

Adolescent Paranoia: Prevalence, Structure, and Causal Mechanisms

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Background: Adolescence can be a challenging time, characterized by self-consciousness, heightened regard for peer acceptance, and fear of rejection. Interpersonal concerns are amplified by unpredictable social interactions, both online and offline. This developmental and social context is potentially conducive to the emergence of paranoia. However, research on paranoia during adolescence is scarce. **Method:** Our aim was to examine the prevalence, structure, and probabilistic causal mechanisms of adolescent paranoia. A representative school cohort of 801 adolescents (11–15 y) completed measures of paranoia and a range of affective, cognitive, and social factors. A Bayesian approach with Directed Acyclic Graphs (DAGs) was used to assess the causal interactions with paranoia. **Results:** Paranoid thoughts were very common, followed a continuous distribution, and were hierarchically structured. There was an overall paranoia factor, with sub-factors of social fears, physical threat fears, and conspiracy concerns. With all other variables controlled, DAG analysis identified paranoia had dependent relationships with negative affect, peer difficulties, bullying, and cognitive-affective responses to social media. The causal directions could not be fully determined, but it was more likely that negative affect contributed to paranoia and paranoia impacted peer relationships. Problematic social media use did not causally influence paranoia. **Conclusions:** There is a continuum of paranoia in adolescence and occasional suspicions are common at this age. Anxiety and depression are closely connected with paranoia and may causally contribute to its development. Paranoia may negatively impact adolescent peer relationships. The clinical significance of paranoia in adolescents accessing mental health services must now be established.

Key words: directed acyclic graphs/persecutory ideation/psychosis/affective symptoms/youth mental health

Introduction

There is no age of greater feelings of social vulnerability than adolescence. Friendships are often transient, bullying is all-too-common, and online social media provides a source of social comparison, ambiguous interactions with others, and opportunity for criticism.^{1,2} During this period of developmental change adolescents become more attuned to the intentions of others, aware of how others perceive them, and hypersensitive to potential rejection.³ Peer relationships seem unpredictable and avoiding social rejection becomes a primary motivator of behavior.⁴ The social world may feel increasingly uncertain and to some adolescents potentially hostile. In this context, judgments about the intentions of other people may become skewed towards the negative. Paranoid thoughts that others are deliberately trying to harm you may follow.⁵

We set out to examine the prevalence, structure, and causal mechanisms of paranoia at this key developmental stage. A small number of previous studies indicate paranoid thoughts are common and continuously distributed in adolescents, with approximately a quarter reporting frequent suspicions.^{6,7} As shown in adults a hierarchy of paranoia is likely to occur where severe ideas of threat build upon common social concerns.^{8,9} Yet little is known about the content of paranoid thoughts during adolescence. Even less is known about causal factors. Contributory causal mechanisms identified in a theoretical model of paranoia in adults include negative affect, worry, negative self-beliefs, sleep dysfunction, and safety-seeking behaviors.⁵ Negative social experiences further influence the likelihood that persecutory ideas will take hold.¹⁰ These suspicions will likely reflect the social context of adolescence, which for many young people occurs online to variable degrees. Preliminary research suggests addictive internet use^{11,12} and emotional reactivity to social media is associated with higher paranoia in young people.¹³ Engaging with social information online in ways

that increase feelings of vulnerability or preoccupation with threat could influence emerging paranoia. The interaction between paranoia, psychological processes, and social factors during adolescence will likely be complex.

In this study, we use an advanced network approach for causal discovery: Directed Acyclic Graphs (DAGs). A DAG is the underlying structure of a Bayesian network, a graph encoding conditional dependence relationships between variables.¹⁴ We use DAGs to assess the probabilistic causal interactions between adolescent paranoia and theoretically important factors identified from a cognitive model⁵ and the existing literature. We examine negative affect,¹⁵ body image concerns,¹⁶ and sleep dysfunction,¹⁷ as well as 2 potentially important social factors at this age: bullying¹⁸ and social media use.¹³ Both problematic social media use (addictive use and excessive use at night) and cognitive-affective responses to social media (emotional reactivity, self-comparison, and threat-focused safety-seeking behaviors) were assessed. This approach does not hypothesize or test a specific causal structure. Instead, we use Bayesian inference to learn the most likely causal relationships within our data which we represent with a DAG.

Method

Participants

Using opt-out parental consent, every pupil ($N = 947$) in school years 7–10 from a secondary school in Leicestershire, United Kingdom was invited to take part. This provided a representative cross-sectional school cohort of adolescents aged 11–15 years. All classes were approached over 1 week, and pupils providing written assent completed questionnaires within a 60-minute lesson led by J.C.B. or a teacher. A total of 801 adolescents participated, representing 85% of students enrolled at the school (mean age = 13.3 y, $SD = 1.16$). Participants included 410 girls (51%), 382 boys (48%), and 9 “other gender” (1.1%). Most participants were White British (78.5%) and the second largest ethnicity was South Asian (6.9%). Ethical approval was obtained from the University of Oxford Medical Sciences Interdivisional Research Ethics Committee (R50453/RE001).

