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The Youth Online Diagnostic Assessment (YODA): Validity of a new tool to assess anxiety disorders in youth.

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Abstract

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3 This study developed an online diagnostic tool for anxiety disorders in youth, and evaluated
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5 its reliability and validity amongst 297 children aged 6 – 16 years ($M_{age} = 9.34$, 46% male).
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7 Parents completed the online tool, the Youth Online Diagnostic Assessment (YODA), which
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9 is scored either using a fully-automated algorithm, or combined with clinician review. In
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11 addition, parents and children completed a clinician-administered diagnostic interview and
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13 self-report measures of internalizing and externalizing symptoms and wellbeing. The fully-
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15 automated YODA demonstrated relatively weak agreement with the diagnostic interview for
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17 identifying the presence of any anxiety disorder and specific anxiety disorders, apart from
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19 separation anxiety (which had moderate agreement). The clinician-reviewed YODA showed
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21 better agreement than fully-automated scoring, particularly for identifying the presence of
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23 any anxiety disorder. The YODA demonstrated good agreement with parent-reported
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25 measures of symptoms/interference. The YODA offers a fully or largely automated method
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27 to determine the presence of anxiety disorders in youth, with particular value in situations
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29 where low-resource assessments are needed. While it currently requires further research and
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31 improvement, the YODA provides a promising start to the development of such a tool.
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40 **KEYWORDS:** anxiety disorders, internet, assessment, diagnosis.
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Anxiety disorder is a prevalent and interfering problem across the lifespan and has one of the earliest ages of onset of any mental health condition.¹ Psychological treatment, particularly cognitive behavioral therapy (CBT), is considered efficacious and a first line intervention for youth with anxiety disorders.^{1,2} Studies suggest that CBT produces superior diagnostic remission compared to control treatments.^{3,4} Yet despite the efficacy of treatment, many anxious youth do not receive appropriate help.⁵

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Common barriers to service use include limited access (e.g., trouble getting to services, not being able to afford services, or not being able to get an appointment), inconvenience, stigma or poor mental health literacy (e.g., uncertainty about whether a child needs help, where to get help, and assuming the problem will go away on its own).⁶ Computer-assisted or internet-delivered treatments have been developed in order to address some of these barriers to treatment. Evidence suggests that treatment for anxious youth over the internet is efficacious, although evidence is still limited.^{7,8} Diagnostic remission varies from 30-81%.⁹ Unfortunately, the nature of traditional diagnostic evaluations typically relies on personal interaction and attendance at a clinic (although some alternatives such as telephone delivery have been utilized¹⁰), which is inconsistent with the primary principles of internet-delivered therapy. As a result, internet intervention trials almost never evaluate their impact on diagnostic outcomes.¹¹ Development of a reliable and valid online tool that requires minimal resources to assess clinical diagnoses would be of value to such trials as well as to related research such as population-level epidemiological research.

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The most commonly used instruments to assess anxiety diagnoses in youth are the Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV),¹² the Diagnostic Interview Schedule for Children (DISC-IV),¹³ the Development and Wellbeing Assessment (DAWBA),¹⁴ or the Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS).¹⁵

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These diagnostic tools (and their predecessors) have shown reasonable psychometric properties, especially inter-rater reliability, although assessment of validity has been considerably less extensive.^{16, 17} However, their use outside traditional clinical settings is limited by their high resource requirements (e.g., hours of implementation by a highly qualified practitioner). In response, some efforts have been made to reduce the clinical and associated administrative burden of well-established diagnostic tools by utilizing computerized scoring. Research suggests that the psychometric properties of these diagnostic tools are maintained using automated scoring, for example the DISC^{18, 19} or DISC screeners²⁰. Nonetheless, these methods still rely on lengthy, face-to-face delivery by an interviewer.

Computerized administration of diagnostic tools provides a further opportunity to automate assessment and overcome many of the barriers of traditional diagnostic assessment. Among adult samples, computerized diagnostic assessment has led to similar outcomes as determined through face-to-face administration (See²¹ for a review of computer assessment in adult anxiety). Among adolescents, computer programs that display and score structured interviews or allow responses to be voice-recorded produce reliable and valid diagnoses equivalent to interviewer-led administration across a range of populations.^{22,23,24,25} Some research also shows that youth disclose more stigmatizing behaviors when they audio-record their interview responses²⁶ and that automatic administration removes interviewer error.¹⁵ While these computerized and voice-recording systems have clear benefits, difficulties updating software have also been experienced²⁷ limiting their longevity and reach.

