Article

Networks of ADHD and SCT Symptoms in Emerging Adulthood

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Abstract

Objective: Emerging adulthood (18–25 years) is a transitional and understudied developmental period. Yet, little is known about how specific symptoms of ADHD, as well as those from the related SCT domain, may differentially relate to one another during this period, if there are differences based on biological sex, or how closely results will align with adulthood. **Methods:** We used network analysis techniques to explore the structure of ADHD and SCT symptoms within emerging adulthood, with additional comparisons between sexes as well as between emerging adulthood and adulthood. Using an online platform, 8,506 adults reported on their symptoms of ADHD and SCT. **Results:** Symptoms grouped together within their respective domains during emerging adulthood with no significant differences in overall network structure between sexes. Similarly, network structure appeared to be robust across emerging adulthood and adulthood. **Conclusion:** Such consistency supports a conceptualization of ADHD in emerging adulthood as similar to adulthood. (*J. of Att. Dis. XXXX; XX(X) XX-XX*)

Keywords

sluggish cognitive tempo, ADD/ADHD, adult ADHD

Emerging adulthood (18–25 years) bridges the developmental period between adolescence and adulthood. This stage encapsulates a period where emerging adults are expected to take on more responsibility (e.g., live independently, operate finances) while still undergoing brain development (Arnett, 2000). This discrepancy between skill level and ongoing development is highlighted even more for those with ADHD, whose daily living and executive functioning skills are already impaired (Barkley et al., 2008). Although ADHD has historically been considered a childhood disorder, recent studies have increasingly recognized the persistence of ADHD symptoms throughout adulthood (40%–50% of children with ADHD continue to meet criteria into adulthood; Kessler et al., 2010; Leopold et al., 2016; Sibley et al., 2016;). Yet, despite these notable prevalence rates, little remains known pertaining to the characterization of ADHD and SCT symptomatology during emerging adulthood as well as if symptom structure may differ between males and females. Further, it is unclear if ADHD's symptom structure in this transitional period may be distinct from or resemble that of adulthood.

Emerging adulthood represents a dramatic change in responsibilities that overlap with common areas of impairment for those with ADHD. For example, emerging adults may be expected to manage their own physical and mental healthcare, maintain steady employment, or sustain committed romantic relationships (Arnett, 2000). All of these decisions ostensibly would be completed with less parental oversight and school support than was available in childhood and adolescence (Arnett, 2000). Additionally, ADHD symptoms may be changing as well, with prior work suggesting the inattentive symptom domain remains consistently prominent throughout development, whereas the hyperactive/impulsive symptom domain may become less prominent and SCT may become slightly more prominent (Becker et al., 2016; Leopold et al., 2016).

Furthermore, these age-related symptom changes could be moderated by biological sex. Previous sex differences have been identified for prevalence rate, which is higher for adult males versus females (1.6:1, Willcutt, 2012), as well as for severity of symptom endorsement and related impairment, with college females reporting worse outcomes (Fedele et al., 2012; Jaconis et al., 2016). Although gender differences in ADHD phenotypes have been suggested, such as for inattentive symptoms, this area remains ambiguous

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with other research suggesting gender differences may be less pronounced (Rucklidge, 2010).Similar to other disorders, sex differences as a whole remain an understudied area (Hartung & Lefler, 2019). Clarification of ADHD and SCT symptom structure within this developmental period thus represents an important clinical aim, given that symptom structure during emerging adulthood may be distinct from both childhood and adulthood and thus require different personalized assessment and intervention approaches.

Application of Network Theory to ADHD and SCT

Network theory encompasses an innovative paradigm shift that may shed light on age and sex-based differences in the expression of ADHD and SCT symptomatology. In contrast to current models of ADHD that group related symptoms within more general domains to elucidate shared etiological mechanisms and outcomes (i.e., latent factors of inattentive and hyperactive/impulsive symptoms; reviewed in Arias et al., 2018), network theory instead focuses on individual symptoms, as well as the relations among them, as active ingredients that may explain how the disorder manifests (Borsboom & Cramer, 2013). *Crucially, these differential symptom-to-symptom relations may account for heterogeneity in disorder expression, including that identified in emerging adulthood and between males and females.*

