consisting of multiple indicators). In the current study, we sought to identify profiles that can be used to group individuals based upon their similarity with respect to grit-related indicator variables. After identifying the extent to which individuals could be classified based upon these indicator variables, we considered whether the resultant profiles, which varied in terms of their grit trait levels, differed with regards to patterns of SU that we know confer heightened risk for SUDs and long-term misuse (i.e., early SU initiation (SU prior to age 15) and polySU) (Hingson, Heeren, Zakocs, Winter, & Wechsler, 2003; Moss et al., 2014; Roche, Ahmed, & Blum, 2008; Swift, Coffey, Carlin, Degenhardt, & Patton, 2008).

In terms of grit-related characteristics, multiple indicator measures were chosen which represented unique features thought to contribute to variability in grit (i.e., perseverance and passion for long-term goals). Importantly, uncovering potential heterogeneity in the characteristics thought to contribute to grit could not necessarily be accomplished with a univariate approach. The measures that were identified as important, yet distinct, contributors to grit included those assessing long-term expectations and planning (e.g., planning to attend college), the ability to commit to activities in a meaningful way (i.e., in ways that result in accomplishments), and items that provided evidence of challenging one's self (i.e., self-reliance, engaging in demanding activities such as working hard on schoolwork). In addition, given that self-regulation and grit are highly correlated (Duckworth & Gross, 2016), we examined levels of externalizing behaviors to examine its contribution to grit-related traits. Externalizing behaviors were included to assess self-regulation abilities since self-regulation is highly predictive of

variability in externalizing behaviors across development (Perry, Calkins, Dollar, Keane, & Shanahan, 2018). Indeed, it has been posited that the decline in externalizing behaviors during development may be evidence of the emergence of self-regulatory skills (Calkins & Dedmon, 2000).

Our primary hypothesis was that individuals with profiles characterized by more grit-related traits would be less likely to engage in risky patterns of SU (e.g., early SU, high levels of SU, and polySU). Based upon CM literature and theories of cumulative risk (Garrido, Weiler, & Taussig, 2018; Thompson et al., 2015; Turner, Shattuck, Finkelhor, & Hamby, 2017), our secondary hypothesis was that more severe CM (i.e., maximum severity of each type of maltreatment, number of CPS records) would predict profiles with fewer grit-related traits. Moreover, since earlier CM has been linked with poorer outcomes (e.g., working memory and inhibitory control; Cowell, Cicchetti, Rogosch, & Toth, 2015; Harpur et al., 2015), we considered the extent to which developmental timing of CM predicted grit-related profiles. Specifically, we hypothesized that earlier CM would be associated with profiles with lower levels of grit-related traits. Although studies have not examined whether grit is related to specific types of CM, a wealth of literature has demonstrated that CM type differentially influences various domains of functioning across development (e.g., cognitive, social, mental health; English et al., 2005; Fantuzzo, Perlman, & Dobbins, 2011; Pears, Kim, & Fisher, 2008; Spinazzola et al., 2014). Thus, an exploratory analysis of the data considered whether CM type (i.e., neglect, physical abuse, sexual abuse, and emotional abuse) was related to grit-related trait profiles.

Methods

Participants

The current sample was comprised of individuals who participated in the Longitudinal Studies on Child Abuse and Neglect (LONGSCAN) consortium study (Runyan et al., 2014), a prospective, longitudinal study that followed 1,354 children (51% female) and their families

every two years from ages 4-18. The LONGSCAN study comprehensively assessed individual, family, and environmental risk factors for and consequences of exposure to CM. The study involved collaboration from 5 regional data collection sites across the United States, which included children with reported and substantiated cases of CM as well as groups of comparison children at each study site.

The subsample selected for the current study ($N=355$; ~51% female) included only those children who had a Child Protective Services (CPS) report of CM and at least 4 out of the 5 grit indicator variables for the LPA (see Tables 1 & 2 for full details). Importantly, 80% of participants had at least 1 substantiated report of maltreatment (range = 1 – 32; $M = 4.02$, $SE = 0.23$). Although the sample included children with substantiated and unsubstantiated reports of CM, there is long-standing evidence that the physical and psychological consequences of CM do not differ for substantiated and unsubstantiated reports (Kohl, Jonson-Reid, & Drake, 2009; Kugler et al., 2019; Leiter, Myers, & Zingraff, 1994).

