Integrating Multiple Informants' Reports: How Conceptual and Measurement Models May Address Long-Standing Problems in Clinical Decision-Making

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Abstract

Assessing youth psychopathology involves collecting multiple informants' reports. Yet, multi-informant reports often disagree, necessitating integrative strategies that optimize predictive power. The *Trait* score approach leverages principal components analysis (PCA) to account for the context and perspective from which informants provide reports. This approach may boost the predictive power of multi-informant reports and thus warrants rigorous testing. We tested the *Trait* score approach using multi-informant reports of adolescent social anxiety in a mixed clinical/community sample of adolescents (*n*=127). The *Trait* score incrementally predicted observed social anxiety (*β*s: .47-.67) and referral status (*OR*s: 2.66-6.53), above-and-beyond individual informants' reports and a composite of informants' reports. The *Trait* score predicted observed behavior at magnitudes well above those typically observed for individual informants' reports of internalizing psychopathology (i.e., *r*s=.01-.15). Findings demonstrate the ability of the *Trait* score to improve prediction of clinical indices, and potentially transform widely used practices in multi-informant assessments.

Keywords: Multiple informants; assessment; integrative strategies; principal components analysis; social anxiety

Integrating Multiple Informants' Reports: How Conceptual and Measurement Models May

Address Long-Standing Problems in Clinical Decision-Making

Imagine you are a clinician working with an adolescent who reports a consistent and

impairing fear of social situations, including an intense fear of negative evaluation from others.

Behaviorally, the adolescent avoids social situations and in particular those that involve

interacting with unfamiliar individuals. When unable to avoid these situations, the adolescent

reports enduring them with great distress. In contrast, the adolescent's parent reports minimal

levels of social anxiety and instead identifies behaviors displayed at home that result in the

adolescent under-performing at school (e.g., poor schoolwork, rule-breaking) as important to

focus on in treatment. As a clinician, how will you use this information to inform the care that

you provide? How will you conceptualize the adolescent's social anxiety, and what diagnoses

will you assign? Is one informant "right" and the other "wrong"? As you begin treatment

planning, which adolescent problems ought to be targeted first?

Suboptimal Use of Multi-Informant Reports: A Clinical Decision-Making Problem

In this paper, we address commonly encountered questions in clinical practice by

advancing an innovative strategy for integrating multi-informant reports of youth mental health.

Indeed, we opened this paper with a case example that highlights a common clinical observation:

Youth vary considerably in the contexts in which they display mental health symptoms (e.g.,

home, school; Achenbach, McConaughy, & Howell, 1987) and significant others in their lives

(e.g., parents, teachers) vary in their capacities for observing them within and across these

contexts (Dirks, De Los Reyes, Briggs-Gowan, Cella, & Wakschlag, 2012). To account for these

complexities in clinical presentation, clinicians rely on multiple informants to provide reports of

youth mental health (Hunsley & Mash, 2007). Yet, when implementing this *multi-informant*

approach, informants' reports display overall low-to-moderate levels of convergence (i.e., rs = .20-.30s; Achenbach et al., 1987; De Los Reyes et al., 2015). Consequently, how a mental health professional interprets these *informant discrepancies* has profound implications for crucial clinical decision-making tasks including estimating prognosis, planning treatment, and evaluating treatment effectiveness (Hawley & Weisz, 2003). Yet, despite decades of research attention on these topics, there is little evidence that supports the *integrated* use of multi-informant reports (De Los Reyes & Langer, 2018; Hunsley & Mash, 2007). Does integrating multi-informant data improve the accuracy, outcome, or efficiency of clinical work, relative to alternative practices like choosing a single, "optimal" informant, or examining each informant's report individually? Without an answer to this question, the field lacks clear guidelines for clinicians and researchers seeking to leverage multi-informant reports to improve clinical decision-making (Beidas et al., 2015; Marsh, De Los Reyes, & Lilienfeld, 2018).

In practice, low correspondence often results in assessors shunning multi-informant approaches to assessment and instead making clinical decisions that rely on data from a single source (Loeber, Green, & Lahey, 1990; Loeber, Green, Lahey, & Stouthamer-Loeber, 1989; Marsh, Zeveney, & De Los Reyes, 2019). This practice likely reflects long-held assumptions that low informant correspondence signals measurement error or informant biases (De Los Reyes, 2011). Needless to say, the evidence suggests that no single informant's report robustly predicts clinical indices germane to service delivery. For example, any one informant's report relates at only small-to-moderate levels with observed youth behavior, including for externalizing problems (e.g., rs = .02-.52; Becker, Luebbe, Fite, Stoppelbein, & Greening, 2014; Doctoroff & Arnold, 2004; Henry & Metropolitan Area Child Study Research Group, 2006; Hinshaw, Han, Erhardt, & Huber, 1992; Wakschlag et al., 2008; Winsler & Wallace, 2002) and internalizing

problems (e.g., rs = .01-.33; Becker et al., 2014; Beidel, Turner, Hamlin, & Morris, 2000a; Cartwright-Hatton, Hodges, & Porter, 2003; Hinshaw et al., 1992; Winsler & Wallace, 2002). In fact, correlations between informants' reports and youth behavior vary widely, with most correlations falling in the small range (i.e., majority of rs = .01-.15). Crucially, practitioners and researchers in youth mental health lack instruments that consistently—and at large magnitudes—predict key clinical indices relevant to youth mental health service delivery and research. We need efficient yet comprehensive assessments that, when integrated, improve decision-making in clinical and research settings (Beidas et al., 2015).