For example, there may be different symptom structures of ADHD and SCT, as well as different key symptoms, between sexes. If so, clarification of these differences could facilitate insights into sex-based heterogeneity in the characterization of ADHD, with implications for the assessment of ADHD and SCT and personalized targeting of symptom groups. Further, this work could provide theoretical insight into *why* certain symptoms may be more likely to co-occur, which could be useful for clarifying the nature of specific ADHD and SCT phenotypes. For instance, rather than *talking excessively* and *difficulty sustaining attention* occurring solely because of shared etiological mechanisms, it is possible that a tendency for *talking excessively* may be directly (or bidirectionally) related to *difficulties sustaining attention.* Network analysis focuses on these symptom-to-symptom relations, potentially providing an additional invaluable source of information for characterizing ADHD and SCT during emerging adulthood.

Central Symptoms

Network analysis provides a quantitative means to identify central, or important, symptoms that are robustly connected to other symptoms in the network. Prior work has suggested that inattentive symptoms *easily distracted* and *difficulty sustaining attention* are core to ADHD networks over the lifespan (Martel et al., 2016). Moreover, symptom clusters became more visually differentiated and less tightly grouped together with increasing age. Lastly, impulsive symptoms have been suggested as central to combined ADHD and ODD networks over time (Martel et al., 2017). However, none of these studies examined ADHD and SCT symptoms in emerging adulthood or compared different networks based on sex. Rather, Martel and colleagues (Martel et al., 2016) grouped together emerging adulthood with other periods of adulthood, possibly missing key developmental differences. Further, networks were compared across periods of childhood but not periods of adulthood, despite prior work suggesting differences in the characterization of ADHD between childhood/adolescence and adulthood (Martel et al., 2012; Olson, 2002). By identifying central symptoms within emerging adulthood and between sexes, we may be able to focus on more relevant targets for intervention for this developmental stage (e.g., organizational skills training for "difficulty sustaining attention" vs. behavior management for "talks excessively").

Network Comparisons

Network theory also allows for comparisons of symptom structure across different periods of adulthood and between sexes. Previous work identified age effects in the relations among ADHD symptoms from childhood to young adulthood, with symptoms becoming more visually differentiated over time (Martel et al., 2016). Yet, it remains unclear whether this developmental trend may continue throughout emerging adulthood to adulthood, with the use of latent variable models precluding an exploration of differences in relations among ADHD symptoms. Further, previous work has not been able to statistically compare symptom structure across different groups, instead relying on visual interpretation. By quantitatively examining the robustness of symptom structure across sexes and age groups, we can better determine if our conceptualization and treatment of ADHD, as well as SCT, can be applied from childhood throughout the lifespan or if conceptualizations of ADHD and SCT need to be adjusted based on age and/or sex. Unlike previous theoretical orientations, network theory readily accommodates such an exploration of symptom-level relations.

Purpose

The purpose of this study was to examine the structure of ADHD and SCT symptoms, at the symptom level, between sexes in emerging adulthood (i.e., 18–25 years) based on self-report. Further, the networks of symptoms between emerging adulthood and adulthood (i.e., 25–64 years) were compared to assess for robustness between age groups. Based on previous work assessing developmental patterns of ADHD symptom domains as described above, we hypothesized that emerging adults would have inattentive symptoms as core to its network, such as *easily distracted*

and *difficulty sustaining attention*. It was also hypothesized that hyperactive/impulsive symptoms would be less core to the network, particularly hyperactive/impulsive symptoms related to physical activity that may be more childhood-specific (e.g., *runs or climbs*).

Method

Participants

Recruitment of participants occurred within Amazon's Mechanical Turk program (MTurk; https://www.mturk.com). MTurk is a global marketplace to access a workforce of over 500,000 individuals who complete tasks (e.g., surveys) for monetary compensation. The results of numerous studies demonstrate that MTurk is becoming an increasingly useful platform for conducting behavioral research, recruiting individuals from typically hard to reach populations, and even cross-validating data drawn from more traditional samples (Mason & Suri, 2012; Rouse, 2015; Shapiro et al., 2013; Smith et al., 2015). The MTurk platform allows access to populations that are more diverse than traditional samples and more representative of the US population as a whole (Buhrmester et al., 2011; Paolacci & Chandler, 2014). The results of several studies demonstrate that the quality of data derived from MTurk samples is qualitatively and quantitatively similar, and at times superior to traditional samples (e.g., college populations and internet-forums), both in terms of reliability and validity (Buhrmester et al., 2011; Hauser & Schwarz, 2016; Holden et al., 2013; Johnson & Borden, 2012). Further, Hauser and Schwarz (2016), found that MTurk participants were more attentive to study instructions than traditional college populations. For the current study, MTurk participants were limited to individuals residing within the United States.