Measures

Childhood maltreatment. CPS maltreatment narrative records were coded by LONGSCAN researchers using the Modified Maltreatment Classification System (MMCS; English et al., 1997). The MMCS is used to classify and quantify CM characteristics such as the type (i.e., physical abuse, sexual abuse, psychological/emotional abuse, and neglect), timing, and severity (i.e., ranging from 1 = less severe abuse or neglect to 6 = most severe abuse or neglect). CPS records were acquired and coded using the MMCS every 2 years from 0 to 18 years of age. In the current study, we included MMCS data for ages 0 to 16.

We considered several dimensions of CM, including maximum severity for each type of maltreatment and the total number of CPS records ($M = 5.43$, $SE = 0.24$; range = 1 – 21) across all time points (Table 3). This latter measure was used as a global indicator of CM chronicity. In addition, we included information regarding whether or not participants had CPS records for

each maltreatment type. Lastly, to assess the effects of timing of CM, we coded whether participants had reports for each abuse type earlier (ages 0 – 8) or later (9 – 16) in development. These age ranges were chosen to approximate developmental timing before and after puberty, as this has been shown to be a potentially critical distinction in the proliferation of CM effects on developmental outcomes, particularly for those who experience abuse earlier in development (e.g., Cowell et al., 2015; Harpur et al., 2015).

Grit-related variables. A specific measure of grit was not collected as part of the LONGSCAN protocol. Thus, the resilience-related measures that were selected to approximate grit included 1) future expectations, 2) leadership and honors, 3) self-reliance, 4) engaging in demanding activities, and 5) presence (or absence) of externalizing behaviors. Each of these measures is described in detail below.

Future expectations. The Future Events Questionnaire (FEQ; Knight et al., 2008; McCabe & Barnett, 2000) was used to assess, at age 16, adolescents' future planning and expectations about their employment, education attainment, and family. Adolescents answered 10 questions regarding how likely they viewed a specific outcome would occur in their future (1=very unlikely to 5=very likely). Only the education/career and financial stability items were used to assess future expectations since the family factor items yielded low variability in the current subsample (i.e., 69% endorsed wanting to get married and/or have children) and because the education/career and financial stability subscales were deemed more relevant for assessing individual's future orientation as a contributing factor to grit. For the education/career subscale, example items included the extent to which one expected to 1) graduate from high school/get a GED, 2) go to college, and 3) get the job they want. For the financial stability subscales, example items included whether one expected to 1) have children without being married, 2) go on welfare, and 3) get divorced. These subscales had moderate to good reliability (education/career Cronbach α = .72; financial α = .65) and were summed to obtain an overall

future expectations measure for the present study (overall $M = 30.28$, $SE = .25$; range = 15 – 40).

Leadership and honors. To assess the extent to which adolescents were committing to and engaging meaningfully in school as well as extracurricular activities, we used the Community Connectedness measure to examine if they had received recognition through leadership positions or honors in the past year (Knight et al., 2009). This measure assesses multiple aspects of community involvement as well as attainment of honors and leadership roles in the past year at age 18. A sum of the quantity of leadership activities (e.g., sports team captain or co-captain, school club officer) and honors (e.g., school awards, honor roll, community service awards, job recognition) was examined ($M = 3.65$, $SE = .18$; range = 0 - 16).

Self-reliance and engaging in demanding activities. The Adolescent Coping Orientation for Problem Experiences questionnaire (ACOPE; McCubbin et al., 2001) was designed to evaluate adolescents' coping styles and behaviors using twelve subscales of different strategies for managing stress and difficult situations at age 18. Adolescents were asked how frequently (1 = never to 5 = most of the time) they engage in particular coping behaviors. In the current subsample, the self-reliance and engaging in demanding activities subscales were used. The self-reliance sum scores had a possible range of 0 to 30 ($M = 19.56$, $SE = .25$; range = 6 – 30). Example items include how often adolescents 1) try to see the good things in a difficult situation, 2) organize their life and what they have to do, 3) get a job or work harder at one, 4) try to make decisions for themselves. The demanding activities sum scores had a possible range from 0 to 20 ($M = 10.92$, $SE = .18$; range = 4 – 20). Example items include how often adolescents 1) get more involved in activities at school or in their community, 2) try to improve themselves, 3) work hard on schoolwork and other projects. Both subscales had moderate to good reliability (demanding activities $\alpha = .67$; self-reliance $\alpha = .74$). Importantly, these subscales were entered

as separate indicators into the LPA, as they are conceptualized as separate competencies that may uniquely contribute to grit-related functioning.