Addressing the Clinical Decision-Making Problem: The *Trait* Score Approach

Nearly 20 years ago, Kraemer and colleagues (2003) proposed an integrative approach with potential for addressing these longstanding assessment issues. We refer to this strategy as the "*Trait* score approach" and it reflects an insightful observation by Kraemer and colleagues: To arrive at a clinically useful set of multi-informant reports, one must select informants who systematically vary in the contexts and perspectives from which they observe youth. Stated differently, assessors should select informants who, for systematic reasons, tend to provide discrepant reports. This reflects an innovative departure from historical thinking on low convergence in multi-informant assessments. Rather than considering low informant convergence as a *problem* for decision-making, assessors might leverage low convergence to *enhance* decision-making.

The underlying assumptions of the *Trait* score approach fundamentally differ from assumptions underlying alternative strategies for integrating continuous, multivariate data. For instance, researchers often take a *Composite* score approach to integrate multi-informant reports, essentially by taking the simple average among continuous scores taken from informants' reports

(De Los Reyes, Alfano, Lau, Augenstein, & Borelli, 2016). The *Composite* score approach has

its reference to the very origins of classical test theory (Borsboom, 2005). In particular,

Edgeworth (1888) asserted that variations among individual raters of the same behavior reflect

"error" around a "true score" representation of the behavior being assessed. In this respect, the

Composite score approach treats variations among informants' reports as error. In contrast, the

Trait score approach assumes that reports vary from one another both systematically and due to

measurable factors.

Kraemer and colleagues (2003) advanced a mathematical model for sources of variability

that contribute to an informant's rating of youth symptoms:

$$Informant's\ Rating = Trait + Context + Perspective$$

Kraemer and colleagues' model harkens back to decades of research on techniques for

aggregating multivariate data (e.g., factor analysis; Tabachnick & Fidell, 2001). In fact, Kraemer

and colleagues' innovation is in leveraging a data aggregation technique that has historically

been used to parsimoniously aggregate *multiple item responses* on a measure of someone's

behavior to, instead, parsimoniously aggregate *multiple informants' ratings* on a measure of

someone's behavior. To implement their theoretical approach, Kraemer and colleagues applied

principal components analysis (PCA) to a carefully curated set of multi-informant reports. This

statistical approach is consistent with 50 years of research that points to robustly low levels of

correspondence among informants' reports (Achenbach et al., 1987; De Los Reyes et al., 2015).

Further, mental health professionals commonly solicit the reports of informants who qualitatively

vary in the contexts in which they observe the behaviors about which they provide reports (e.g.,

parents at home vs. teachers at school) as well as the perspectives from which they provide

reports (e.g., self-reports vs. observer-reports; De Los Reyes et al., 2013). The PCA approach

advanced by Kraemer and colleagues (2013) requires selecting informants who vary across these systematic factors and thus assumes that the factors explaining variability among the informants' reports entered into the model are linear combinations of orthogonal variables. This approach reflects a conservative and falsifiable strategy for integrating multi-informant data. Indeed, to the degree that the data entered into the model violate assumptions of orthogonality among informants' reports, the resulting information gleaned from the model should fail to predict clinically relevant criterion variables, over-and-above alternative approaches.

The Kraemer and colleagues (2003) approach involves synthesizing the variability among informants' reports into three sources: *Context* (i.e., environment in which the informant observes youth), *Perspective* (i.e., whether the report comes from an observer- or self-rater), and *Trait* (i.e., concerns that manifest across contexts and perspectives). This approach is designed to identify these three sources of variability among informants' reports through extraction of three components, with specific sources of variability being identified through examination of component weights. That is, Kraemer and colleagues posit that when one selects informants who vary in their contexts and perspectives, one component (i.e., *Trait* score) reflects variability for which all three informants' reports load strongly and in the same direction. Further, two additional components reflect variability for which informants' reports load consistent with a *Context* score (i.e., informants from different contexts load in opposite directions) and *Perspective* score (i.e., self-reports load in the opposite direction of observer informants' reports). By isolating a component reflecting concerns that manifest across contexts and perspectives, Kraemer and colleagues proposed that the *Trait* score optimizes multi-informant reports for maximal utility in predicting a wide array of clinical outcomes. This approach, which holds great promise, has yet to be rigorously tested.