Measures

Demographics. Several demographic questions were asked to ascertain participants' age, sex, and ADHD diagnostic history. Based on self-report, 1,199 (14%) participants reported a previous ADHD diagnosis and 742 (9%) currently met criteria for ADHD. ADHD diagnosis was defined in the current study as more than five inattentive symptoms, more than five hyperactive/impulsive symptoms, or more than five symptoms of both domains on the self-reported ADHD Rating Scale, along with two or more areas of impairment and symptom onset before age 12.

Barkley Adult ADHD Rating Scale; Fourth Edition (BAARS-IV; self-report: Current symptoms). The BAARS-IV (Barkley, 2011) is a self-report scale of current ADHD and SCT symptomatology and related impairment in adults. The 30-item scale contains nine items to measure inattentive symptoms, nine items to measure hyperactive/impulsive symptoms, nine items to measure SCT symptoms, and three items to determine the age of onset of symptomatology as well as areas of impairment. Participants endorse their behavior over the past 6 months using a four-point Likert scale ranging from 1 (*Never or rarely*) to 4 (*Very often*). Psychometric data on the BAARS-IV have revealed that it has excellent internal consistency ($\alpha = .92$), high construct and face validity, and acceptable test-retest reliability ($r = 0.75$). For the current sample, the internal consistency of the BAARS-IV was good to excellent ($\alpha = .87$–$.93$). The 27 symptom items were used in the current study.

Procedure

The following procedures were reviewed and approved by the institutional review board. In order to help ensure that participants did not provide answers untruthfully in order to artificially meet eligibility criteria for future studies, participants were not informed that this study was specifically related to ADHD. Rather, participants were informed that the survey was a pre-screener to examine mental health and demographic factors among MTurk workers to determine eligibility to participate in future studies. After providing informed consent, participants provided responses to several demographic questions and completed the BAARS-IV. Participants were compensated $0.15 for completing the pre-screener survey and providing the correct response to the attention check question.

Analytic Approach

The original dataset ($N = 9{,}282$) was screened, prior to analyses, for issues that could affect the interpretation of the results. MTurk participants who did not start or finish the pre-screener ($n = 586$) and those aged 65 and older ($n = 157$) were removed prior to further inspection of the data. Next, if there were missing data on outcomes of interest, or if a participant incorrectly answered the attention check item, their data was removed from the dataset. Participants with missing age ($n = 6$) or BAARS-IV data ($n = 18$) were removed prior to analyses. Lastly, examination of MTurk worker identification numbers revealed that no individual participated in the survey more than once. The final dataset used for analyses included 8,506 participants who were diverse across age (ranging from 18 to 64 years old, $M = 34.12$, $SD = 10.54$), sex (61.7% female), and geography (comprising all 50 US states and Washington, DC). Participants were divided in two sexes (i.e., male, female) and two age groups (i.e., emerging adulthood [ages 18–25], adulthood [ages 26–64]).

Sample characteristics, including means and standard deviations of inattention, hyperactivity/impulsivity, and SCT symptoms, across age groups are reported in Table 1. Analyses first explored global network structure and then narrowed focus to more specific symptoms and edges.

Table 1. Descriptive Statistics Across Age Ranges.