Externalizing behaviors. Externalizing behaviors were assessed at age 18 with the widely used Youth Self-Report measure, which is based on the Child Behavior Checklist (YSR; Achenbach, 1991). This measure evaluates a wide array of behaviors. In our models, we included raw self-report sum scores for externalizing behaviors ($\alpha = .88$), as a measure of regulatory abilities ($M = 9.45$, $SE = .39$; range = 0 – 35). For each item, adolescents were provided statements and asked to respond with 0 = *Not True*, 1 = *Somewhat or sometimes true*, or 3 = *Very true or often true*. Example items include: 1) I act too young for my age, 2) I have trouble concentrating or paying attention, 3) I disobey my parents/at school.

Substance Use. Various self-report measures of SU were collected at 12, 14, 16, and 18 years of age. A version of the Tobacco Alcohol and Drugs (TAD; Knight et al., 2009) questionnaire was administered at ages 12, 16, and 18 years old. The TAD was developed for LONGSCAN based upon the Youth Risk Behavior Survey (Brener et al., 2002), the Monitoring the Future Study (Johnston, O'Malley, & Bachman, 1999), and the CHAMPS study (Black, Laliberte, & Santelli, 1999) and was designed to assess use across a wide range of substances (e.g., alcohol, cigarettes, marijuana, cocaine, stimulants, prescription drugs not prescribed, heroin, and hallucinogens). For the purposes of this study, we included items that captured whether participants reported using each substance in the past year (at 12, 16, and 18 years old) and how many days they recall using each substance in that year. Although the TAD was not available at age 14, participants were administered the Diagnostic Interview Schedule for Children (DISC-IV; Schaffer et al., 2000). The DISC-IV contains several modules that capture whether and how often adolescents reported using alcohol, tobacco, marijuana, and/or other substances in the past year. Percentages of the current sample reporting SU for any substance at each age are reported in figure 1. It is notable that these rates of use are comparable, if not

slightly higher at age 18, for the Monitoring the Future study, which is one of the largest longitudinal studies of SU among adolescents in the U.S. (Johnston, et al., 2020).

For our models, multiple indices were computed to capture SU including: 1) SU severity (i.e., how often adolescents reported using each drug in the past year at ages 12, 14, 16, and 18 ($M = 9.19$, $SE = 0.66$; range = 0 – 63); 2) SU at any time point (coded as 0 or 1; 76% used); 3) early SU (i.e., any reported SU at ages 12 or 14 (coded as 0 or 1; 38% early use); 4) polySU (i.e., reporting SU for more than 1 drug at each time point (coded as 0 or 1; 51% polySU); 5) persistent polySU (i.e., reporting using more than 1 drug at 2 or more time points (coded as 0 or 1; 21% polySU).

Analytic Plan

To uncover the heterogeneity in grit-related traits in youths with a history of CM, we conducted an LPA. Prior to analyses, all indicator and outcome variables were examined for violations of skew and kurtosis, of which there were none. Missing data ranged from 0% to 6.5% for all variables. Individuals were included only if they were missing 1 or less indicators. The LPA was conducted using Mplus v.7.4 (Muthén & Muthén, 2015). To identify the best model (i.e., number of profiles), we examined several established criteria. First, to compare model fit, we used Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and sample size adjusted BIC. Lower values for each of these model comparison criteria indicate improved model fit (Nylund, Aparauhov, & Muthén, 2007). Second, the Lo-Mendell-Rubin (LMR) likelihood ratio test was used to compare whether the current number of profiles (k) is a superior fitting model than the model with one fewer profile (i.e., $k - 1$; Wang & Wang, 2012). Finally, relative entropy for each model was used to determine how accurately the model has delineated separate profiles, with higher values indicating better accuracy (range = 0.0 to 1.0). An entropy value of 0.40 is considered low, 0.60 is average, and 0.80 is high (Celeux & Soromenho, 1996).