Building an Evidence Base for Selecting Informants: The Operations Triad Model

To optimize the predictive power of the approach, Kraemer and colleagues (2003) argue that one should use a "mix-and-match" criterion to identify those informants who systematically vary in sources of variability (Figure 1). This approach is similar to Global Positioning System (GPS) technologies that use data from three satellites to triangulate on a precise location in space. With GPS, one cannot achieve triangulation with data from a single satellite, nor can one arrive at triangulated data using three satellites situated in the same location in space. Similarly, no single "optimal informant" exists to assess youth mental health, and three similar informants (e.g., three teachers) would not provide effective triangulation given their position in the same space or environment (e.g., school). Importantly, the process by which one identifies triangulated satellites requires data to ensure that the satellites are, in fact, situated in optimal locations in space. Similarly, the *Trait* score approach holds value insofar as an evidence base exists to support that low correspondence among reports reflects systematic processes. The Operations Triad Model (OTM; De Los Reyes et al., 2013) provides a guide for building such an evidence base for multi-informant assessments. In particular, the OTM facilitates detecting circumstances in which low convergence among multi-informant reports reflects meaningful, systematic information about clinical phenomena. As such, the OTM facilitates determining which informants might be most appropriate to use when applying the *Trait* score approach.

Several studies informed by the OTM reveal that systematic patterns of multi-informant reports facilitate characterizing clinical presentations. For example, relative to patterns of parent-teacher reports that diverge in estimates of youth autism spectrum disorder symptoms, patterns of parent-teacher reports that converge on moderate or high levels of such symptoms point to increased clinical severity of the youth being evaluated (e.g., medication, diagnosis; Lerner, De

Los Reyes, Drabick, Gerber, & Gadow, 2017). Interestingly, these patterns in multi-informant reports also have predictive utility: In a recent study of psychiatric inpatient intake assessments, patterns of agreement or disagreement in parent-adolescent reports of adolescent affective symptoms facilitated prediction of treatment outcomes (Makol, De Los Reyes, Ostrander, & Reynolds, 2019). In fact, an emerging body of evidence indicates that informants who vary in their contexts and perspectives provide meaningful information about cross-contextual consistencies in behavior (De Los Reyes, Henry, Tolan, & Wakschlag, 2009; Hartley et al., 2011; Kwon et al., 2012), mental health service use (Jones et al., 2019; Makol & Polo, 2018), and treatment outcomes (Becker-Haimes, Jensen-Doss, Birmaher, Kendall, & Ginsburg, 2017). In sum, research across psychopathology domains, informants, measurement methods, and developmental periods support that multi-informant reporting patterns yield meaningful clinical information. This work supports a key assumption of Kraemer and colleagues' (2003) *Trait* score approach: Variations among informants' reports reflect systematic factors germane to the clinical presentations of those assessed. In turn, informants should be selected for the unique information they provide, in an effort to optimize the utility of youth mental health assessments.

The Need for Rigorous, Conceptually Grounded Research

Despite the promise of Kraemer and colleagues' (2003) approach, it is historically underutilized and has yet to be rigorously examined. This is largely due to the lack of conceptual frameworks and basic science to guide researchers in selecting appropriate informants to leverage in assessments. Further, although Kraemer and colleagues propose that the *Trait* score is the primary predictive tool derived from their approach, it remains an empirical question as to whether the *Context* and *Perspective* scores also yield valuable clinical information. Beyond these conceptual issues, practical challenges have curtailed rigorous tests of *Trait* scores. Given

resource limitations, assessments rarely include the three informants necessary to implement the approach. This occurs despite the fact that evidence-based assessment of youth mental health entails collecting multi-informant reports (Hunsley & Mash, 2007). Even among studies that estimate *Trait* scores, use of non-parallel measures across informants hinder the interpretability of study findings (e.g., Perren, Stadelmann, Burgin, & Von Klitzing, 2006). Further, prior *Trait* score studies have been largely limited to use of parent, youth, and teacher reports (Perren et al., 2006; Noordhof, Oldehinkel, Verhulst, & Ormel, 2008) and examinations of youth externalizing problems (Houts, Caspi, Pianta, Arseneault, & Moffit, 2010). Finally, no study to our knowledge has examined whether the *Trait* score displays incremental validity in predicting independent criterion variables (e.g., observed behavior, clinical status), over-and-above alternative strategies for either examining informants' reports individually or aggregating data (e.g., composite score).

Current Study

Using Kraemer and colleagues' (2003) approach, we surmised that a *Trait* score derived from a set of strategically selected informants will significantly boost the power of multi-informant assessments to predict criterion variables taken using other modalities, over-and-above the levels of correspondence typically observed between informants' reports and these modalities (i.e., *r*s = .01-.15; Becker et al., 2014; Beidel et al., 2000a; Cartwright-Hatton et al., 2003; Hinshaw et al., 1992; Winsler & Wallace, 2002). In this study, we applied the *Trait* score approach to social anxiety assessments in a mixed clinical/community sample of adolescents. To provide a conservative test of this approach, we examined whether the *Trait* score predicted independent criterion variables above-and-beyond well-established measures of social anxiety taken from individual informants' reports. We addressed three aims. First, we expected the social anxiety *Trait* score to demonstrate incremental validity in predicting observed adolescent social

anxiety in controlled laboratory tasks, relative to well-established measures of social anxiety taken from individual informants' reports. <u>Second</u>, we expected the social anxiety *Trait* score to demonstrate incremental validity in distinguishing adolescents on referral status (i.e., clinic-referred vs. community control), relative to well-established measures of social anxiety taken from individual informants' reports. <u>Third</u>, we expected the social anxiety *Trait* score to provide incremental prediction of criterion variables, over-and-above an alternative strategy for integrating multi-informant reports, namely the *Composite* score approach.