	Ages 18–25	Ages 26–64
	n = 1,932 (22.7%)	*n* = 6,574 (77.3%)
	M (SD)	*M (SD)*
Symptom count		
Inattention	2.54 (2.65)	1.80 (2.46)
Hyperactive/impulsive	2.24 (2.35)	1.63 (2.17)
Sluggish cognitive tempo	3.12 (2.74)	2.22 (2.55)
BAARS-4 Impairment count	2.19 (1.38)	1.87 (1.48)
	n (%)	
Males	836 (43.3)	2,419 (36.8)
Meets current ADHD criteria	206 (10.7)	536 (8.2)
Reported prior ADHD diagnosis	328 (17.0)	871 (13.2)
Presentation type		
Inattentive	101 (5.2)	264 (4.0)
Hyperactive-impulsive	37 (1.9)	111 (1.7)
Combined	65 (3.3)	152 (2.3)
Do not know or remember	118 (6.1)	337 (5.1)

Note. Symptom range = 0 to 9; Impairment = number of impairment domains endorsed on the BAARS-IV; range = 0 to 4; Meets current ADHD criteria = BAARS-IV Current Self-Report with five or more IA or HI symptoms, two or more areas of impairment, and symptom onset before age 12.

Using the R package qgraph (Epskamp et al., 2012), networks were constructed using Graphical Gaussian Models with the Least Absolute Shrinkage Selection Operator (glasso) and extended Bayesian information criterion model (eBIC, Friedman et al., 2008). This resulted in sparse networks containing only the strongest spearman correlations, with minimal correlations reduced to zero through regularization. Strongly connected nodes were in the center of the network with less connected nodes on the periphery of the network (Fruchterman & Reingold, 1991). A gamma (γ) hyperparameter of .5 was selected for the EBIC to maximize specificity of relations within networks (Epskamp & Fried, 2018).

To interpret networks, communities of symptoms were identified using the *spinglass* algorithm from the *igraph* package in *R* (Csardi & Nepusz, 2006). A community is a cluster of nodes that exhibits many connections within the cluster but fewer connections outside of it. The algorithm was run 1,000 times in order to determine the most stable number of clusters (i.e., the median number resulting from the algorithm). Then, expected influence (i.e., the sum of the absolute edges attached to a node while accounting for negative edges) was used to determine central symptoms within the network (Boccaletti et al., 2006; Epskamp et al., 2012; Robinaugh et al., 2016). Case-dropping analyses using the bootnet package in R (Epskamp et al., 2018) were conducted to determine how many cases, or participants, could be removed and still maintain a .7 correlation between symptoms' expected influence values in the old and new networks. Edge weights were calculated with 95% confidence intervals using bootnet as well (Epskamp et al., 2018). To determine central symptoms, we conducted bootstrapped tests statistically comparing the expected influence of symptoms within networks (detailed information is included in the Supplemental Material). Central symptoms were identified as those that exhibited a significantly ($p < .05$) higher expected influence than other symptoms based on bootstrapped comparison tests, as well as those that had standardized expected influence value greater than 1.

Networks were then compared across sex and age groups using the Network Comparison Test (NCT) in R (van Borkulo, 2018). Given the lack of sex differences between networks, age group comparisons included participants of all sexes (e.g., intersex). Using 1,000 permutations, the NCT indicated if there were significant differences in the overall edge weights (i.e., partial correlations between nodes) by assessing the maximum difference between respective edge weights in network pairs (*M*). Additionally, the NCT compared network pairs on global strength (i.e., the summed strength of all edges), and respective individual symptoms' expected influence values

Results

Network Interpretation

Figure 1 depicts networks in emerging adulthood, with Figure 2 depicting expected influence values. Detailed results pertaining to the stability of edges in networks as