Measures

To assess paranoia, a new measure was designed and validated in the current sample; the Bird Checklist of Adolescent Paranoia (B-CAP). Eighteen items were generated to represent a spectrum of severity of paranoia with content relevant to adolescents (eg, friends, school, and social media). Participants rate the frequency of thoughts over the past fortnight on a 6-point scale. The total score demonstrated excellent internal consistency (Cronbach’s $\alpha = .92$) and convergent validity with the paranoia subscale of the Specific Psychotic

Experiences Questionnaire⁶ ($r = .84$, $P < .001$) and the Social Mistrust Scale¹⁹ ($r = .68$, $P < .001$). Participants rated a Visual Analogue Scale (VAS) concerning whether they were “more fearful of others than I should be” from 0 (“No more than I should”) to 100 (“Much more than I should”). This VAS was significantly correlated with B-CAP paranoia ($r = .41$, $P < .001$).

The Revised Anxiety and Depression Scale (RCADS)–Short²⁰ measured negative affect. RCADS T -scores, standardized by age and gender, of 70+ indicate clinical levels of anxiety and depression. The Body Esteem Scale for Adolescents and Adults²¹ measured body image concerns. The Adolescent Sleep Wake Scale–Short²² measured sleep difficulties and the Insomnia Severity Index (ISI)²³ measured insomnia; an ISI score above 9 defined a clinical insomnia subgroup.²⁴ The peer problems subscale of the Strengths and Difficulties Questionnaire²⁵ measured peer difficulties and the Multidimensional Peer Victimization Scale (MPVS)²⁶ assessed bullying.

The Bergen Social Media Addiction Scale²⁷ assessed addictive social media use. Four novel social media measures were created and validated for this study ([supplementary material 1](#)). Social media use at night was assessed using 6 items relating to frequency (eg, “How long do you usually spend on social media when you are in bed before sleeping?”) and impact (eg, “It is hard to stop using social media when I need to sleep”). To assess emotional reactivity to social media, participants rated the frequency of 7 negative emotions (eg, “scared,” “sad”) while using social media. Ten items assessed online safety-seeking behaviors—ie, actions to avoid threat while using social media (eg, “be careful what I post so it can’t be used against me”). Seven items assessed how often participants compared themselves negatively to others on social media (eg, “I’m not as attractive as other people I see on social media”).

Statistical Analysis

Analyses were conducted using R, version 3.4.1.²⁸ Weekly item endorsement was used to examine paranoia prevalence. The frequency distribution of total items endorsed was examined against an exponential model. We assessed the hierarchical structure of items using the correlation between endorsement rates for each item and number of additional items endorsed, corrected for the contribution of that item.²⁹

To assess the factor structure of paranoia items Exploratory Factor Analysis (EFA) was conducted using principal axis factoring (due to the lack of multivariate normality³⁰) and Confirmatory Factor Analysis (CFA) using the MLR robust maximum likelihood estimator.³¹ Model fit was assessed using a relative/normed chi-square test (χ^2/df) of < 3.0 ,³² a Comparative Fit Index (CFI) and Tucker–Lewis Index (TLI) of > 0.95 , a Root Mean Square Error of Approximation (RMSEA) of $<$

0.06, and a Standardized Root Mean Square Residual (SRMR) of < 0.08 .³³

For DAGs analysis participants who did not finish the questionnaires, or had 1 or more entirely missing questionnaires, were excluded ($n = 59$). With a missing at random³⁴ assumption for remaining participants, multiple imputation was conducted for each questionnaire using the mice package.³⁵ Five imputed datasets were created. The analysis was conducted using the total scores for every variable within each of these 5 datasets and the results combined.

To examine the causal interactions with paranoia, we use a Bayesian method of causal discovery with DAGs. A DAG is a probabilistic graphical model representing conditional dependence relationships between sets of variables. Each variable is represented by a node, and pairs of nodes may be joined by a directed edge (\rightarrow). A directed cycle, that is, a circular sequence of edges leading from a node back to itself, is not allowed. If there is an edge from $A \rightarrow B$, we say A is a parent of B ; this implies that after controlling for other parents, B remains dependent on A . If the graph is causally interpreted then A is a direct cause of B .¹⁴ Conversely, the absence of an edge represents independence once earlier variables in the network are considered. Using Bayesian inference, it is possible to discover the most likely causal structure between variables from patterns observed in a given dataset. However, as distinct causal models can lead to the same patterns, it is not possible to learn all the causal links from observational data (see [supplementary material 2](#) for details).

To determine which causal DAG structures were compatible with our data, we use Bayesian analysis to obtain a posterior probability distribution over the set of possible graphs. Following the method of Moffa et al,¹⁰ we use the Partition Markov Chain Monte Carlo (MCMC) algorithm³⁶ to sample from this distribution in proportion to the probability for each possible graph. In other words, graphs with a better fit to the data (after accounting for model complexity) were selected most often. For a fair comparison between graphs with different structures, graphs were fitted using a multivariate normal distribution with an inverse Wishart prior distribution on the covariance matrix.³⁷ All variables were matched to the quantiles of a normal distribution. On this transformed dataset, we used the BiDAG package³⁸ to run partition MCMC for 10 million iterations on the 5 imputed datasets, thinned by a factor of 1000 to obtain 50 000 sample DAGs from the posterior distribution. We averaged over this sample to estimate the posterior probability of each edge in the network.

For each sampled graph, we also drew a sample from the posterior distribution of the covariance matrix. These were used, in conjunction with the graphs, to estimate the total causal effect of each variable on every other variable ([supplementary material 2](#)). The total effects comprise

both direct effects (with other variables constrained) and indirect paths via other variables. Causal effects are expressed as z -scores with 90% credible intervals (CIs). For a significant causal effect to occur, a causal pathway must be present in one direction in at least 95% of non-zero sampled effects.