While computerized administration of structured diagnostic instruments has shown some promise, considerably more empirical evaluation is needed, especially among younger populations. In particular, comparison of decisions from computer-administered assessment

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against traditional face-to-face assessment is critical. For example, the Mini-International Neuropsychiatric Interview²⁸ can now be completed electronically; however, to our knowledge, no peer reviewed evaluations of the new delivery method have been published. Similarly, the authors of the Development and Wellbeing Assessment (DAWBA) now recommend online rather than interviewer administration of the instrument (see <http://dawba.info/b0.html>) but to our knowledge published research has not directly compared the two methods of administration in order to confirm their equivalence. In one attempt to provide some comparison, prevalence of disorders obtained via the online DAWBA were compared against prevalence in similar cohorts of children using previous face-to-face administration of the instrument.²⁹ Results showed similar prevalence rates and the authors concluded that the online version was “good enough” for service planning. To date, the only study that has directly compared face to face and internet administration of a diagnostic interview for youth specifically evaluated a module of the Diagnostic Interview Schedule for Children (DISC) for youth ADHD.²⁷ The results showed excellent agreement between the two forms of administration, providing good support for the validity of diagnosis over the internet. However, the study was restricted to one form of psychopathology and the fact that ADHD is characterized by clear and overt symptoms, might have made the validity higher than would be expected for other forms of psychopathology. In particular, assessment of internalizing symptoms, which are characterized by fewer overt behaviors and more subjective internalizing experiences, may be more difficult to identify through computer administration.

To maximize the value of computer-administered diagnostic assessment, completely automated scoring would be the ideal. Indeed, most of the existing online assessments produce an automated/algorithm-based diagnostic decision or symptom score using the forced-choice responses provided by respondents. However, they typically also allow

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clinician review of additional free text responses to increase validity.^{27,29} Not surprisingly, clinician judgement has typically been found to produce better agreement against traditional administration methods, yet algorithm results are promising (e.g., agreement between interviewer and online DISC agreement for ADHD diagnosis and symptoms was moderate to strong; $\kappa = .71$, ICC = .87).²⁷

Internet administered diagnostic tools are particularly promising because they utilize simple and widely accessible technology, are convenient and low-cost, confidential, and remove the risk of interviewer administration error and the need for data entry. As internet-delivered interventions for youth anxiety grow in popularity, affordable and reliable diagnostic tools for anxiety disorders that similarly circumvent the time and geographic proximity limitations of face-to-face interviews will be necessary to identify individuals in need of treatment and ensure that quality diagnostic evaluations of internet-delivered CBT are feasible. Such tools will also have important benefits for rapid population level identification of anxiety in youth. In both instances, the value and purpose of computer-administered diagnostic interviews is not to replace clinical interviews when face-to-face consultation is feasible and possible, but to offer a diagnostic-based assessment for the identification of anxiety that warrants treatment in circumstances when face-to-face clinical interviews are not feasible. Yet, we should not assume that the psychometrics of existing interviewer administered diagnostic tools (no matter how well established the interviewer-administered tool) are equivalent to computer-administered versions of the same tool. Therefore, given the lack of evidence regarding the psychometric properties of existing diagnostic tools being made available via online administration, a new online diagnostic tool with published psychometric evaluation is needed.

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The aim of the present study was to assess the agreement between a new internet-delivered, parent-report, diagnostic interview for youth anxiety disorders and 1) in-person diagnostic interviews, and 2) established symptom/interference questionnaires. We restricted the computerized instrument to parent-report to maximize efficiency, based on data showing that clinician-based diagnoses for anxious children show strongest agreement with parent reports.^{30,31} We expected good agreement between internet-administered and face-to-face interviews for anxiety disorder absence/presence, and severity scores. We expected large positive correlations between internalizing symptoms and anxiety interference on questionnaires, and anxiety symptom severity reported via the online diagnostic tool, and small correlations between externalizing symptoms on questionnaires and anxiety symptom severity reported via the online diagnostic tool. Finally, we expected slightly stronger agreement for decisions made following a computer algorithm combined with brief clinician review than via computer-based algorithm alone.

Method

Participants

Participants were 297 children and adolescents aged 6 – 16 years (mean age 9.34 years, SD = 2.3, 45.8% male) who 1) attended Macquarie University's Centre for Emotional Health Clinic for assessment between 2012 and 2014 to determine inclusion in a large clinical trial (n = 204),³² 2) completed post-treatment assessments (n = 36) following treatment at the Clinic, or 3) completed assessments as part of a study recruiting confident children aged 7-11 years (n = 21).³³ The latter two samples were recruited in an effort to extend the variability of presentations assessed and test whether the tool is sensitive to treatment changes and non-clinical presentations.

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Inclusion in the present study was based on completion of both a face-to-face diagnostic interview (Anxiety Disorders Interview Schedule (ADIS-IV-C/P),¹² and a computerized diagnostic assessment (Youth Online Diagnostic Assessment (YODA), described below) within a two-week period at the relevant time point. This window was set to reduce time variability and to ensure feedback about diagnoses would not have been provided prior to completing the second assessment.

Measures

*Anxiety Disorders Interview Schedule for DSM-IV parent and child interview (ADIS-IV-C/P).*¹² The ADIS-IV-C/P (ADIS) assesses anxiety, mood, and externalizing disorders in children and adolescents according to DSM-IV criteria. Each participant and their primary caregiver completed the ADIS with a trained graduate or clinical psychologist. Parent and child were interviewed separately. Diagnoses and Clinical Severity Ratings (CSR, 0 – 8) were assigned in two ways; 1) based on information provided by both parent and child (Composite), and 2) based on information provided by the parent only (Parent). When diagnostic criteria were met, a CSR of four or more was indicative of a clinical diagnosis. A principal diagnosis was assigned for the disorder causing greatest interference. All diagnostic decisions were made under the supervision of an experienced diagnostician and no feedback was provided to families about diagnoses or eligibility for the clinical trial prior to confirmation with a supervisor. A total of 49 ADIS interviews (16%) were double-coded. Interrater reliability for the presence of any anxiety disorder in the child's profile was $k = .728$, presence of a primary anxiety disorder was $k = .77$, and kappas for social anxiety, generalized anxiety and separation anxiety were $k = .71$, $k = .84$ and $k = .91$, respectively.