Research Demonstration: Applying the *Trait* Score Approach to Adolescent Social Anxiety

In line with the example we presented at the opening of this paper, we demonstrate the utility of the *Trait* score approach with an innovative, evidence-based approach to multi-informant assessments of adolescent social anxiety. We seek to use this demonstration to highlight how the *Trait* score approach addresses two key limitations in evidence-based assessment of youth mental health problems broadly, and adolescent social anxiety in particular. First, when parents and adolescents disagree, assessors often make judgments that more closely align with parent reports, relative to adolescent reports (Brown-Jacobsen, Wallace, & Whiteside, 2011; Hawley & Weisz, 2003). In social anxiety assessments, parent-adolescent discrepancies often result in the interpretation that a social desirability bias leads adolescents to downplay or underreport their social anxiety symptoms (De Los Reyes et al., 2015). In contrast, by placing an emphasis on selecting informants who systematically vary in the context and perspective from which they rate youth mental health symptoms, the *Trait* score approach *forces* discrepancies among reports. That is, by normalizing the presence of discrepant reports, the approach provides methods for integrating these reports.

Second, parents serve as "gatekeepers" who play a crucial role in initiating mental health care and thus evidence-based assessments involve collecting both parent and adolescent reports, particularly for internalizing concerns (Makol & Polo, 2018). Yet, prior work indicates that relying *only* on these two informants yields insufficient clinical information. First, relative to children from earlier developmental periods, parents of adolescents have reduced access to and understanding of their adolescent's activities and relationships with peers (Smetana, 2008). Adolescent social anxiety often manifests in interactions with peers, making the peer context a key target of treatment (Hofmann et al., 1999). In support of these ideas, parent reports of adolescent social anxiety fail to predict adolescents' self-reported experiences in interactions with unfamiliar peers (Deros et al., 2018). Parents' lack of access to the peer context likely contributes to the low correspondence often observed between parent and adolescent reports of adolescent social anxiety. In contrast, to triangulate on the *Trait* score, the Kraemer and colleagues (2003) approach requires three carefully selected informants who vary in context and perspective.

When assessing adolescent social anxiety, which informants should be leveraged in the *Trait* score approach? In their self-reports, adolescents provide information from a self-perspective and across contexts. In contrast, parents provide information about mental health concerns observed in the home context, but often do not directly observe adolescents in non-home contexts. Although teachers commonly stand in as a third informant in multi-informant assessments of youth externalizing problems, they may not be the key third informant to leverage when applying the *Trait* score approach to adolescent social anxiety. Given that information about the unfamiliar peer context is crucially lacking in assessments of adolescent social anxiety, an optimal informant would have opportunities to observe the adolescent within social

interactions with unfamiliar peers. Commonly used methods for collecting peers' reports, such as peer nominations, provide information that is predictive of youth social anxiety (Gazelle, Workman, & Allan, 2010). However, these approaches often require large groups of peers to provide valid estimates of functioning for any one adolescent, and lack feasibility due to ethical concerns (e.g., obtaining parent consent to collect peer reports; Card & Hodges, 2008).

Recent work in evidence-based assessment of adolescent social anxiety supports use of a third informant: *unfamiliar peer confederates*. These individuals "stand in" as unfamiliar peers and interact with adolescents in brief, structured social interactions designed to elicit anxiety (Anderson & Hope, 2009; Beidel, Rao, Scharfstein, Wong, & Alfano, 2010; Deros et al., 2018). In fact, unfamiliar peer confederate reports yield psychometrically sound data that (a) hold incremental value in predicting adolescent social anxiety concerns relative to parent reports, (b) distinguish adolescents on referral status, and (c) predict adolescents' anxiety-related experiences in social interactions as indexed by both adolescent self-repots of state arousal and observer ratings (Deros et al., 2018; Glenn et al., 2019). Taken together, unfamiliar peer confederates provide rich information about adolescents' non-home, peer contexts, and thus represent an ideal third informant to report on adolescent social anxiety. In the present study, we leverage a curated, evidence-based set of informants that consist of parents, adolescents, and unfamiliar peer confederates, to assess adolescent social anxiety using the *Trait* score approach.

Method

Participants

We recruited study participants from the Washington, DC, Maryland, and Northern Virginia areas using advertisements posted online (e.g., Craigslist) and flyers posted in local businesses (e.g., cafes, libraries, doctor's offices). Participants responded to one of two posted

advertisements: (1) study providing a no-cost social anxiety evaluation for adolescents (i.e.,

clinic-referred adolescents) and (2) nonclinical study on family relationships (i.e., *community

control adolescents*). All study procedures described below were held consistent across

participants, regardless of referral status.