Results

Prevalence

Paranoid thoughts were commonly endorsed by adolescents, with weekly occurrence by item ranging from 7% to 32% ([table 1](#)). The mean number of paranoid thoughts endorsed was 3.26 (SD = 4.07). The total items endorsed followed a single, continuous distribution that closely fitted an exponential curve ($r = .97$; [figure 1](#)). The mean score for all 18 paranoia items was 12.5 (SD = 14.0). Girls reported significantly higher paranoia (mean = 15.8, SD = 15.0) than boys (mean = 8.25, SD = 10.9; $F(2,790) = 49.7$, $P < .001$). Paranoia was similar across age year groups with no interaction between age and gender ($F(5,790) = 1.07$, $P = .38$).

Sleep problems were notably prevalent with 42% ($n = 334$) in the clinical range for insomnia. Average levels of anxiety and depression were consistent with normative data,²⁰ although 11% ($n = 91$) scored above the RCADS clinical threshold. Adolescents in this clinically elevated subgroup (mean age = 13.5, SD = 1.05) were predominantly female ($n = 65$, 71%) and had substantially higher paranoia scores (mean = 31.2, SD = 18.7). Of those who responded ($n = 779$), 95% of participants ($n = 736$) reported using social media, with 81% ($n = 629$) using it every day. Of those who used social media, 41% used it for more than 4 hours per day (see [supplementary material 1](#) for descriptive statistics).

Structure

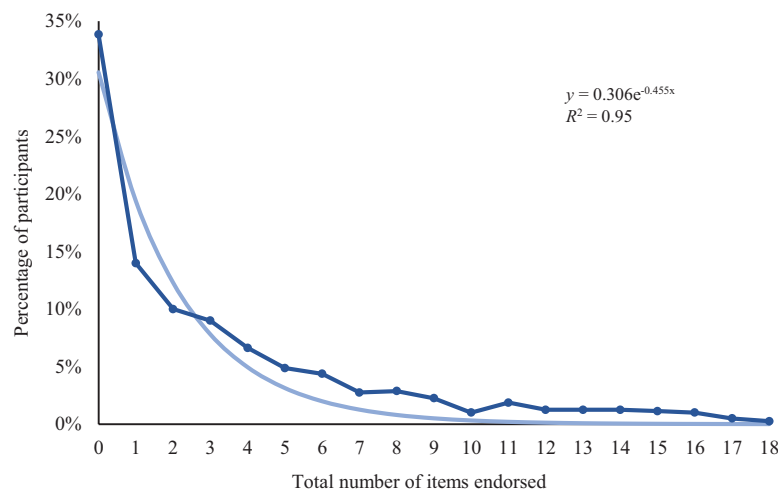
Individual paranoia items were associated with endorsing 3.72–7.65 additional paranoia items (mean = 5.66, SD = 0.91). For each item, endorsement frequency was significantly correlated with the number of additional items endorsed ($r = -.75$, $P < .001$). In other words, those who endorsed rarer items reported more paranoid thoughts in total.

EFA identified a 3-factor structure of paranoia items explaining 51% of the variance. These factors were labeled social harm (8 items), conspiracy (5 items), and physical threat (5 items). Factor correlations were high (social harm and conspiracy $r = .80$; social harm and physical threat $r = .66$; conspiracy and physical threat $r = .72$). A 3-factor CFA model demonstrated excellent model fit with no modifications ($\chi^2 = 279.9$, $df = 132$, $P < .001$, $\chi^2/df = 2.12$, CFI = 0.96, TLI = 0.95, RMSEA = 0.053, SRMR = 0.045) ([supplementary material 1](#)). As shown in [figure 2](#), a hierarchical factor model with identical fit

Table 1. Percentage Endorsement of Individual Paranoia Items in Last 2 Weeks

Item	0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	At least Weekly (2+) (%)
Social harm							
1 I'm sure people are gossiping about me on social media	64	15	12	5	2	2	21
2 People at school are trying to make me feel unwanted	57	17	12	6	4	3	25
3 I am being pushed out of conversations on purpose	57	20	12	5	3	2	22
4 People are trying to embarrass me in class on purpose	57	22	11	5	2	2	20
5 My friends or partner are ignoring my messages to upset me	74	14	5	3	1	1	10
6 People are making sly comments to upset me	65	19	8	5	1	2	16
7 I think people are lying to me on purpose	46	24	15	7	4	4	30
8 People say things under their breath to wind me up	55	20	12	7	2	3	24
Conspiracy							
9 Nasty tricks are being played on me	79	13	6	1	0	1	8
10 People are trying to confuse me on purpose	66	18	9	4	2	2	17
11 Groups of people are planning against me	81	10	4	2	1	3	10
12 People are collecting my information or photos to use against me	83	10	4	1	1	1	7
13 I'm sure people are seeking revenge on me	75	14	5	2	1	3	11
Physical threat							
14 I feel like I am being followed or stalked	75	13	7	3	1	1	12
15 I am scared of what strangers will do to me	44	23	13	8	4	7	32
16 People will try to kidnap me	74	11	7	4	1	2	14
17 I could be attacked at any time	57	20	9	6	2	6	23
18 I feel unsafe around people everywhere I go	68	13	8	4	3	3	19

Note: 0 = never; 1 = once; 2 = couple of times; 3 = few times a week; 4 = everyday; 5 = all the time. At least weekly endorsement is a score of 2 ("couple of times") or above.