Youth Online Diagnostic Assessment (YODA). The YODA is an online diagnostic assessment developed to assess and diagnose anxiety disorders in children and adolescents

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according to DSM-IV criteria.^{34,i} The parent-report YODA is completed by parents of children and adolescents aged 7 – 17 years. The YODA assesses the main DSM-IV anxiety disorders and specific phobias, excluding posttraumatic stress disorder (PTSD) and panic/agoraphobia due to their relative scarcity among younger populations.³⁵ The assessment includes a combination of closed and open questions. Closed questions use yes/no responses or severity/frequency scales targeting individual symptoms and DSM-IV criteria, and open-ended questions require written descriptions of behaviors, cognitions, and resulting impact on functioning. Screening questions lead each diagnostic category, with negative responses to screening initiating an automated skip of the remaining questions for that disorder. When completed after treatment, the interview begins with questions about changes that have occurred since the last assessment.

The YODA is initially computer-scored, using yes/no responses to closed questions, programmed in line with DSM-IV criteria. Computer-scoring generates an initial summary outlining whether criteria have been met for each disorder. A mental health professional subsequently reviews and evaluates the open-ended descriptive responses to determine the final result for each diagnostic category. The clinician is able to subsume diagnoses where reported difficulties overlap substantially, override responses to closed questions in cases where written responses to open-ended questions clearly contradict the closed question response, and benchmark interference ratings against standard exemplars.

Based on this evaluation, the clinician was able to make the final diagnostic decision for each disorder (and for overall anxiety): 0 = *No disorder(s)*, 1 = *Clinical/meets diagnostic*

ⁱ A version reflecting DSM-5 criteria and a youth-report YODA are also being developed.

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criteria (for at least one disorder.). A Clinician Severity Score (CSS) was also assigned per disorder and for overall anxiety, based on number/frequency of symptoms, degree/frequency of impairment in functioning, and intensity/frequency of distress, rated on a 5-point scale ranging from 0 = *Minimal or absent*, 1 = *Mild*, 2 = *Moderate*, 3 = *Substantial*, and 4 = *Pervasive*. The clinician was able to seek supervision during the assessment process, and each instance of supervision was documented. Clinicians were trained graduates or clinical psychologists, and were blind to the participant's ADIS-determined diagnosis. The review process took clinicians an average of 6.87 minutes to complete (range 2 to 20, SD = 0.18). Supervision was sought for eight assessments (2%). Twenty percent of all YODAs (n = 58) were double coded for the purposes of establishing interrater reliability.

Questionnaire measures: A range of commonly used and well validated questionnaires were completed by caregivers and children to assess child symptoms and interference.

The Spence Children's Anxiety Scale (SCAS) child report³⁶ and parent report³⁷ is a measure of child anxiety symptoms. Participants rate their agreement with the 44 (child) and 38 (parent) items on a 4-point likert scale ranging from 0 (Never) to 3 (Always). Scores are summed to reflect total anxiety, drawn from six subscales (Panic attacks and agoraphobia, separation anxiety, social phobia, physical injury fears, obsessive compulsive, and generalized anxiety). The measure is widely used and has strong psychometric properties in clinical and general population samples.

The 13-item Short Mood and Feeling Questionnaire (SMFQ)³⁸ Angold et al., 1995) is a child and parent report measure of child depressive symptoms. Participants rate whether items reflect their feelings and actions over a two-week period according to a 3-point Likert

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scale, (0) True, (1) Sometimes, (2) Not True. Both parent and child-report forms have strong psychometric properties.³³

The Strengths and Difficulties Questionnaire (SDQ)³⁹ assesses overall internalizing and externalizing symptoms drawn from four subscales measuring emotional symptoms, peer problems, conduct problems and hyperactivity/inattention. Participants rate how true each statement is of them on a 3-point scale where 0 is Not true, 1 is Somewhat True, and 2 is Certainly true. The measure is widely used and has strong reliability and validity.⁴⁰

Finally, the Child Anxiety Life Interference Scale (CALIS)⁴¹ is a parent-report and child report measure of life interference and impairment associated with the child's anxiety. Participants rate the extent of distress caused by anxiety and the degree of impact that anxiety has on a number of domains of life using a 5 point Likert scale 0 (Not at all) to 4 (A great deal).