After determining best model fit, profiles were compared on patterns of SU and CM, respectively, using the Auxiliary (BCH or DCAT) function in MPlus (Asparouhov & Muthén, 2014; Bolck, Croon, & Hagenaars, 2004). The BCH and DCAT methods are used to conduct between-profile comparisons by including the outcome variable in a separate step of the model, which prevents unwanted shifts in the profile (Asparouhov & Muthén, 2014). The BCH method was used for continuous outcome variables and the DCAT method was used for categorical outcome variables. Both methods estimate an omnibus result based upon profile-specific differences and conduct pairwise comparisons.

Results

Latent Profile Models

The fit statistics for models containing 1, 2, 3, 4, and 5 profile solutions are shown in Table 4. Although the AIC, BIC, and adjusted BIC all decreased with a greater number of profiles, the LMR p -value indicated 3-profile solution was optimal. In addition, the relative entropy indicated that the 3-profile solution provided the most accurate classification. The estimated means for the 3-profile solution for each indicator variable contributing to the latent grit construct are shown in Figure 2. Profile 1 was characterized by the highest level of externalizing behaviors ($M = 10.49$, $SE = 1.38$) as well as the lowest levels of expectations about their future ($M = 27.39$, $SE = 1.12$), leadership and honors ($M = 2.83$, $SE = 0.67$), self-reliance ($M = 11.48$, $SE = 1.05$), engaging in demanding activities ($M = 6.81$, $SE = 6.81$) and represented 10% of the total sample ($N = 36$). In light of prior evidence regarding the role of these characteristics in grit, profile 1 was labeled as the Low Grit group. Profile 2 included 69% of the sample ($N = 247$) and was characterized by lower levels of externalizing behaviors ($M = 9.62$, $SE = 0.54$) than the Low Grit profile. In addition, Profile 2 had scores that were in between the low and high profiles for expectations about their future ($M = 30.19$, $SE = 0.40$), leadership and honors ($M = 3.05$, $SE = 0.27$), self-reliance ($M =$

19.20, $SE = 0.37$), and engaging in demanding activities ($M = 10.31$, $SE = 0.24$). Profile 2 was labeled as the Average Grit group. Finally, Profile 3 consisted of 20% of the sample ($n = 72$) and was characterized by the lowest levels of externalizing behaviors ($M = 8.35$, $SE = 0.84$) and the highest levels of the more positive behaviors; future expectations ($M = 32.00$, $SE = 0.56$), leadership and honors ($M = 5.92$, $SE = 0.56$), self-reliance ($M = 24.58$, $SE = 0.60$), and engaging in demanding activities ($M = 14.83$, $SE = 0.74$). Therefore, Profile 3 was labeled as the High Grit group.

To determine the extent to which the three profiles are statistically distinguishable on each indicator, we conducted a one-way ANOVA with post-hoc analyses. Findings revealed significant differences between groups for 4 out of the 5 indicators: future expectations ($F_{(2,348)} = 14.10$, $p < .001$), leadership/honors ($F_{(2,351)} = 26.76$, $p < .001$), self-reliance ($F_{(2,353)} = 293.45$, $p < .001$), and demanding activities ($F_{(2,353)} = 200.90$, $p < .001$). There were no significant differences between groups for the externalizing behaviors indicator ($F_{(2,330)} = 1.15$, $p = .32$).

Post-hoc analyses were conducted using Bonferroni corrected adjusted alpha levels of $p < .016$. For future expectations, Low grit had significantly lower future expectations compared to both Average Grit ($p < .001$) and High Grit ($p < .001$). Similarly, Average Grit had significantly lower future expectations than High Grit ($p = .01$). For leadership and honors, the Average and Low Grit profiles did not significantly differ from each other. However, the High Grit profile engaged in significantly higher levels of leadership/honors than the Low and Average Grit profiles ($p < .001$ for both). In terms of self-reliance, all profiles differed from one another such that Low Grit had significantly less self-reliance compared to the Average and High Grit profiles (both $p < .001$). The High Grit profile also had significantly more self-reliance than the Average Grit profile ($p < .001$). A similar pattern emerged for engaging in demanding activities whereby the Low Grit profile had the lower levels compared to the Average and High Grit profiles (both $p < .001$). The High Grit profile engaged in more demanding activities than the Average Grit profile as well ($p < .001$).