**Fig. 1.** Distribution of total paranoia items endorsed in adolescents fitted against an exponential curve.

indices included a general paranoia factor that strongly predicted the 3 subordinate factors (0.77–0.93).

Causal Mechanisms

Figure 3 shows the average of the 50000 sampled DAGs. The edge color intensity represents the proportion of sampled graphs in which that edge was present. For clarity, only edges present in over 50% of graphs are displayed. Directed edges (→) represent significant direct causal effects where that orientation occurred in over 90% of cases in which

an edge was present. Undirected edges depict relationships where this threshold for a consistent causal direction was not met. In these cases, an edge between 2 variables occurred frequently, indicating high certainty that there is a direct causal dependence between them, but that either direction could be plausible from the data.

All affective, cognitive, and social variables were significantly correlated with paranoia (supplementary material 1). However, the DAG analysis identified a complex network of interactions. Once the contribution of other variables was controlled, there was high certainty paranoia

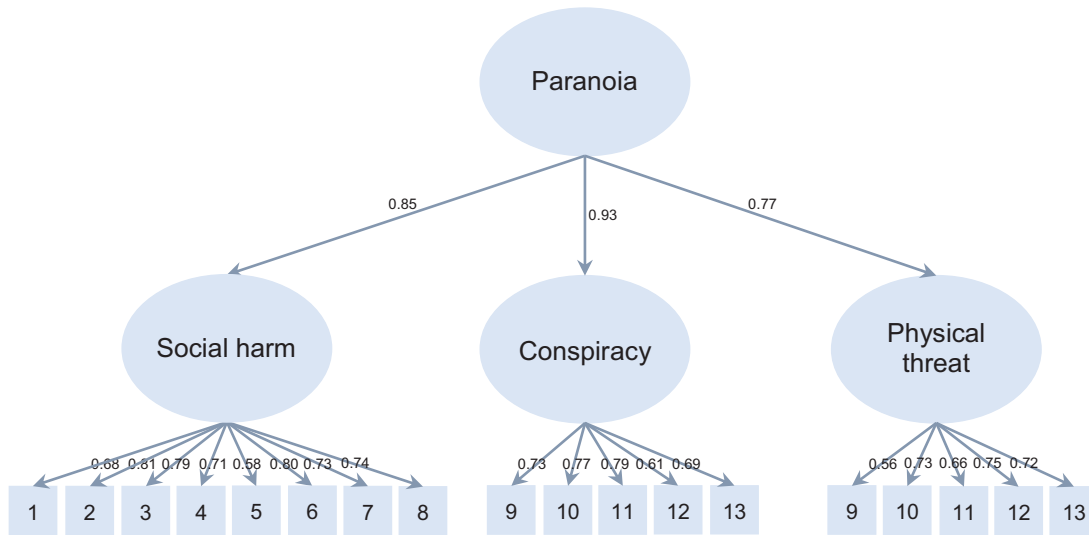


Fig. 2. Second-order 3-factor model of paranoia items.

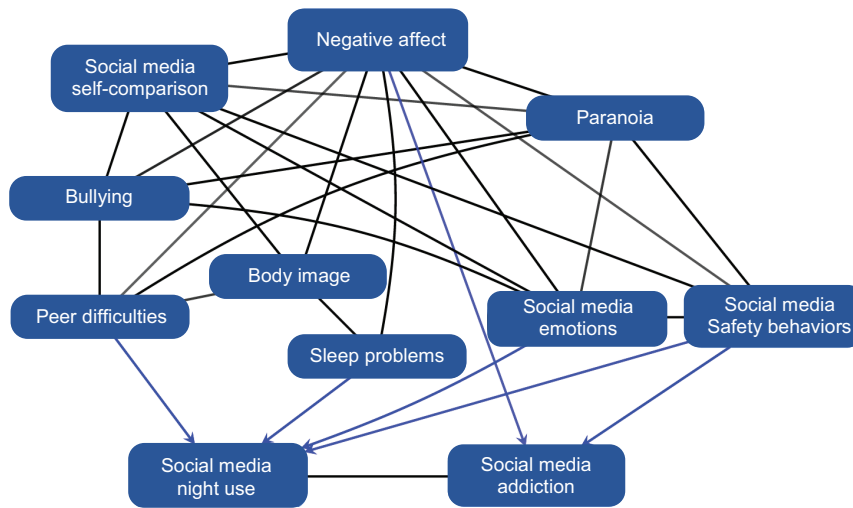


Fig. 3. Directed Acyclic Graph (DAG) of relationships between paranoia and emotional, cognitive, and social variables. Directed edges (→) indicate significant causal effect.

had direct causal relationships with negative affect, peer difficulties, bullying, social media safety-seeking behaviors, negative comparison on social media, and emotional reactivity to social media (figure 3). However, the direction of these relationships was not well identified, as represented by the undirected edges. The proportion of sampled DAGs containing a causal pathway from each variable to paranoia and vice versa, with the average total causal effects (z_i), is shown in table 2. The proportion of cases where the observed effect is direct (as opposed to indirect through other variables), and the size of the direct effect (z_d), is shown for each orientation.