Procedures

Research studies for both the clinical and non-clinical samples were approved by Macquarie University's Human Research Ethics Committee. Informed written consent was obtained from all parents, as well as from children 14 years and above with children under 14 years providing verbal assent. Children and adolescents who were assessed for, or completed, treatment in a clinical trial or program, completed the ADIS and the YODA as part of a larger battery of assessments. The same parent completed both diagnostic assessments. YODA and questionnaires were completed prior to the ADIS for all but 28 participants in this group. For assessment conducted following treatment, clinicians were blinded to the participant's treatment condition and baseline diagnoses and severity ratings. The order of administration of the YODA (and questionnaires) and ADIS was randomized for this sub-sample.

1 For the non-clinical sample, children and their parents completed the ADIS over the
2 telephone, in addition to completing the YODA. Participation was voluntary, and families
3 received a \$20 grocery voucher for their time. The order of administration of the YODA (and
4 questionnaires) and ADIS was randomized for this sub-sample.
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10 **Data analysis**

11 To test agreement between diagnostic interviews delivered by clinicians (ADIS, via
12 parent and via composite report) and online (YODA, via algorithm and via clinician review),
13 Kappas were calculated for dichotomously coded variables (i.e., presence vs. absence of an
14 anxiety disorder). Intra-class correlation coefficients (ICC) were calculated for continuous
15 variables (i.e. severity/interference scores). Finally, Pearson's correlations were conducted to
16 determine the association between interview scores (ADIS and YODA) and questionnaire
17 measures assessing anxiety symptoms, anxiety interference, internalizing symptoms and
18 externalizing symptoms. We report the agreement between the YODA and both parent-only
19 and composite ADIS scores because we want to determine the agreement between the new
20 online tool and current gold-standard diagnostic interviews i.e., composite report on the
21 ADIS that utilizes information from both parents and children, but at the same time want to
22 compare results from the new parent-completed tool with equivalent information collected
23 via clinician interview i.e., parent ADIS. To ensure adequate power we only report disorder-
24 specific agreement amongst sub-samples of at least 50 participants, where the specific
25 disorder is present anywhere in the participant's profile (i.e., primary or otherwise). In line
26 with recommendations for interpreting Kappa in health care settings, a Kappa coefficient
27 above .9 was considered almost perfect, between .8 and .9 strong, between .6 and .79
28 moderate, .4 and .59 weak, .21-.39 minimal and less than .2 was considered not to have any
29 agreement³⁷. Such interpretations of Kappa are much more stringent than traditional Cohen's
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interpretations. An ICC of $> .81$ was considered excellent reliability; $.60$ - $.80$ was substantially reliable; $.41$ - $.60$ was moderately reliable; $.21$ - $.40$ was fairly reliable; and less than $.20$ was considered poor.^{42,43} A significance level of $.05$ was also used to evaluate the ICC and Pearson correlation coefficient analyses.

Results

Table 1 presents participant demographic characteristics. The number of adolescents and primary diagnosis were different across subsamples as an intended result of recruiting the different groups. There were no significant unintended demographic differences between subsamples except for parent age, whereby parents were younger in the community subsample. Table 2 presents a summary of the Kappa coefficients (including confidence intervals), sensitivity and specificity and percentage agreement for the presence/absence of specific anxiety disorders between the YODA algorithm and the ADIS parent and composite scores respectively. Separation anxiety disorder had the strongest agreement between the YODA algorithm and both parent ($\kappa = .73$, PA = 62%) and composite ($\kappa = .68$, PA = 60%) reports on the ADIS. There was poorer agreement for diagnosing generalized anxiety disorder (GAD; $\kappa = .40$, PA = 49% with parent-ADIS and $\kappa = .36$, PA = 48% with composite ADIS), and social anxiety disorder ($\kappa = .39$, PA = 51% for parent-ADIS and $\kappa = .36$, PA = 50% for composite ADIS). Sensitivity ranged from 56% to 81% for identifying individual anxiety disorders according to parent report ADIS and 54% to 74% on composite ADIS. Specificity ranged from 79% to 93% with parent-ADIS and 78% to 93% on composite-ADIS. Agreement between the YODA algorithm score and both the ADIS parent ($\kappa = .52$, PA = 59%) and composite ($\kappa = .51$, PA = 60%) scores was weak to moderate for identifying the presence of any type of primary anxiety disorder. Sensitivity was 78% for parent and composite ADIS. Specificity was 90% for parent-ADIS and 91% for composite-ADIS.

1 We further evaluated the agreement (Kappa) between the YODA according to
2 clinician reviewed scores and the ADIS according to both parental and composite reports. As
3 summarized in Table 2, results were similar or better than agreement against the YODA
4 algorithm. Specifically, agreement was better for social anxiety disorder ($\kappa = .53$, PA = 50%
5 for parent-ADIS and $\kappa = .47$, PA = 50% for composite ADIS), and any anxiety disorder ($\kappa =$
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To compare assessment tools on agreement related to clinical severity of symptoms, the ICC scores between the ADIS CSR (parent and composite report) and YODA algorithm interference score or YODA clinician-reviewed severity scores (CSS; Table 3) were evaluated. No significant associations were found between ADIS severity (parent or composite) and YODA algorithm interference score for any anxiety disorder; however for YODA clinician-review CSS, all analyses were statistically significant with at least moderate levels of agreement.