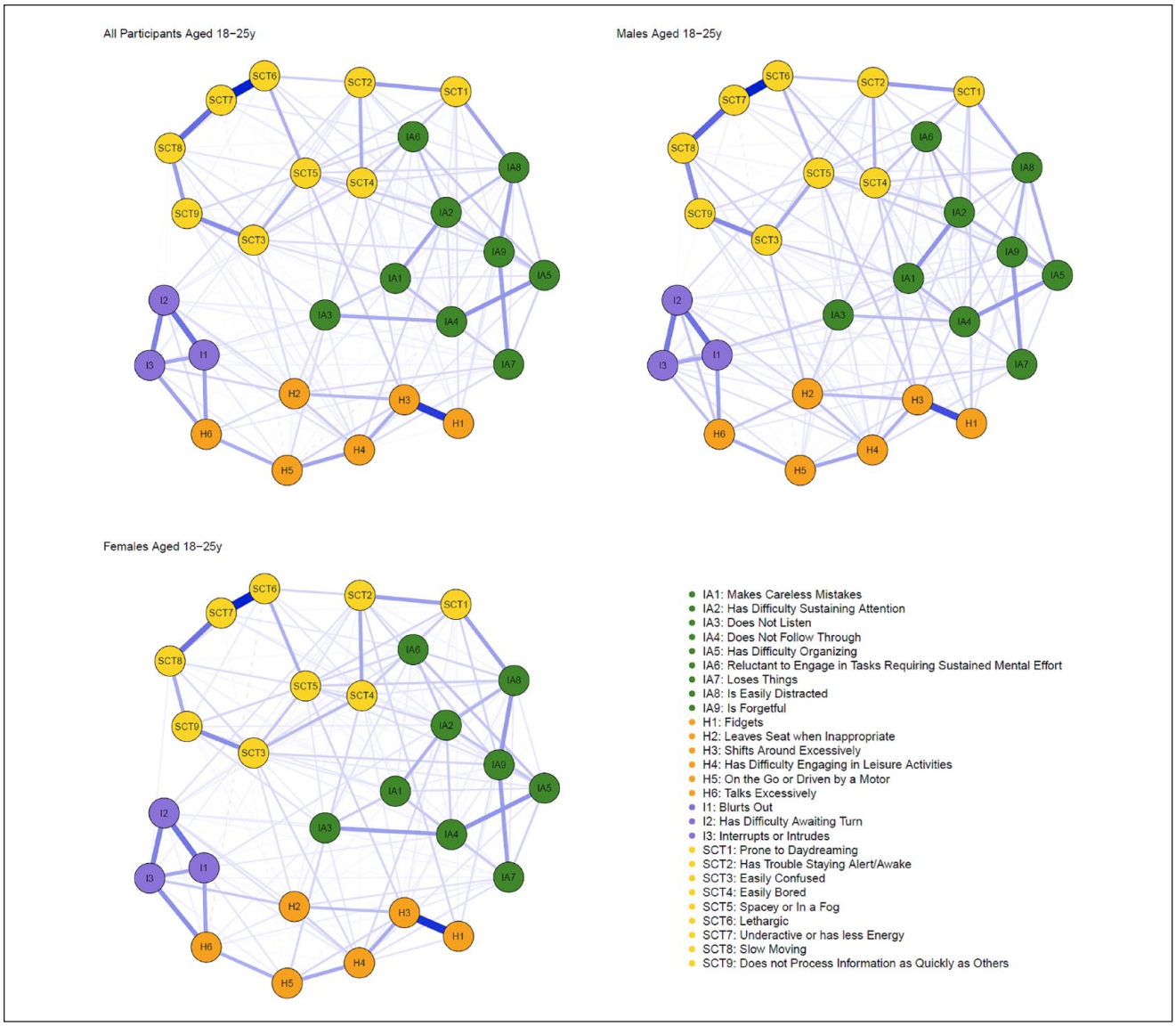

Figure 1. Network of inattention, hyperactivity, impulsivity, and sluggish cognitive tempo symptoms for the emerging adulthood sample.
Note. Symptoms are represented via nodes, with the thickness of the blue (positive relation) and red (negative relation) lines between these nodes representing regularized partial correlations. IA = inattentive; H = hyperactive; I = impulsive; SCT = sluggish cognitive tempo.

well as comparison of symptoms' expected influence are available in the Supplemental Material. Community detection results generally provided support for established inattentive and hyperactive/impulsive ADHD symptom domains, although some ambiguity emerged among hyperactive/impulsive symptoms (i.e., *fidgets* and *has difficulty engaging in leisure activities* appeared to cluster into their own community). Further, two communities emerged within the SCT symptom domain: a "daydreamy or inconsistent alertness" community (made of symptoms *prone to daydreaming, trouble staying alert, easily bored*, as well as the inattentive symptom *is easily distracted*), as well as a "slow/sluggish or sleepy" community (made up of symptoms *easily confused, spacey, lethargic, underactive, slow moving, does not seem to process information as quickly*). Based on case-dropping analyses, expected influence appeared to be stable (*CS*-coefficient = .75). This index suggested *shifts around excessively* (hyperactivity) as the most central symptom, followed by *is easily distracted* (inattention) *easily confused* (SCT), *spacey* (SCT), and *difficulty sustaining attention* (inattention).