A direct effect between paranoia and negative affect was present in all samples, indicating a causal relationship was highly likely. Although the direction was uncertain,

a pathway from negative affect → paranoia occurred in 70% of graphs, suggesting a likely causal contribution of negative affect. However, the reverse direction was also plausible with this orientation occurring in the remaining 30% of graphs. Regardless of direction, the size of the causal effects for negative affect were the largest of all the variables in the network.

Body image concerns and sleep difficulties were conditionally independent of paranoia, represented by the lack of an edge in figure 2. Although pathways were often identified between paranoia and both body image and sleep difficulties, direct causal effects were small and infrequent (table 2). A zero causal effect was observed between paranoia and body image and sleep difficulties in 9% and 30% of graphs respectively, highlighting greater uncertainty in

Table 2. Average Causal Effects Between Paranoia and all Other Variables

Causal Effects	Pathway Present	Total z	90% CI	Direct Present	Direct z	90% CI
Variable to paranoia						
Negative affect	70%	0.57	0.39–0.72	100%	0.43	0.32–0.63
Body image	46%	–0.21	–0.49 to –0.01	44%	–0.05	–0.15–0.00
Sleep	23%	0.19	0.00–0.46	38%	0.03	0.00–0.10
Peer difficulties	18%	0.21	0.07–0.49	99%	0.15	0.06–0.44
Bullying	46%	0.40	0.22–0.68	100%	0.29	0.20–0.57
SM night use	1%	0.03	–0.01–0.10	3%	0.00	0.00–0.00
SM addiction	1%	0.07	0.00–0.41	54%	0.03	0.00–0.09
SM safety behaviors	40%	0.39	0.19–0.67	100%	0.26	0.16–0.44
SM self-comparison	62%	0.38	0.10–0.67	73%	0.16	0.00–0.40
SM emotion reactivity	47%	0.27	0.06–0.64	80%	0.15	0.00–0.38
Paranoia to variable						
Negative affect	30%	0.59	0.41–0.76	100%	0.48	0.36–0.72
Body image	45%	–0.26	–0.51 to –0.02	24%	–0.04	–0.23–0.00
Sleep	47%	0.25	0.00–0.48	21%	0.02	0.00–0.13
Peer difficulties	82%	0.28	0.15–0.44	99%	0.22	0.12–0.32
Bullying	54%	0.42	0.28–0.64	100%	0.35	0.25–0.54
SM night use	94%	0.10	–0.04–0.38	1%	0.00	0.00–0.00
SM addiction	92%	0.14	–0.02–0.43	14%	0.01	0.00–0.11
SM safety behaviors	60%	0.37	0.19–0.63	100%	0.26	0.17–0.41
SM self-comparison	37%	0.36	0.07–0.61	72%	0.17	0.00–0.45
SM emotion reactivity	51%	0.30	0.06–0.59	79%	0.16	0.00–0.37

Note: “Pathway present” = the proportion of DAGs sampled where that pathway occurred; “Total z ” = average total causal effect when that pathway was present; “Direct present” = when that pathway occurred, the proportion of cases where the effect was direct; “Direct z ” = the average size of the direct effect; CI = credible interval. SM = social media.

their direct relationship. Notably, young people scoring above the cutoff for insomnia ($n = 334$) had significantly higher paranoia (mean = 18.4, SD = 16.6) compared to the rest of the sample (mean = 7.24, SD = 8.36; $t(442.2) = 11.0$, $P < .001$). Although this highlights the clear relationship between sleep problems and paranoia ($r = .45$, $P < .001$), their independence in the DAGs indicates the association was sufficiently explained by other variables, most notably negative affect (figure 3).

Paranoia and peer difficulties were dependent on each other in 100% of cases and a direct effect was nearly always present (99%). The direction was not certain; however, paranoia was more likely to contribute to peer difficulties with this orientation occurring in 82% of sampled DAGs. Although a direct relationship between paranoia and bullying was always present, the direction was very uncertain: a pathway from paranoia → bullying occurred in 54% of graphs and the reverse direction occurred in the other 46%.

Despite moderate correlations with social media addiction ($r = .42$, $P < .001$) and night use ($r = .34$, $P < .01$), causal pathways from these measures to paranoia occurred in only 1% of sampled DAGs with negligible total causal effects ($z_t < 0.1$). This suggests high certainty that problematic social media use did not have a causal effect on paranoia. Although a causal pathway in the reverse direction occurred in 92% and 94% of samples for social media addiction and night use, these were primarily indirect with negligible direct effects ($z_d < 0.01$). Notably,

these social media use variables were significantly caused by several factors, including negative affect, peer difficulties, sleep problems, social media emotional reactivity, and social media safety-seeking behaviors, represented by the directed edges in figure 2.

The DAGs analysis identified dependant relationships between paranoia and cognitive-affective responses to social media, although the directions were uncertain. The strongest effect was for threat-focused safety-seeking behaviors where both an edge and a direct causal effect were always present. Paranoia contributed to online safety-seeking behaviors (60%) more often than the reverse orientation (40%). In almost all cases there was a pathway in either direction between paranoia and both negative self-comparison (99%) and emotion reactivity to social media (98%). However, there was a larger indirect contribution to these relationships with less certainty in the direct effects, represented by the CIs including zero and an increased proportion of cases where the causal effect was indirect.