The Pearson correlations between the YODA algorithm interference score with the parent and child report of internalizing (SCAS, SDQ and SMFQ), externalizing (SDQ) and anxiety interference (CALIS) scores were also evaluated. Statistically significant and moderate to substantial levels of positive correlations were found between the YODA algorithm and internalizing measures including the SCAS, the SDQ-Internalizing subscale and the SMFQ child and parent scores (see Table 4). A statistically significant, positive strong correlation was also found between the YODA algorithm interference score with parent report of anxiety interference (CALIS; .69). However, only a modest positive association was found between the YODA algorithm interference score and the CALIS child report (.38). Small significant positive correlations were also found between the YODA

1 algorithm interference score and externalizing symptoms (SDQ) according to both child and
2 parent (.18 and .24 respectively). A similar pattern emerged when testing the association
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4 between YODA clinician-reviewed severity scores and parent- and child- reported
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6 symptoms/interference, with one exception (see Table 4). Using clinician-reviewed YODA
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8 severity scores, the small associations with externalizing symptoms (parent and child report)
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10 were no longer significant. The pattern of associations between YODA scores and
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12 symptom/interference scores was equivalent or stronger than the relationships between total
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14 ADIS CSRs for anxiety disorders and symptom/interference scores, with one exception. The
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16 ADIS was less related to parent-reported externalizing symptoms, according to the SDQ, than
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18 the YODAⁱⁱ.
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23 **Coder Reliability**

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26 Inter-rater reliability on the clinician-reviewed YODA was high for presence of specific
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28 anxiety disorders ($\kappa = .73 - .89$) and any anxiety diagnosis ($\kappa = .93$, see Table 5). It was also
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30 high for severity scores of specific anxiety disorders (ICC's between .92 and .96) and overall
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32 anxiety severity (ICC = .90).
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37 **Discussion**

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40 Traditional, clinician-delivered interviews provide the gold standard assessment for
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42 delivery of traditional, personal clinical services. However, such interviews are not always
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44 possible (for example population level scoping studies; screening of large samples; online
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46 interventions etc) and for these circumstances, the availability of empirically validated
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53 ⁱⁱ The same pattern of results emerged for correlations between symptom and interference measures and number
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55 of anxiety disorders across both tools (i.e., using YODA algorithm, YODA clinician-review and ADIS (parent-
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57 only or combined report)).
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1 alternatives that require low levels of clinical resources are vital. The purpose of this study
2 was to evaluate the validity of a new, online diagnostic tool to identify anxiety disorders
3 among youth, the Youth Online Diagnostic Assessment (YODA). The YODA can be utilized
4 in two ways: either based on an entirely automated algorithm or including modifications to
5 the algorithm by a qualified clinician based on open-ended descriptors provided by parents.
6
7 Given the nature of diagnosis, clinician-reviewed diagnoses are likely to provide the greatest
8 utility across the majority of contexts such as clinical triage, or treatment outcome research.
9
10 Nonetheless, automated algorithms will be of value under certain circumstances, such as
11 population screening or the delivery of fully automated interventions across large populations
12 and we therefore, included outcomes from both scoring methods. In either format the YODA
13 showed initial promise as a potential tool to use when clinician interview is not feasible.
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27 Determining the ability of a diagnostic instrument to identify the presence or absence
28 of a particular condition relies on having an objective marker of that condition. While this
29 may be possible in the field of physical health, psychometric evaluation of instruments
30 assessing mental health suffer from the lack of any objective method to demonstrate a mental
31 disorder. As a result, structured, face-to-face, diagnostic interviews are often considered the
32 gold standard. However, they are themselves not without potentially serious limitations. In
33 the current case, the “gold standard” that we relied on, the ADIS-CP, had an inter-rater
34 reliability to detect the presence or absence of mental disorder of only .73 (referred to as
35 “moderate” according to stringent clinical standards⁴²). In turn, this means that the maximum
36 agreement that can be demonstrated between the gold standard and any new measure cannot
37 be greater than kappa = .73. In the current study, agreements demonstrated between the
38 YODA and ADIS-CP appeared relatively poor. However, these figures need to be interpreted
39 in light of the above caveat.
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Overall, agreement between the YODA algorithm and standard face-to-face clinical interview (composite-ADIS) was in the range of $\kappa = .34$ and $\kappa = .68$, with percentage agreement in the range of 48% – 60% for the presence of a specific anxiety disorder. Agreement between ADIS and YODA-algorithm for the presence of *any* anxiety disorder was $\kappa = .51$, with 60% agreement. As expected, agreement when using the clinician-reviewed YODA was better, especially for identifying the presence of any anxiety disorder. Kappas to identify the presence of a specific anxiety disorder ranged from .47 to .71 and percentage agreement ranged from 50% - 61%. More importantly, agreement between ADIS and YODA clinician-review for the presence of *any* anxiety disorder was $\kappa = .70$, showing 65% agreement. The agreement between clinician-reviewed identification of any anxiety disorder and the ADIS ($\kappa = .70$) was extremely close to the inter-rater agreement within the ADIS itself ($\kappa = .73$), indicating that the YODA clinician-reviewed diagnosis approached the upper limits of agreement.