Eligible dyads were required to: (a) be fluent in English, (b) understand the consenting

and interview process, and (c) have an adolescent aged 14-15 years who the parent did not report

as having a history of learning or developmental disabilities. The total sample included 127

caregiver-adolescent dyads (43 clinic-referred, 84 community control). Adolescents were 14 or

15 years old (M_{age} = 14.46, SD = 0.50) and 85 adolescents were female (66.9%). Based on parent

report, adolescents' race/ethnicity included (values exceed 100% given that multiple categories

could be selected): African American/Black (53.5%), Caucasian/European American/White

(33.1%), Hispanic/Spanish/Latino/a (10.2%), Asian American/Asian (5.5%), American Indian

(0.8%), other (7.9%). Caregivers included the adolescent's biological mother/father (95.3%) or

other caregiver (4.7%). Caregivers reported household income using a scale with 10 categories

that varied by $100 increments. Based on this scale, 26.0% of families had a weekly household

income of $500 or less, 22.0% had a weekly household income between $501 and $900, and

52.0% had a weekly household income of $901 or more per week.

In all study analyses, we pooled the clinic-referred and community control samples. This

approach mimics displays of dimensionally varying social anxiety in the general population and

is consistent with dimensional models of psychopathology (Casey, Oliveri, & Insel, 2014).

Further, we selected this approach given prior work indicating that dimensional approaches to

assessing psychopathology exhibit greater reliability and validity relative to categorical

approaches (Markon, Chmielewski, & Miller, 2011). Nonetheless, we conducted analyses to

determine whether clinic-referred and community control groups differed on key demographic characteristics (i.e., adolescent age/gender, adolescent racial/ethnic background, family income, parent's relationship to adolescent, parent's marital status). Given the exploratory nature of these tests, we applied a Bonferroni correction (i.e., 11 tests and thus a corrected p-value of .0045) and observed non-significant differences between the clinic-referred and community control samples, thus justifying our pooled sample approach.

Procedure

We received Institutional Review Board approval for all study procedures. Prior to beginning the study, caregivers provided consent for themselves and their adolescent. Adolescents and caregivers completed a battery of counterbalanced survey measures using Qualtrics software. After completing survey measures, adolescents participated in counterbalanced mock social interaction tasks with trained peer confederates. We trained undergraduate research assistants to interact as unfamiliar peer confederates with adolescent participants across mock social interaction tasks. Upon completion of the study, families received $100 in monetary compensation for participation.

Measures

Survey measures. Parents completed a demographic questionnaire. Parents, adolescents, and unfamiliar peer confederates completed a battery of survey measures to assess the adolescent's social anxiety. These informants completed measures with parallel survey items, with only minor modification made to fit each informant's perspective (i.e., "My child" for caregiver measures, "I" for adolescent measures, "The participant" for unfamiliar peer confederate measures). As described below, unfamiliar peer confederates completed survey measures following their interactions with adolescents in social interaction tasks.

Our aims involved testing the validity of the *Trait* score approach including the incremental validity of this approach above-and-beyond alternative approaches (i.e., individual reports and *Composite* score approach). This necessitated use of three different measures of adolescent social anxiety, so as to avoid method confounds in measures used across the various approaches. First, parents, adolescents, and unfamiliar peer confederates completed the *Social Interaction Anxiety Scale* (SIAS; Mattick & Clarke, 1998), a 20-item measure for assessing social anxiety concerns that adolescents may experience during social interactions (example item: "I have difficulty making eye contact with others."). Informants rated items on a scale ranging from 0 (*Not at all characteristic or true of me*) to 4 (*Extremely characteristic or true of me*). Informants' reports on the SIAS display convergent validity and distinguish adolescents on referral status (Deros et al., 2018; Glenn et al., 2019).

Parents and adolescents also completed the widely used *Social Phobia and Anxiety Inventory for Children* (SPAIC; Beidel, Turner, & Morris, 1995), a 26-item measure in which informants endorse how often the adolescent feels nervous or scared when in various social scenarios (e.g., public speaking). Several items include "sub-items" that require informants to rate the adolescent's social anxiety with different interaction partners (e.g., "adults" vs. "boys or girls his/her age that he/she knows" vs. "boys or girls his/her age that he/she doesn't know"). These sub-items were averaged at the item level to create a composite score. Parents and adolescents rated items using a scale ranging from 0 (*Never*) to 2 (*Always*). Parent and adolescent reports on the SPAIC exhibit convergent and construct validity, distinguish adolescents on referral status, relate to observers' ratings of social skills and anxiety, and are sensitive to treatment response (Beidel et al., 1995; Beidel et al., 2000a; Beidel, Turner & Morris, 2000b).

Parents, adolescents, and unfamiliar peer confederates completed parallel forms of the Social Phobia Scale (SPS; Mattick & Clarke, 1998). The SPS is a 20-item measure for assessing adolescents' fears of being scrutinized by others during routine activities (example item: "I become nervous if I have to write in front of other people."). Informants rated items on a scale ranging from 0 (*Not at all characteristic or true of me*) to 4 (*Extremely characteristic or true of me*). The SPS demonstrates high internal consistency, discriminates individuals on diagnostic status, and is sensitive to treatment response (Mattick & Clarke, 1998; Deros et al., 2018).

In the present study, we used multi-informant SIAS scores in PCA-analyses to identify a social anxiety *Trait* score, and parent and adolescent SPAIC reports and unfamiliar peer confederate SPS reports as independent assessments of social anxiety in incremental validity analyses. Further, we used parent, adolescent, and unfamiliar peer confederate SPS reports to create a composite variable in tests of the incremental value of the *Trait* score over-and-above composite scoring methods.