Discussion

Prevalence and Structure

Our findings are consistent with the view that adolescence can be a socially challenging time, highlighting mistrust of others may be part-and-parcel of daily life for a significant minority of adolescents. Many paranoid thoughts were occurring at least weekly for 20%–30% of the

adolescents. Thoughts of physical threat were common—almost a fifth felt unsafe everywhere around people and a third feared what strangers would do to them. There were also concerns about peers deliberately excluding them, making sly comments to wind them up, and lying to them on purpose. Conspiracy concerns were less frequent, with 10% thinking groups of people were plotting against them. Rarer paranoid ideas occurred alongside more common items, replicating a hierarchical structure of paranoia seen in adults whereby extreme fears about others build upon normal social concerns.^{8,9} Girls reported significantly higher levels of paranoia than boys in this sample; this gender difference is consistent with evidence that adolescent girls can be less trusting,³⁹ more sensitive to potential social exclusion,⁴⁰ and more socially anxious than boys.⁴¹ Like experiences such as anxiety and depression, the overall incidence of paranoia followed a single, continuous distribution. Clinical paranoia would likely represent a quantitative shift along this continuum, characterized by more frequent and persistent suspicions that impair functioning. Such paranoid thoughts in adolescents are likely antecedents of persecutory delusions.⁵

Causal Mechanisms

We used an innovative Bayesian approach using DAGs to examine the causal mechanisms of paranoia during adolescence. In our analysis, we found likely direct causal relationships between paranoia and negative affect, peer difficulties, bullying, and cognitive-affective responses to social media. While the direction of these effects was uncertain, examining the probability of each direction within our data allowed a tentative understanding of causal patterns.

There was a robust interaction between negative affect and paranoia in adolescents. Affective symptoms had the strongest relationship with paranoia and showed high certainty for a direct causal effect. Although both directions were plausible, negative affect was more likely to causally contribute to paranoia than vice versa. The uncertainty in the direction may be expected given evidence of a reciprocal interaction between negative affect and paranoia over time.⁴² Yet the likely causal contribution of negative affect is consistent with evidence from adults^{15,43} and previous findings that anxiety, worry, and depression predict paranoia persistence in a clinical sample of adolescents.¹³ This suggests affective processes may be particularly promising intervention targets for adolescent paranoia.

Paranoia was highly correlated with both body image concerns and sleep problems, but they were conditionally independent once other variables were controlled. Examination of the total causal effects (including both direct and indirect pathways) showed paranoia and body image concerns likely causally influenced each other, but mostly indirectly through other variables such as negative

affect and negative self-comparison on social media. Similarly, a causal pathway between paranoia and sleep difficulties was probable, but this occurred primarily via a shared contribution of negative affect. This is in line with experimental evidence that the impact of impaired sleep on paranoia is almost fully mediated by negative affect.⁴⁴ Treating disrupted sleep is a method of reducing paranoia,¹⁷ which may largely be explained via the mechanism of improving mood.

There was a direct interaction between paranoia and certain social factors in the adolescents. Although paranoia had a strong direct relationship with bullying, either causal direction was equally plausible. This is consistent with the DAGs analysis of Moffa et al¹⁰ which could not determine directionality without the prior assumption that bullying was antecedent to paranoia. Our findings suggest this assumption may not hold for cross-sectional associations. Rather than a direct causal relationship, a shared genetic propensity that increases an individual's vulnerability to both being victimized and endorsing unfounded paranoid ideas may be partly responsible for the association.¹⁸ Another possibility is due to biased perceptions of threat, people experiencing paranoia may be more likely to incorrectly perceive hostility.⁴⁵ Our model found a stronger probability that paranoia causally contributed to peer difficulties than the other way around, with this direction occurring 82% of the time. As a sensitive period for social development,³ the likely impact on peer relationships suggests recognizing and treating paranoia may be especially important during adolescence.

Social media was a frequent part of daily life for most of the adolescents. Although problematic social media use was moderately associated with paranoia, it did not causally contribute to paranoia or any other variable. Multiple intermediate variables accounted for the correlations between paranoia and social media addiction and excessive night use. Contrary to concerns of a detrimental causal role of social media on mental health,^{46,47} problematic social media use was instead a consequence of existing psychological and social difficulties. However, our findings did suggest how young people respond to social content online may be important. Paranoia interacted with social media emotional reactivity, negative comparisons to others, and online safety-seeking behaviors. This is consistent with causal mechanisms highlighted in a cognitive model of paranoia,⁵ and longitudinal evidence that emotional reactivity to social media maintains paranoia in adolescents.¹³ A reciprocal causal relationship is likely, whereby paranoid fears activate these threat-focused cognitive processes that in turn bias threatening appraisals of social content, both online and offline, and maintain ongoing mistrust.⁵

As a time of heightened social processing and hypersensitivity to peer rejection,^{3,48} adolescence may provide the psychological conditions upon which paranoia may

flourish. Yet the clinical significance of paranoia at this age is currently unclear. The prevalence of paranoid thoughts in this school cohort and close interaction with affective symptoms suggests paranoia will likely occur alongside common mental health problems in youth. Research assessing the clinical presentation of paranoia in adolescents accessing mental health services is now needed.

Limitations

There are clear limitations to our study. The use of a single school may limit the generalizability of our findings, and it is possible young people's responses were influenced by the presence of their peers. A potential concern with self-report paranoia questionnaires is whether they measure unfounded suspicions as opposed to genuine instances of hostility. Although a degree of measurement error is likely, experimental studies in adults show self-report measures are associated with unfounded paranoia in controlled virtual reality scenarios.⁴⁹ Furthermore, our measure was associated with participants' ratings that their fears of others are excessive.