It is not surprising that the identification of the presence of any anxiety disorder showed greater agreement against the ADIS than diagnoses of specific anxiety disorders. Given the considerable overlap between anxiety disorders, both conceptually and in practice, it is logical to assume that distinguishing between these disorders will be harder than identifying the presence of any one. In addition, sample sizes were considerably smaller for these analyses, reducing their reliability. Sensitivity (i.e., the ability to correctly identify youth with anxiety disorders) was strong when looking at the detection of any anxiety disorder, especially using the clinician-reviewed score. Against composite ADIS diagnosis, sensitivity for the YODA algorithm score was 78% and for the clinician-reviewed score was 89%. As expected, sensitivity to detect separate anxiety disorders was more variable (ranging from 68% to 74%). Specificity (the ability to correctly identify youth without anxiety) was also strong when looking at the overall identification of any anxiety disorder. Against

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composite ADIS diagnosis, specificity was 91% for the algorithm scoring and 93% for the clinician-reviewed scoring (and ranged from 75% to 94% for identifying specific anxiety disorders).

Agreement between the YODA and ADIS for continuous measures of interference/severity followed a similar pattern. There was moderate to large agreement between clinician-reviewed YODA severity scores and ADIS CSR for specific disorders, but agreement was poor for YODA algorithm interference and ADIS clinician severity. Further improvement of the YODA algorithm interference score is required in order to provide a continuous measure of severity/interference akin to ADIS CSR.

When looking at distinguishing individual disorders, consistent with results from reliability of face-to-face structured interviews, the strongest agreement was shown by separation anxiety, given its relatively clear behavioral manifestations. Somewhat lower agreement was shown by social anxiety and generalized anxiety. These effects may be due to several factors. First, both are characterized by more “internal” manifestations of anxiety and may be harder for parents to identify and describe clearly. Second, social and generalized anxiety are more similar to each other than is separation anxiety and in fact can show quite similar characteristics such as perfectionism and concerns about the opinions of others. Along these lines, it is interesting to note that the inter-rater reliability within the ADIS itself was poorer for the diagnoses of generalized and social anxiety disorders than for separation anxiety disorder. Relatedly, we based this study on only parent reports on the YODA and it is likely harder for parents to observe the internal features of these latter disorders than the more overt manifestations of separation anxiety. Consistent with this suggestion, it is interesting to note that the benefit of adding clinician review was considerably greater for diagnoses of

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social and generalized anxiety than for separation anxiety disorder, which was identified quite consistently, even by the automated algorithm.

As noted earlier, although structured diagnostic interviews (such as the ADIS) are often assumed to reflect a gold standard for assessment, it should be noted that this method is not without its own limitations. Within this study the inter-rater reliability for the overall recognition of any anxiety disorder when using the ADIS was only .73, pointing to considerable variability in the recognition and interpretation of symptom profiles between qualified therapists. Although we also refer to the face-to-face interview as the gold standard in this study, it is interesting to note that when compared against parent and self-report questionnaire measures of anxiety, both the YODA and the ADIS showed similar validity. Hence, when compared against questionnaire measures of anxiety, the YODA showed similar (or even stronger) validity than standard face-to-face structured diagnostic interview. This difference was even more stark when comparing against the parent reported questionnaire measure of life interference (CALISp). In this case, the validity of the ADIS clinician-rated severity score (CSR) was considerably lower (.36) than either the YODA clinician-reviewed score (.65) or algorithm score (.69).”

The YODA with algorithm requires almost no clinical resources, but, in its current form showed poorer agreement against traditional clinical diagnostic interviews (especially for diagnosing specific anxiety disorders). When clinician review is added, substantial improvements in agreement against traditional interview are demonstrated, especially for determining the presence of any anxiety disorder, at a cost of relatively minimal clinician time (and supervision). In its current form, the YODA with clinician review can reliably detect the presence of clinical levels of anxiety regardless of type. Further refinements to the YODA are needed and should focus on improving automatic scoring and the ability to

1 identify specific anxiety disorders. Yet, even with clinician review the relatively small
2 amount of resources required provide a promising direction with particular relevance for
3
4 population-level evaluations. This is especially true because anxiety disorders are highly
5
6 comorbid in child samples,¹ and there is consistent evidence that the most common anxiety
7
8 disorders are effectively treated with generic CBT programs both face to face and via the
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10 internet.⁴⁴ As such, identifying the presence (or absence) of a clinical anxiety problem
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12 (regardless of type) can assist with appropriate treatment planning. The development of both
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14 online assessment and treatments for child anxiety provides the opportunity for completely
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16 remote treatment delivery of evidence-based interventions, as well as potentially completely
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18 consumer driven management in the near future.
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25 Some limitations of the study need to be considered in interpreting the results. Firstly,
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27 the YODA was not validated against less frequent types of anxiety or related problems such
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29 as PTSD and Panic Disorder. Secondly, the sensitivity of the YODA is adequate but would
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31 benefit from further refinement, particularly using the automated algorithm and as a measure
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33 of degree of interference. Future research refining items and clinical cut offs will be
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35 beneficial. It will also be important to investigate the YODA in larger and more diverse
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37 samples (for example non-clinical groups, community samples etc). Thirdly, future research
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39 extending the tool to other related emotional health issues will be important to address issues
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41 of comorbidity. ~~Thirdly~~ Additionally, due to small numbers of teenagers, we were not able to
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43 investigate the validity of the parent-report tool by age (child vs adolescent). Similarly, we
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45 did not separately analyze agreement between YODA and ADIS amongst the small group of
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47 participants who completed the YODA after the ADIS. While we restricted the window
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49 between completing the two tools to two weeks to ensure feedback had not been provided to
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51 families following the face-to-face clinical interview, it is possible that the order of
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53 administration may have enhanced agreement rates amongst this small subgroup. Finally,
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although the YODA provided acceptable reliability and validity based on parent-only report, future developments would benefit from obtaining information from youth (both children and adolescents) who may provide more valid information about their own internalizing symptoms. This may be particularly important for efforts to improve the diagnosis of specific anxiety disorders that have fewer behavioral indicators and are defined by internalized experiences/perceptions (e.g., social anxiety or generalized anxiety disorders).