In sum, results provided support for groups of robustly related symptoms consistent with inattentive, hyperactive, and impulsive symptom domains, as well as SCT-related slow/sluggish/sleepy and daydreamy domains. Further, *shifts around excessively* emerged as the most central

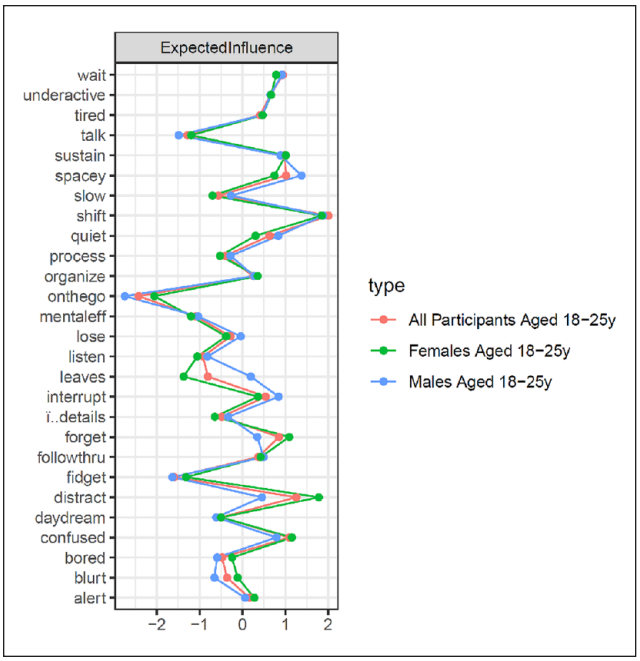

Figure 2. Expected influence *z*-scores for the network of inattention, hyperactivity, impulsivity, and sluggish cognitive tempo symptoms in the emerging adult sample.
Notes. Values farther to the right indicate higher expected influence, thus implying that the respective symptom demonstrated more robust relations, in general, with all other symptoms of ADHD and SCT.

symptom, with symptoms associated with being easily distracted, confused, spacey, and having difficulty sustaining attention also emerging as central.

Network Robustness

Network comparison test for biological sexes in emerging adulthood. As a preliminary analysis, we examined correlations between respective relations among ADHD and SCT symptoms across males and females, and results suggested these correlations were, in general, robustly correlated ($r = 0.67$). Omnibus tests suggested no differences, overall, in network structure ($p = .40$), with follow-up analyses suggesting no differences in individual edges as well ($ps > .05$). No differences in global strength were found between male (global strength = 12.62) and female (global strength = 12.78) networks ($p = .52$). However, the expected influence value of the symptom *leaves seat* was significantly higher ($p = .03$) in males (0.96) than females (0.74). Overall, network structure was generally robust across males and females, although the expected influence of *leaves seat* was significantly higher in males.

Network comparison test comparing emerging adulthood versus adulthood. Detailed results from analyses in the Adulthood sample are available in the Supplemental Material. Preliminary analyses suggested respective relations among symptoms were, in general, robustly correlated ($r = 0.80$) in emerging adulthood and adulthood. Regarding network structure, omnibus NCT tests suggested no significant differences in network structure across age groups ($p = .23$), with follow-up analyses suggesting no differences in any respective individual edges ($ps > .05$). Comparison of networks' global strength suggested no difference ($p = .38$) between emerging adulthood (global strength = 12.93) and adulthood (global strength = 13.36). No differences in expected influence were found for any symptoms between age groups ($ps > .05$). In sum, the results of network comparison tests based on age group suggested general robustness in network structure and global strength.

Discussion

The examination of ADHD symptom structure in emerging adulthood could provide a meaningful step toward understanding how this developmental period functions, particularly in relation to adulthood. In the current study, we sought to address this issue by conceptualizing symptom-level relations during emerging adulthood as well as between sexes. Further, the emerging adulthood network was compared to the adulthood network for robustness. Community detection analyses and symptom-level interpretation suggested that symptoms during emerging adulthood differentiated into distinct "inattention," "hyperactivity," and "impulsivity" clusters, as well as "slow/sluggish or sleepy" and "daydreamy or inconsistent alertness" SCT clusters. Centrality indices suggested *shifts around excessively* (hyperactivity), *is easily distracted* (inattention), *easily confused* (SCT), *spacey* (SCT), *difficulty sustaining attention* (inattention), and *difficulty awaiting one's turn* (impulsivity) as central symptoms. Lastly, no differences in the structure and global strength of networks were identified based on sex or age group, suggesting general robustness in ADHD networks' structure between sexes as well as between early adulthood and adulthood.