Bayesian methods using DAGs are a significant progression upon commonly used statistical techniques for observational data. Within a network of variables, DAGs can obtain robust information about which variables are independent and which are causally related, with details of both the strength and likely direction of effects. Bayesian methods also improve the reliability of the identified network by quantifying the uncertainty in both the model selection procedure and estimation of parameters. As such, replication of the analysis in a similar dataset is likely to give consistent results. However, we must be cautious in drawing causal inferences from cross-sectional data. Indeed, causality using DAGs can only be inferred under strict assumptions. This includes an assumption of causal sufficiency where the variables measured are sufficient to control for confounding relationships. We must also assume faithfulness: that is, a complicated causal mechanism does not lead to an observationally simpler model "by chance."¹⁴ A limitation of DAGs is they are unable to model the reciprocal relationships likely to occur within psychological and social constructs. The assumption within a DAG of "one true" causal direction may therefore obscure the complexity of these relationships. Dynamic network approaches with longitudinal data may be needed to decode reciprocal relationships that occur over time.⁴² Despite these limitations, DAGs provide novel opportunities to generate robust causal hypotheses from observational data and identify testable intervention targets to reduce paranoia in adolescents.

Supplementary Material

Supplementary material is available at <https://academic.oup.com/schizophreniabulletin/>.

Funding

This study was funded by a National Institute of Health Research (NIHR) Research Professorship to D.F. (NIHR-RP-2014-05-003).

Acknowledgment

The authors have declared that there are no conflicts of interest in relation to the subject of this study.

References

1. Best P, Manktelow R, Taylor B. Online communication, social media and adolescent wellbeing: a systematic narrative review. *Child Youth Serv Rev*. 2014;41:27–36.
2. Singleton A, Abeles P, Smith IC. Online social networking and psychological experiences: the perceptions of young people with mental health difficulties. *Comput Human Behav*. 2016;61:394–403.
3. Blakemore SJ, Mills KL. Is adolescence a sensitive period for sociocultural processing? *Annu Rev Psychol*. 2014;65:187–207.
4. Blakemore S. Avoiding social risk in adolescence. *Curr Dir Psychol Sci*. 2018;27:116–122.
5. Freeman D. Persecutory delusions: a cognitive perspective on understanding and treatment. *Lancet Psychiatry*. 2016;3:685–692.
6. Ronald A, Sieradzka D, Cardno AG, Haworth CM, McGuire P, Freeman D. Characterization of psychotic experiences in adolescence using the specific psychotic experiences questionnaire: findings from a study of 5000 16-year-old twins. *Schizophr Bull*. 2014;40:868–877.
7. Wigman JT, Vollebergh WA, Raaijmakers QA, et al. The structure of the extended psychosis phenotype in early adolescence—a cross-sample replication. *Schizophr Bull*. 2011;37:850–860.
8. Bebbington PE, McBride O, Steel C, et al. The structure of paranoia in the general population. *Br J Psychiatry*. 2013;202:419–427.
9. Freeman D, Garety PA, Bebbington PE, et al. Psychological investigation of the structure of paranoia in a non-clinical population. *Br J Psychiatry*. 2005;186:427–435.
10. Moffa G, Catone G, Kuipers J, et al. Using directed acyclic graphs in epidemiological research in psychosis: an analysis of the role of bullying in psychosis. *Schizophr Bull*. 2017;43:1273–1279.
11. Guglielmucci F, Saroldi M, Zullo G, Munno D, Granieri A. Personality profiles and problematic internet use in a sample of Italian adolescents. *Clin Neuropsychiatry*. 2017;14:94–103.
12. Xiuqin H, Huimin Z, Mengchen L, Jinan W, Ying Z, Ran T. Mental health, personality, and parental rearing styles of adolescents with Internet addiction disorder. *Cyberpsychol Behav Soc Netw*. 2010;13:401–406.
13. Bird JC, Waite F, Rowsell E, Fergusson EC, Freeman D. Cognitive, affective, and social factors maintaining paranoia in adolescents with mental health problems: A longitudinal study. *Psychiatry Res*. 2017;257:34–39.
14. Pearl J. *Causality: Models, Reasoning, and Inference*. Cambridge, UK: Cambridge University Press; 2009.
15. Freeman D, Stahl D, McManus S, et al. Insomnia, worry, anxiety and depression as predictors of the occurrence and persistence of paranoid thinking. *Soc Psychiatry Psychiatr Epidemiol*. 2012;47:1195–1203.