Summary

At this current stage, the clinician-augmented YODA appears to be a reasonable instrument to broadly detect the presence/absence of overall anxiety disorder. This makes it very useful for a range of contexts – screening, population assessment, online intervention. But it still needs more work to improve its specificity, especially in discriminating between specific disorders. While more work is required to improve the tool, it is an important step given almost no evidence exists for the psychometric properties of computer or online-administered assessment tools used to assess diagnostic criteria (e.g., DSM-IV or DSM-5).

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Table 1 Demographic details

	Full Sample (N = 297)	Treatment seeking subsample (n = 240)	Post-treatment subsample (n = 36)	Confident subsample (n = 21)
Females %	54.2	50.4	52.8	42.9
Age, M (SD), range	9.34 (2.26), 6 - 16	9.37 (2.31), 6 - 16	9.42 (2.43), 7 - 14	8.90 (1.22), 7 - 11
Adolescents, n (%)	49 (16.5)	39 (16.25)	10 (27.8)	NA
Child Ethnicity %				
Australian, New Zealander, Aboriginal, Torres Strait Islander	65.7	62.9	83.3	66.7
European	23.9	27.6 ^a	8.3 ^b	9.5 ^b
Asian, African, Middle Eastern, Americas	10.5	9.6	8.4	23.8
Language spoken at home %				
English	94.9	94.6	94.4	100
Mandarin	1	1.3	0	0

Running Head: A new online diagnostic tool for youth - The YODA

Cantonese	0.7	0.4	2.8	0
Other	3.4	3.8	2.8	0
Parent gender, Female %	91.6	92.1	83.3	100
Parent age, M (SD), range	42.62 (4.809), 29 - 60	42.87 (4.76), 32 – 60 ^a	42.56 (5.27), 31 - 53	39.81 (3.70), 29 – 46 ^b
Carer highest level of education %				
University degree	64.3	64.6	61.1	66.7
Vocation / Tafe / Certificate / Diploma	25.6	27.1	22.2	28.6
Year 12 or equivalent	6.1	5.8	8.3	4.8
Year 10 or equivalent	3	2.5	8.3	0
Carer employment status %				
At home by choice	27.3	27.1	22.2	38.1
Full time employment	29	29.6	27.8	23.8
Part time employment	40.4	40.0	47.2	33.3
	2.7	2.5	2.8	4.8

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Running Head: A new online diagnostic tool for youth - The YODA

Student (part / full time) or illness/disability Unemployed	0.7	0.8	0	0
Relationship to child, biological parent %	99.3	99.2	100	100
Family Type %				
Two parent	87.5	86.1	91.7	95.2
Single parent	8.8	9.7	5.6	4.8
Step / Blended or Other	3.7	4.2	2.8	0
Primary Diagnosis (according to composite ADIS) %				
Nil	15.2	2.9	47.2	100
Generalized Anxiety Disorder	33	37.9	19.4	0
Social Anxiety Disorder	18.9	21.7	11.1	0
Separation Anxiety Disorder	9.8	12.1	0	0

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Running Head: A new online diagnostic tool for youth - The YODA

Specific Phobia	6.3	6.7	11.2	0
Panic Disorder	.7	0.8	0	0
Anxiety Disorder NOS	1	1.3	0	0
Obsessive Compulsive Disorder	3.7	4.2	2.8	0
Major Depressive Disorder or Dysthymic Disorder	1.3	0.8	5.6	0
ADHD or ODD	4.7	5.8	0	0
Non-internalizing/externalizing disorders	4.9	5.8	2.8	0

NOS = not otherwise specified, ADHD = Attention Deficit Hyperactive Disorder, ODD = Oppositional Defiant Disorder

Superscripts represent differences between subsamples across demographic characteristics

Table 2: Validity of presence/absence of anxiety disorders according to YODA algorithm alone or clinician-review (N=297)