Behavioral Tasks

Task descriptions. Adolescents completed a series of counterbalanced social interaction tasks with unfamiliar peer confederates adapted from prior research on social anxiety among children, adolescents, and adults (Anderson & Hope, 2009; Beidel et al., 2000a, 2010). Participants took approximately 20 minutes to complete these tasks which included a Simulated Social Interaction Test (SSIT; adapted from Curran, 1982; Beidel et al., 2000a), Unstructured Conversation Task (UCT; adapted from Beidel et al., 2010), and Impromptu Speech Task (IST; adapted from Beidel et al., 2010). Detailed descriptions of these tasks and training of unfamiliar peer confederates are available elsewhere (Deros et al., 2018; Glenn et al., 2019). Across tasks, adolescents interacted with research assistants trained to pose as adolescents. Unfamiliar peer

confederates were masked to adolescents' clinical information, including referral status, and had

no prior interaction with adolescents. Adolescents' reactions when interacting with these

unfamiliar peer confederates predict their reactions when interacting with same-age peers in

independent tasks (Karp et al., 2018).

In the SSIT, adolescents participated in a series of five role-playing scenes (e.g.,

offering/accepting assistance, giving/receiving a compliment) with a gender-matched peer

confederate. In each scene, adolescents had two opportunities to speak and we trained peer

confederates to provide two scripted responses. In the UCT, adolescents participated in an

unstructured, adolescent-driven three-minute role-play with a gender-matched peer confederate.

We provided the following instructions to adolescents: "Pretend that you are at a new school and

don't know anyone." We trained peer confederates to respond neutrally to adolescents and allow

adolescents to lead the conversation. In the IST, adolescents participated in a speech task in

which they delivered a speech to a small audience of unfamiliar peers about various topics (e.g.,

public health, politics). Adolescents were provided a three-minute period of preparation after

which they were provided a ten-minute period to complete their speech.

Adolescent social anxiety behavioral ratings. We used a behavioral coding scheme

developed by Beidel and colleagues (Beidel et al., 2000a, 2010; Scharfstein, Beidel, Sims, &

Finnell, 2011) to obtain independent observers' ratings of adolescent social anxiety in social

interaction tasks. Two independent observers used video-recordings of social interaction tasks to

make macro-level ratings of adolescent social anxiety on a 5-point scale rating from 1

(*Animated*) to 5 (*Severe anxiety*). Independent observers made a total of 7 ratings (i.e., 5 SSIT

ratings, 1 UCT rating, 1 IST rating), and we computed a social anxiety composite rating across

tasks. Inter-rater reliability for the two independent observers' ratings of social anxiety were in

the excellent range (average *intraclass correlation* = .76). For the current study, we had 105

participants with complete behavioral rating data available.[1]

Data Analytic Plan

      Trait **score identification.** We conducted PCA using procedures described by Kraemer et

al. (2003). Specifically, we conducted an unrotated PCA using three "items", namely the total

scores of parent, adolescent, and unfamiliar peer confederate SIAS reports. In this respect, our

subject-to-item ratio (i.e., 127/3 = 42.3:1) falls well above the typical subject-to-item ratios

deemed "large" within PCA modeling contexts (e.g., 20:1; see Osborne & Costello, 2004).

Within this unrotated PCA, we set the number of components to be extracted to three. As

described previously, we examined principal component weights for each informant's report to

determine whether we identified *Trait*, *Context*, and *Perspective* scores.

      Prediction of independent criterion variables. To conduct rigorous tests of the

incremental validity of an assessment tool and avoid criterion contamination, independent

criterion variables should be used that are completely independent from individual informants'

reports (Garb, 2003). Thus, in our tests of the incremental validity of the *Trait* score approach,

we conducted a series of hierarchical linear regressions to evaluate whether the *Trait* score

provides incremental prediction of observed adolescent behavior and referral status. We also

conducted secondary analyses to determine whether the *Context* and *Perspective* scores provided

incremental predication of these independent criterion variables.

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[1]We conducted chi-square analyses to determine whether participants with and without behavioral rating data differed on key demographic characteristics (i.e., adolescent age/gender, family income, parent's relationship to adolescent, parent's marital status). We did not conduct chi-square analyses for race/ethnicity for these two groups given that doing so would require comparisons of groups with cell sizes including fewer than 5 participants. Given the exploratory nature of these tests, we applied a Bonferroni correction (i.e., 5 tests and thus a corrected *p*-value of .01). We observed non-significant differences between participants with and without behavior rating data available.