Robustness in Network Structure Across Age and Sex

Results suggested robustness with regard to network structure and global strength of associations among symptoms between emerging adulthood and adulthood. This was in contrast to previous work in childhood, which found that the visual structure and centrality of symptoms changed over different periods of childhood (Martel et al., 2016). Such homogeneity, if replicated, may indicate that ADHD in adulthood could be conceptualized as one cohesive age group, rather than splitting into emerging adulthood and adulthood. Further, these results are particularly notable given the lack of research examining sex differences in

psychopathology (Hartung & Lefler, 2019), including ADHD (Williamson & Johnston, 2015).

Additionally, since network analysis is a novel, data-driven statistical technique, there have been critiques regarding the stability of network-related results, with some prior work suggesting inconsistent results across different populations (Forbes et al., 2017, 2021). However, network stability across the two sexes and age groups in the current study appeared to provide preliminary support for the replicability of network analysis results. As the focus of the field turns more toward network dynamics across different samples, our results provide credence for network analytic techniques ability to provide stable and generalizable results.

ADHD and SCT Symptoms Cluster in Symptom Domains Throughout Adulthood

Results of the current study suggested that symptoms of ADHD in emerging adulthood differentiated into inattentive, hyperactive, impulsive, and two SCT clusters. These results corroborated prior work that has suggested that ADHD symptoms during adulthood may be best characterized as belonging to one of three symptom domains (i.e., inattention, hyperactivity, and impulsivity), as opposed to the two domains (i.e., inattention, hyperactivity/impulsivity) that have been found to characterize ADHD symptoms during childhood and adolescence (American Psychiatric Association, 2013; Hardy et al., 2007; Lahey et al., 1994; Span et al., 2002). However, there was overlap among hyperactivity/impulsivity symptoms within the impulsivity cluster, perhaps suggesting that these domains were still differentiating themselves during this developmental stage.

These results also differed from another study that employed a network approach to ADHD symptoms in adulthood, albeit in a college sample rather than the current community sample (Martel et al., 2016). Specifically, this prior work suggested that self-reported ADHD symptoms in a college sample were visually all one cluster of symptoms, without symptom domains. However, community detection techniques were not available at that time to quantitatively delineate possible symptoms clusters and partial correlations were not used for edge weights, both of which may contribute to differences in results. Further, when using collateral report, Martel et al. (2016) found that symptoms visually differentiated into mental effort, disorganization, motor overactivity, and verbal impulsivity clusters, which are generally consistent with ADHD symptom domains. The conflicting results from the current study and Martel et al. (2016) study suggest that self-report and collateral report methods may yield different information regarding the characterization and heterogeneity of ADHD symptoms. Thus, future studies of ADHD in emerging adults should use both self-report and collateral report.

Results also suggested symptoms within the SCT domain as related but distinct from other clusters of ADHD symptoms, providing support for previous studies which have suggested that SCT may present as a distinct entity from ADHD (Becker et al., 2016, 2020; Burns et al., 2017; Fassbender et al., 2015). Further, findings provided support for previously specified "Slow/Sluggish or Sleepy" and "Daydreamy or Inconsistent Alertness" dimensions within the general SCT domain (Becker et al., 2016). Yet, where prior work would reflect relations among these symptoms through underlying latent factors, use of network analysis techniques allowed for an exploration of differential relations among symptoms themselves. Given that SCT has been suggested as an intermediary factor that may at least partially explain the link between ADHD symptoms and internalizing disorders (Kamradt et al., 2018), additional, longitudinal application of the network approach could ultimately help clarify heterogeneity in the onset of SCT symptoms in emerging adults with ADHD. This work may be particularly important for adults, given prior work exploring developmental patterns of ADHD-related symptoms have suggested that inattentive symptoms persist throughout adulthood, while SCT symptoms increase slightly (Leopold et al., 2016; Olson, 2002). Future conceptualizations of adult ADHD may be both more comprehensive and more accurate by including the two dimensions of SCT.