Grit Profile Comparisons of SU

There were significant differences between the profiles for two of the SU outcome variables (see Figure 3a). First, profiles were significantly different from each other for lifetime polySU ($\chi^2_{(2, N=355)} = 5.77, p = 0.05$). Participants in the High Grit profile were less likely to engage in lifetime polySU than those in the Average Grit ($\chi^2_{(1, N=319)} = 5.01, p = 0.02$) but not the Low Grit ($\chi^2_{(2, N=108)} = 3.51, p = 0.06$) profiles. The Average Grit and Low Grit profiles were not significantly different for polySU ($\chi^2_{(2, N=283)} = 0.14, p = 0.71$). Second, persistent polySU was also significantly different between profiles ($\chi^2_{(2, N=355)} = 7.62, p = 0.02$; see Figure 3b). Specifically, the High Grit profile was significantly less likely to engage in persistent polySU compared to the Average Grit profile ($\chi^2_{(1, N=319)} = 7.62, p = 0.02$). The Low Grit groups was not significantly different in persistent polySU compared to either the High or Average Grit groups. SU ever, SU severity, and early SU were not significantly different between the profiles.

Grit Profile Comparisons of Maltreatment Type, Timing, and Severity

The grit profiles did not differ with regards to their CM characteristics including the number of CPS records, maltreatment type, timing, or severity (See Supplementary Materials for Table S1).

Discussion

The present study sought to determine the extent to which there is variability in grit-related characteristics in a sample of adolescents with a history of CM. Specifically, we considered the whether heterogeneity in grit-related characteristics could be categorized and whether this categorization was related to SU behaviors that are predictive of problematic patterns of SU. LPA revealed that for participants in the LONGSCAN study and for the chosen grit-related characteristics, there were 3 grit-related profiles, which we described as Low Grit, Average Grit, and High Grit.

These profiles differed on all grit-related indicators with exception of externalizing behaviors (i.e., engaging in demanding activities, leadership/honors, self-reliance, and expectations about the future). The comparable levels of externalizing behaviors is largely consistent with literature demonstrating that disruptions in self-regulation and the development of externalizing behaviors into adolescence is a lasting adverse impact of CM (Herrenkohl & Herrenkohl, 2007; Mills et al., 2013; Moylan et al., 2010). Despite the comparable levels of externalizing behaviors across profiles, in our iterative testing of LPA models, externalizing behaviors were key in uncovering a solution. This suggests that the way in which externalizing behaviors interacted with the other indicators in each profile may be important in delineating those processes that drive grit in this population. Unlike other studies showing associations between self-regulation and grit (Duckworth & Gross, 2016), an alternative interpretation may be that self-regulation does not maintain the same predictive ability of grit in those who have experienced CM.

Our secondary aim was to examine whether different grit-related profiles were associated with differences in SU behaviors. In particular, we were interested in those SU behaviors that portend increased rates of problematic SU and SUD. We found that adolescents exhibiting higher grit were less likely to engage in polySU (i.e., using more than 1 substance ever or using more than 1 substance across 2 or more time points) compared to adolescents with average levels of grit. These SU outcomes are consistent with a prior study demonstrating that higher levels of grit are related to less SU in adolescents (Guerrero et al., 2016) and suggest that these effects may also apply to samples of at-risk youth. Interestingly, the Low Grit adolescents did not differ from the Average and High Grit profiles in their drug use. However, it is notable that their pattern of polySU were in the same direction and was statistically comparable to the Average Grit profile (i.e., higher levels of polySU than no polySU). Though difficult to interpret a null finding, it is plausible that the characteristics of grit that we examined play a more protective role against polySU at greater levels, as in the High Grit profile. In

contrast, at the lowest levels of grit, the characteristics measured here may be of less consequence for patterns of polySU and/or there may be other factors that have greater impact on patterns of polySU for the Low Grit profile in particular.