First, we examined whether the SIAS *Trait* score explained variance in observed adolescent social anxiety, over-and-above the explanatory value of individual informants' reports on independent social anxiety measures. Behavioral observations contribute to evidence-based assessment and clinical decision-making tasks, in particular in assessing behaviors crucial to understanding an individual's presenting problems and measuring change in target behaviors over the course of treatment (Groth-Marnat & Wright, 2016). For example, prior work using the behavioral coding scheme leveraged in the present study finds that observed behavior can be used to estimate treatment response (Beidel et al., 2000b, 2010, 2014; Bunnell, Beidel, & Mesa, 2013). Thus, in evaluating the *Trait* score approach, we selected observed behavior as an independent criterion variable to determine whether the *Trait* score could predict social anxiety observed in key contexts in which adolescents experience social anxiety. We constructed three separate regression models (i.e., one per informant) with observed adolescent social anxiety as the criterion variable. For these models, we entered parent (i.e., SPAIC), adolescent (i.e., SPAIC), and unfamiliar peer confederate (i.e., SPS) reports of adolescent social anxiety in the first step as independent variables, and the *Trait* score in the second step as an independent variable. These analyses allowed us to determine whether the *Trait* score provided incremental prediction of observed adolescent social anxiety, above-and-beyond prediction provided by well-established, commonly used, individual informants' reports.

Second, we tested the incremental validity of the SIAS *Trait* score using a series of hierarchical logistic regressions. We examined whether the *Trait* score explained variance in adolescent referral status, over-and-above the explanatory value of individual informants' reports on independent social anxiety measures. For clinical decision-making purposes, it is important for measurement tools to distinguish youth with clinically significant concerns from those

without such concerns (e.g., Achenbach & Rescorla, 2001). In fact, researchers commonly use referral status to test the psychometric properties of clinical instruments in research on evidence-based assessment of youth anxiety (De Los Reyes & Makol, 2019; Silverman & Ollendick, 2005). Thus, in evaluating the *Trait* score approach, we selected referral status as an independent criterion variable to determine whether the *Trait* score approach could be used to distinguish youth with and without clinically significant social anxiety concerns. We constructed three separate regression models (i.e., one per informant) with adolescent referral status (0 = community control, 1 = clinic-referred) as the criterion variable. For these models, we entered parent (i.e., SPAIC), adolescent (i.e., SPAIC), and unfamiliar peer confederate (i.e., SPS) reports of adolescent social anxiety in the first step as independent variables, and the *Trait* score in the second step as an independent variable. These analyses allowed us to determine whether the *Trait* score provides incremental prediction of adolescent referral status, above-and-beyond prediction provided by well-established and commonly used individual informants' reports.

Comparing the *Trait* score and *Composite* score approaches. We tested whether the PCA-derived *Trait* score provided incremental prediction of our independent criterion variables, over-and-above a mean-derived *Composite* score. We first computed a social anxiety *Composite* score by creating a variable capturing the average of parent, adolescent, and unfamiliar peer confederate SPS reports ($M = 21.64$, $SD = 11.28$). We selected the SPS to allow for a comparison of the *Trait* score approach to the *Composite* score approach using independent measures of the same construct, each with parallel forms (*Trait* score: SIAS; *Composite score*: SPS). We then constructed two separate regression models (i.e., one per criterion variable) with either observed adolescent social anxiety or adolescent referral status (0 = community control, 1 = clinic-referred) as criterion variables. For these models, we entered the SPS *Composite* variable in the

first step as an independent variable, and the SIAS *Trait* score in the second step as an

independent variable. These analyses allowed us to determine whether the PCA-derived *Trait*

score provided superior prediction when compared to a commonly used integrative method.

For all of our aims, we interpreted statistical significance using a *p*-value threshold of <.

05. We inferred magnitudes of effect sizes based on Cohen's (1988) effect size conventions for

the effect size *r* (low: .10; moderate: .30; large: .50).

Results

Preliminary Analyses

All survey measures displayed acceptable levels of skewness and kurtosis (i.e., scores <

±2.0) and excellent internal consistency (i.e., all α's ≥ .93). We computed bivariate correlations

to examine associations within and between multi-informant social anxiety measures used in our

study and included this information as supplementary material (Supplemental Table 1).

Consistent with prior work (Achenbach et al., 1987; De Los Reyes et al., 2015), correlations for

between-informant ratings of adolescent social anxiety were in the small-to-moderate range (i.e.,

*r*s = .08-.49). Overall, we observed small-to-moderate correlations among informants' SIAS

reports (Figure 2), suggesting that we achieved effective triangulation by selecting informants

who varied in their context and perspective.

Trait Score Identification

In Table 1, we report results from PCA analyses using parent, adolescent, and unfamiliar

peer confederate SIAS reports. Consistent with Kraemer et al. (2003), we identified three

components that displayed patterns consistent with *Trait*, *Context*, and *Perspective* scores.

Specifically, the first component was consistent with a *Trait* score given that loadings for all

informants were positive and large in magnitude. The second component was consistent with a

Context score given that parent and unfamiliar peer confederate reports exhibited contrasting

loadings (i.e., reflecting the home vs. nonhome context of informants) and adolescent reports

loaded between parent and unfamiliar peer confederate reports (i.e., reflecting both contexts).

The third component was consistent with a *Perspective* score given that parent and unfamiliar

peer confederate reports loaded positively and contrasted with adolescent reports (i.e., reflecting

the other vs. self-perspective of informants).