16. Waite F, Freeman D. Body image and paranoia. *Psychiatry Res.* 2017;258:136–140.
17. Freeman D, Sheaves B, Goodwin GM, et al. The effects of improving sleep on mental health (OASIS): a randomised controlled trial with mediation analysis. *Lancet Psychiatry.* 2017;4:749–758.
18. Shakoor S, McGuire P, Cardno AG, Freeman D, Plomin R, Ronald A. A shared genetic propensity underlies experiences of bullying victimization in late childhood and self-rated paranoid thinking in adolescence. *Schizophr Bull.* 2015;41:754–763.
19. Wong KK, Freeman D, Hughes C. Suspicious young minds: paranoia and mistrust in 8- to 14-year-olds in the U.K. and Hong Kong. *Br J Psychiatry.* 2014;205:221–229.
20. Ebesutani C, Reise SP, Chorpita BF, et al. The revised child anxiety and depression scale-short version: scale reduction via exploratory bifactor modeling of the broad anxiety factor. *Psychol Assess.* 2012;24:833–845.
21. Mendelson BK, Mendelson MJ, White DR. Body-esteem scale for adolescents and adults. *J Pers Assess.* 2001;76:90–106.
22. Essner B, Noel M, Myrvik M, Palermo T. Examination of the factor structure of the adolescent sleep-wake scale (ASWS). *Behav Sleep Med.* 2015;13:296–307.
23. Bastien CH, Vallières A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Med.* 2001;2:297–307.
24. Chung KF, Kan KK, Yeung WF. Assessing insomnia in adolescents: comparison of Insomnia severity index, Athens insomnia scale and sleep quality index. *Sleep Med.* 2011;12:463–470.
25. Goodman R. Psychometric properties of the strengths and difficulties questionnaire. *J Am Acad Child Adolesc Psychiatry.* 2001;40:1337–1345.
26. Mynard H, Joseph S. Development of the multidimensional peer-victimization scale. *Aggress Behav.* 2000; 26: 169–178.
27. Schou Andreassen C, Billieux J, Griffiths MD, et al. The relationship between addictive use of social media and video games and symptoms of psychiatric disorders: a large-scale cross-sectional study. *Psychol Addict Behav.* 2016;30:252–262.
28. R Core Team. *R: A Language and Environment for Statistical Computing.* R Foundation for Statistical Computing; 2013. <http://www.R-project.org/2013>.
29. Sturt E. Hierarchical patterns in the distribution of psychiatric symptoms. *Psychol Med.* 1981;11:783–792.
30. Holmes Finch W, French B. *Latent Variable Modeling with R.* New York, NY: Routledge; 2015.
31. Finney SJ, DiStefano C. Non-normal and categorical data in structural equation modeling. In Hancock GR, Mueller RO, eds. *Structural Equation Modeling: A Second Course.* Charlotte, NC: Information Age Publishing; 2008:269–314.
32. Kline R. *Principles and Practice of Structural Equation Modeling.* 2nd ed. New York, NY: The Guildford Press; 2005.
33. Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct Equ Model.* 1999;6:1–55.
34. Little RJ, Rubin D. *Statistical Analysis with Missing Data.* 2nd ed. Hoboken, NJ: Wiley & Sons, Inc; 2014.
35. van Buuren S, Groothuis-Oudshoorn K. MICE: Multivariate imputation by chained equations in R. *J Stat Softw.* 2011;45:1–67. doi:10.18637/jss.v045.i03
36. Kuipers J, Moffa G. Partition MCMC for inference on acyclic digraphs. *J Am Stat Assoc.* 2017;112:282–299.
37. Geiger D, Heckerman D. Parameter priors for directed acyclic graphical models and the characterization of several probability distributions. *Ann Stat.* 2002; 30: 1412–1440.
38. Suter P, Kuipers J. *BiDAG: Bayesian Inference for Directed Acyclic Graphs. R Package Version 1.1.2 2018.* <https://cran.r-project.org/web/packages/BiDAG/BiDAG.pdf>
39. Lemmers-Jansen ILJ, Krabbendam L, Veltman DJ, Fett AJ. Boys vs. girls: gender differences in the neural development of trust and reciprocity depend on social context. *Dev Cogn Neurosci.* 2017;25:235–245.
40. Benenson JF, Markovits H, Hultgren B, Nguyen T, Bullock G, Wrangham R. Social exclusion: more important to human females than males. *PLoS One.* 2013;8:e55851.
41. Gren-Landell M, Tillfors M, Furmark T, Bohlin G, Andersson G, Svedin CG. Social phobia in Swedish adolescents: prevalence and gender differences. *Soc Psychiatry Psychiatr Epidemiol.* 2009;44:1–7.
42. Kuipers J, Moffa G, Kuipers E, Freeman D, Bebbington P. Links between psychotic and neurotic symptoms in the general population: an analysis of longitudinal British national survey data using directed acyclic graphs [published online ahead of print May 29, 2018]. *Psychol Med.* doi:10.1017/S0033291718000879
43. Startup H, Freeman D, Garety PA. Persecutory delusions and catastrophic worry in psychosis: developing the understanding of delusion distress and persistence. *Behav Res Ther.* 2007;45:523–537.
44. Reeve S, Emsley R, Sheaves B, Freeman D. Disrupting sleep: the effects of sleep loss on psychotic experiences tested in an experimental study with mediation analysis. *Schizophr Bull.* 2018;44:662–671.
45. Gromann PM, Goossens FA, Olthof T, Pronk J, Krabbendam L. Self-perception but not peer reputation of bullying victimization is associated with non-clinical psychotic experiences in adolescents. *Psychol Med.* 2013;43:781–787.
46. Crone EA, Konijn EA. Media use and brain development during adolescence. *Nat Commun.* 2018;9:588.
47. Barry CT, Sidoti CL, Briggs SM, Reiter SR, Lindsey RA. Adolescent social media use and mental health from adolescent and parent perspectives. *J Adolesc.* 2017;61:1–11.
48. Sebastian C, Viding E, Williams KD, Blakemore SJ. Social brain development and the affective consequences of ostracism in adolescence. *Brain Cogn.* 2010;72:134–145.
49. Freeman D, Garety PA, Bebbington P, et al. The psychology of persecutory ideation II: a virtual reality experimental study. *J Nerv Ment Dis.* 2005;193:309–315.