Despite CM being a potent predictor of SU and SUDs (Alvarez-Alonso et al., 2016; Mills et al., 2016), our findings provide some insight into the potential protective effect of having higher levels of grit-related traits. These results are particularly interesting given that polySU is related to a number of deleterious outcomes above and beyond developing SUDs, including decrements in neurocognitive functioning and increased psychopathology (Jones et al., 2017; Moody, Franck, Hatz, & Bickel, 2016). For example, compared to individuals who use no or few substances, polysubstance users are consistently shown to be at elevated risk of anxiety, depression, and psychosis (Connor et al., 2013; Hakansson et al., 2011; Jones et al., 2017; Smith et al., 2011). Polysubstance users are also more likely to have long-term poor physical health (Timko et al., 2018) and to develop sexually transmitted infections (Trenz et al., 2013). Uncovering individual characteristics that may protect against polySU could point to potential targets for future preventative interventions. In a population that is already at greater risk of physical and mental health problems, including SUDs, the results reported here are an important step toward identifying potentially malleable individual factors that may protect against the long-term sequelae that often follow CM.

For our final aim, we considered whether characteristics of CM were associated with subsequent grit-related traits. Intriguingly, there were no differences among the profiles in the CM characteristics such as type, timing, and severity. These results indicate that the three profiles were equivalent in terms of their CM histories and, thus, differences in key grit-related characteristics may be driven by other, non-CM related factors. That is, other aspects of the developmental context might be critical to the development of these characteristics. This finding may be particularly important as it suggests that independent of the specific types of traumatic experiences that children may be exposed to, there is a potential equivalency in characteristics

that are protective against maladaptive outcomes. Delineating precisely what those influences are and how they specifically act in order to mediate or moderate the impact of CM on subsequent risk or resilience has the potential to inform the development of more effective evidence-based interventions to prevent the negative impacts of CM and across CM experiences that differ in terms of type, timing, or severity.

With regards to study limitations and future directions, despite LONGSCAN being a large and well-characterized sample of children exposed to maltreatment, the current subsample of LONGSCAN participants is relatively small for an LPA analysis. Simulation studies indicate that the current sample is adequately powered, particularly for the 3-profile solution (Tein, Coxé, & Cham, 2013). However, future work should investigate these processes in a larger sample since it is plausible that a model with a greater number of profiles could be uncovered. Second, though the measures included here are believed to be adequate in capturing the grit construct, our results would be strengthened by the inclusion of a specific measure of grit (i.e., Duckworth et al., 2007). Thus, future work would benefit from using existing measures designed to capture grit to confirm whether increased grit yields similar protective effects against polySU in maltreated samples. Relatedly, obtaining a more sensitive measure of self-regulation would likely enhance our understanding of whether and to what extent self-regulation contributes to grit, particularly in those who have a history of CM. Third, although our analysis included all standard measures of CM, as commonly used in other studies, the profiles uncovered here could differ on other CM characteristics not examined here. Moreover, it is noteworthy that the LONGSCAN subsample examined here had very high rates of neglect (~90%). Thus, if our sample had a different distribution of maltreatment subtypes, it is possible that the results regarding the specificity of CM impacts could have been different. Finally, it is important to acknowledge that 20% of current sample included children with unsubstantiated investigations of CM, which some suggest may confer a different level of risk compared to those with substantiated reports. However, prior work has shown a degree of equivalency between those

with and without substantiated CM reports in terms of the risk of adverse/maladaptive long-term outcomes (Kohl, Jonson-Reid, & Drake, 2009; Kugler et al., 2019; Leiter, Myers, & Zingraff, 1994), suggesting a level of similarity in the experiences of those whose cases are investigated but not substantiated and those that are substantiated.

Here we sought to delineate whether grit-related characteristics vary in individuals with a history of CM and examine whether specific profiles of grit were related to SU. The next step in this line of inquiry will be to further disentangle how grit and SU are related across development in maltreated children. That is, future research should examine the extent to which the profiles uncovered here change over time and are potentially predictive of subsequent SU and SUDs. It may be revealed that grit is a potentially malleable characteristic in youth, and may be relevant for future intervention for those particularly at-risk of developing substance misuse and SUDs.

Conclusions

To the best of our knowledge, the present study is the first to examine grit-related characteristics in adolescents with a history of CM. We uncovered profiles of grit-related resilience that were related to polySU such that those who had the most grit were least likely to engage in polySU during adolescence. Identifying traits that are largely unrelated to cognitive or social functioning, or qualities of the environment (i.e., grit) in those who are at elevated risk of developing SUDs represents a promising avenue for future prevention and intervention efforts.