YODA Parent Report Algorithm	Parent– ADIS					Composite – ADIS (Parent & Child report)				
Diagnosis	Kappa	CI	Sensitivity	Specificity	PA	Kappa	CI	Sensitivity	Specificity	PA
Separation Anxiety	.73	.64 - .82	80.5	92.7	62%	.68	.59 - .77	73.8	92.5	60%
Social Anxiety Disorder	.39	.29 - .49	59.3	79	51%	.34	.23 - .45	55.6	77.8	50%
Generalized Anxiety Disorder	.40	.30 - .50	55.9	85.3	49%	.36	.26 - .46	53.6	84.5	48%
Any Anxiety Disorder	.52	.42 - .62	78.3	89.5	59%	.51	.41 - .61	77.8	90.7	60%
YODA Parent Report with Clinician Review	Parent – ADIS					Composite – ADIS (Parent & Child report)				
Diagnosis	Kappa	CI	Sensitivity	Specificity	PA	Kappa	CI	Sensitivity	Specificity	PA
Separation Anxiety	.73	.64 - .82	77.9	93.6	62%	.71	.62 - .80	73.8	94.4	61%
Social Anxiety Disorder	.53	.43 - .62	77	76.5	50%	.47	.37 - .57	72.2	75.2	50%
Generalized Anxiety Disorder	.50	.40 - .60	69.6	80.9	50%	.48	.38 - .58	67.9	81.4	50%
Any Anxiety Disorder	.73	.64 - .82	90	93	65%	.70	.60 - .80	88.9	92.6	65%

CI = 95% confidence interval; PA = percentage agreement.

Table 3: Inter-class correlations (ICC) between YODA algorithm interference score and ADIS CSR (N=297)

YODA algorithm interference score	Parent – ADIS					Composite – ADIS (Parent & Child report)				
Diagnosis	ICC	CI	df	F	<i>p</i>	ICC	CI	df	F	<i>p</i>
Separation Anxiety	.13	.37-.45	76	1.15	.28	.19	-.25-.48	83	1.24	.17
Social Anxiety Disorder	.21	-.11-.44	134	1.26	.09	.15	-.19-.39	143	1.17	.17
Generalized Anxiety Disorder	.20	-.10-.41	160	1.24	.09	.21	-.07-.42	167	1.27	.07
YODA clinician-reviewed severity score (CSS)	Parent – ADIS					Composite – ADIS (Parent & Child report)				
Diagnosis	ICC	CI	df	F	<i>p</i>	ICC	CI	df	F	<i>p</i>
Separation Anxiety	.49	.20-.68	76	1.96	.002 ^a	.59	.37-.74	83	2.44	<.001 ^a
Social Anxiety Disorder	.65	.50-.75	134	2.83	<.001 ^a	.64	.50-.74	143	2.75	<.001 ^a
Generalized Anxiety Disorder	.36	.12-.53	160	1.56	.003 ^a	.40	.18-.55	167	1.66	.001 ^a

^a p<.01

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Table 4: Pearson correlations between YODA Algorithm interference score or YODA clinician-reviewed severity score (CSS) or ADIS total CSR for anxiety disorders with parent- and self-report measures

Measure	YODA Algorithm Interference Score			YODA Clinician Reviewed CSS			ADIS total CSR for anxiety		
	r	p	N	r	p	N	r	p	N
SCAS Total Score – Child report	.44	<.001 ^a	271	.48	<.001 ^a	271	.40	<.001 ^a	237
SCAS Total Score – Parent report	.72	<.001 ^a	297	.66	<.001 ^a	297	.60	<.001 ^a	262
CALIS – Child Report	.38	<.001 ^a	271	.44	<.001 ^a	271	.28	<.001 ^a	237
CALIS – Parent Report	.69	<.001 ^a	276	.65	<.001 ^a	276	.36	<.001 ^a	262
SMFQ – Child Report	.33	<.001 ^a	271	.37	<.001 ^a	271	.24	<.001 ^a	237
SMFQ – Parent Report	.46	<.001 ^a	276	.34	<.001 ^a	276	.25	<.001 ^a	262
SDQ – Internalizing Scale Child report	.37	<.001 ^a	250	.29	<.001 ^a	250	.33	<.001 ^a	237
SDQ – Internalizing Scale Parent report	.55	<.001 ^a	297	.51	<.001 ^a	297	.38	<.001	262

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SDQ – Externalizing Scale Child report	.18	.006 ^b	250	.12	.054	250	.17	.008 ^b	237
SDQ – Externalizing Scale Parent report	.24	<.001 ^a	297	.11	.07	297	.07	.255	262

CSS = Clinician severity score; CSR = Clinician Severity Rating, SCAS = Spence Children’s Anxiety Scale; CALIS = Child Anxiety Life

Interference Scale; SMFQ = Short Moods and Feelings Questionnaire; SDQ = Strengths and Difficulties Questionnaire. ^ap<.01; ^bp<.05

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Table 5: Inter-rater reliability results on the YODA

Variable	Presence/Absence of disorder		CSS	
	Kappa	p	ICC	p
Separation Anxiety	.85	<.001 ^a	.96	<.001 ^a
Social Anxiety	.89	<.001 ^a	.93	<.001 ^a
Generalized Anxiety Disorder	.73	<.001 ^a	.92	<.001 ^a
Meets criteria for an Anxiety disorder	.93	<.001 ^a	.90	<.001 ^a

CSS = Clinician Severity Score , ^a p < .01