Central Symptoms

Assessment of centrality suggested symptoms from multiple domains as highly influential in characterizing the ADHD network across adulthood. In particular, symptoms associated with *shifts around excessively* (hyperactivity), *easily distracted* (inattention), *easily confused* (SCT), *spacey* (SCT), *difficulty sustaining attention* (inattention), and *difficulty awaiting one's turn* (impulsivity) emerged as strongly related to other symptoms in the network. *Difficulty sustaining attention* was also identified as a key symptom in previous work looking at ADHD symptom structure from childhood to adulthood (Martel et al., 2016). Thus, these symptoms may present as key points of focus for assessment and intervention sequencing aimed at emerging adults with ADHD. Previous studies have posited that the prominence of inattentive symptoms may remain stable, while hyperactivity symptoms decrease and symptoms of SCT increase (Leopold et al., 2016; Martel et al., 2012; Olson, 2002). However, prior work in this area has typically employed latent variable models or symptom count scores that may have conflated the influence of specific symptoms within different domains for characterizing ADHD phenotypes. Therefore, although previous studies have suggested that the hyperactivity symptom domain overall may decrease in relevance with age, it is possible that the specific symptom of difficulty sitting still may play a large role

in characterizing emerging adult ADHD phenotypes. Hence, difficulties sustaining attention, along with a tendency to become confused and difficulties sitting still, may serve a preliminary set of key impairments with which to focus an assessment of ADHD during emerging adulthood. For example, in settings where brevity is key, such as primary care, these key symptoms may be used as a screening tool. Further, accommodations or behavioral goals may target specific symptoms, such as difficulties sitting still, rather than broad symptom domains, such as hyperactivity.

Limitations and Future Directions

The current study is not without limitations. Racial and ethnic data was not collected for this sample, so possible differences among racial and ethnic groups are unknown. Additionally, our sample of older adults (65+ years) was underpowered for analysis. Recent work has questioned if centrality measures are appropriate for interpreting psychological networks (Bringmann et al., 2019). Though we found similar central symptoms across samples, it is important to interpret our results in tandem with other measures, such as edge weights, community detection, and the Network Comparison Test. Further, though network analysis focuses on item-level relations, the NCT compares global metrics of two networks. In the future, tools may become available to allow more item-level comparisons between networks.

A recent article examined the overlap between latent variable modeling and network analysis, questioning if network analysis techniques were necessary beyond latent variable modeling (Preszler & Burns, 2019). Due to the replication crisis widespread throughout psychology, we find consistent results between the two methods to be meaningful for continued support about the structure of ADHD symptoms across adulthood. Stability of results across different samples and age ranges further bolsters the argument for replicability.

Lastly, though there were no sex or age differences in network structure of ADHD symptoms, these results do not extend to endorsement levels of symptoms. Previous work has found differing levels of symptom endorsement based on age and sex (Barkley et al., 2011; Fedele et al., 2012; Jaconis et al., 2016). Thus, differences in levels of symptom endorsement may still exist, even though we did not find structural differences based on sex and age. Future work could investigate possible age and sex differences in symptom endorsement as well as establish normative data based on those differences, if necessary.

Conclusion

Adult ADHD symptoms have gained validity in recent years, but detailed examination of symptom structure throughout emerging adulthood has remained scarce. This developmental period is particularly important as it represents major life changes that occur between adolescence and adulthood with a focus on increased independence and executive functioning. The current study focused on the structure of inattentive, hyperactive, impulsive, and SCT symptoms during emerging adulthood between sexes as well as comparing the network to an adult network. We found that there were no differences in networks' edge weights or connectivity based on sex or age, suggesting stability of symptom structure across differing samples. Moreover, emerging adults' self-reported ADHD symptom structure was visually and statistically delineated by symptom domain, with central symptoms representing each domain. Future work may explore the clinical implications of our results by targeting central symptoms for interventions that could be used in adults regardless of sex or age.

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Supplemental Material

Supplemental material for this article is available online.

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