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Table 1. Participant Demographics

Age at first CPS referral M(SE); range	T1 Age M(SE)	T2 Age M(SE)	T3 Age M(SE)	T4 Age M(SE)	T5 Age M(SE)	T6 Age M(SE)	T7 Age M(SE)	Sex F:M	Race W:B:L:NA:A:M:O
1.62(.12); 0 – 15.87	4.32 (0.02)	6.23 (0.02)	8.25 (0.02)	12.31 (0.02)	14.37 (0.03)	16.37 (0.02)	18.47 (0.04)	181:174	120:134:32:3:3:61:2

Note. W = White, B = Black, L = Latino/a, NA = Native American, A = Asian, M = Mixed Race, O = Other

Table 2. Age(s) and Ns for each indicator and outcome variable

Measures		
	Age(s) Years	N
<i>Indicators</i>		
Future Expectations	16	350
Leadership/Honors	18	353
Externalizing Behaviors	18	332
Self-reliance	18	355
Demanding Activities	18	355
<i>Outcomes</i>		
SU severity	12, 14, 16, 18	355
SU ever	12, 14, 16, 18	355
SU early	12, 14, 16, 18	355
Poly SU	12, 14, 16, 18	355
Maltreatment	0-16	355

Table 3. LONGSCAN Subsample Maltreatment Characteristics

Abuse Type	Severity (1-6) M(SE)	Percentage who experienced type	Percentage with early timing	Percentage with late timing
Physical Abuse	1.22(0.07)	55%	44%	28%
Sexual Abuse	1.07(0.08)	32%	23%	13%
Emotional Abuse	2.13(0.11)	58%	47%	26%
Neglect	3.40(0.08)	90%	87%	29%

Table 4. Summary of model fit for latent profile models

Profiles:	AIC	BIC	Adjusted BIC	Relative Entropy	LMR p	Proportion of smallest group
1	9766.678	9805.400	9773.675	--	--	--
2	9647.692	9709.646	9658.887	0.598	0.0110	.366
3	9595.832	9681.019	9611.225	0.781	0.0111	.101
4	9555.430	9663.849	9575.021	0.736	0.1290	.099
5	9541.723	9673.375	9565.513	0.755	0.8732	.096

Note. AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, and LMR = Lo-Mendell-Rubin likelihood ratio test. 3-profile solution is highlighted in grey.

Figure Legends

Figure 1. Percentage of SU Across Time. Percentage of adolescents reporting any SU at data collection time points for ages 12, 14, 16, and 18.

Figure 2. Estimated Means of Indicator Variables for 3-profile Latent Profile Model. Estimated means for the Low, Average, and High Grit profiles from the 3-profile solution. FE = Future Expectations, LH = Leadership and Honors, EXT = externalizing behaviors, SR = Self-reliance, DA = Demanding Activities. Significant (i.e., $p < .016$) group differences from post-hoc analyses are indicated above each bar with the following letters: *L* = different from Low Grit, *A* = different from Average Grit, and *H* = different from High Grit.

Figure 3. Between-Profile Differences in Lifetime and Persistent PolySU. Fig3a. Polysubstance Use Ever. Fig 3b. Persistent Polysubstance Use. *Note.* * = $p < .05$.

Figure 1. Percentage of SU across time

Figure 2. Estimated means of indicator variables for 3-profile latent profile model.

Figure 3. Between-profile differences in lifetime and persistent polySU

Supplementary Materials

Table S1. Between-profile comparisons for maltreatment type, severity, and timing

Measure	χ^2	df	<i>p</i>
Number of CPS records	2.13	2	0.34
<i>Type</i>			
Physical Abuse	0.01	2	0.99
Sexual Abuse	1.63	2	0.44
Emotional Abuse	0.60	2	0.74
Neglect	0.54	2	0.76
<i>Severity</i>			
Physical Abuse Max Severity	0.66	2	0.72
Sexual Abuse Max Severity	2.74	2	0.25
Emotional Abuse Max Severity	0.20	2	0.91
Neglect Max Severity	1.41	2	0.49
<i>Timing</i>			
Early Physical Abuse	0.06	2	0.97
Early Sexual Abuse	3.18	2	0.20
Early Emotional Abuse	0.32	2	0.85
Early Neglect	0.65	2	0.72