Prediction of Observed Adolescent Behavior

In Table 2, we report analyses examining the incremental validity of the SIAS *Trait* score

in predicting observed adolescent social anxiety. In the first step of each regression, individual

informants' reports of social anxiety predicted observed adolescent social anxiety at moderate-

to-large magnitudes (i.e., βs = .30-.52). In the second step of each regression, the *Trait* score

predicted incremental variance in observed adolescent social anxiety, over-and-above the

variance accounted for by individual informants' reports (i.e., βs = .47-.67). Overall, the *Trait*

score accounted for an additional 13-29% of the variance in observed social anxiety, representing

moderate-to-large effects. In additional regression analyses, the *Context* and *Perspective* scores

inconsistently predicted incremental variance in observed adolescent social anxiety, over-and-

above the variance accounted for by individual informants' reports (i.e., effects ranging from

non-significant to large in magnitude; see Supplemental Tables 2 and 3).

Prediction of Referral Status

In Table 2, we report analyses examining the incremental validity of the *Trait* score in

predicting adolescent referral status. In the first step of each regression, individual informants'

reports on independent measures of social anxiety predicted adolescent referral status (i.e., ORs

= 1.03-1.11). In the second step of each regression, the *Trait* score predicted incremental

variance in adolescent referral status, over-and-above the variance accounted for by the

individual informants' reports. For every one-unit increase in the *Trait* score in the second step

of regression models, adolescents were approximately 3 to 7 times more likely to be in the clinic-

referred group, relative to the community control group. In additional regression analyses, the

Context and *Perspective* scores inconsistently predicted incremental variance in adolescent

referral status, over-and-above the variance accounted for by individual informants' reports (i.e.,

effects ranging from non-significant to small in magnitude; see Supplemental Tables 2 and 3).

Comparing the *Trait* Score and *Composite* Score Approaches

We conducted analyses to determine whether the *Trait* score provided incremental

prediction of criterion variables, over-and-above a *Composite* score calculated by averaging the

three informants' SPS reports. We found a large and positive correlation between the *Composite*

and *Trait* score ($r = .88$, $p < .001$), and non-significant correlations between the *Composite* and

Context ($r = -.06$, $p = .48$) and *Perspective* ($r = .004$, $p = .96$) scores. This pattern of correlations

suggests that although the *Trait* and *Composite* scores show a high degree of overlap, they

capture unique information derived from informants' reports.

Using a hierarchical liner regression model, we examined whether the SIAS *Trait* score

provided incremental prediction of observed adolescent social anxiety, over-and-above the SPS

Composite score. In the first step of the regression model, the *Composite* score explained

significant variance in observed adolescent social anxiety, $\beta = .54$; $\Delta R^2 = .30$; $F\Delta(1,101) =$

42.55; $p < .001$. In the second step of the regression model, the *Trait* score explained incremental

variance in observed adolescent social anxiety, over-and-above the *Composite* score, $\beta = .60$;

$\Delta R^2 = .08$; $F\Delta(1,100) = 12.75$; $p < .01$.

Using a hierarchical logistic regression model, we examined whether the SIAS *Trait* score provided incremental prediction of adolescent referral status, over-and-above the SPS *Composite* score. In the first step of the regression model, the *Composite* score explained significant variance in adolescent referral status, $b = .09$; $OR = 1.10$; $p < .001$. In the second step of the regression model, the *Trait* score explained significant variance in adolescent referral status, over-and-above the *Composite* score, $b = 1.45$; $OR = 4.26$; $p < .01$.

To fully evaluate the incremental validity of the *Trait* score, we conducted additional regression analyses in which we examined whether the SPS *Composite* score provided incremental prediction of observed adolescent social anxiety and referral status, over-and-above the SIAS *Trait* score. In the first step of the regression model, the *Trait* score explained significant variance in observed adolescent social anxiety, $\beta = .61$; $\Delta R^2 = .38$; $F\Delta(1,101) = 60.84$; $p < .001$. In the second step of the regression model, the *Composite* score did not explain incremental variance in observed adolescent social anxiety, over-and-above the *Trait* score, $\beta = .01$; $\Delta R^2 = .00$; $F\Delta(1,100) = .01$; $p = .94$. In the first step of the regression model, the *Trait* score explained significant variance in adolescent referral status, $b = 1.30$; $OR = 3.66$; $p < .001$. In the second step of the regression model, the *Composite* score did not explain significant variance in adolescent referral status, over-and-above the *Trait* score, $b = -.02$; $OR = .99$; $p = .72$. Overall, these findings support that the *Trait* score, which is derived using PCA, provides incremental prediction of criterion variables over-and-above well-established individual informants' reports and widely used integrative methods. Specifically, the *Trait* score, which partials out variance from context and perspective (i.e., r of "0" between *Trait* score and *Context* and *Perspective* scores), provides a more precise index of the domain being assessed, relative to both the *Composite* score and individual informants' reports.

Discussion

Main Findings

In this study, we rigorously examined the validity of the *Trait* score approach when applied to adolescent social anxiety assessments. To our knowledge, our study provided the most rigorous and conservative test of the *Trait* score approach to date, through use of theoretical frameworks and basic science to guide selection of informants, parallel measures across informants, independent criterion variables, and comparisons to an alternative integrative approach. We had three main findings. First, the *Trait* score incrementally predicted observed social anxiety, over-and-above individual informants' reports, with moderate-to-large magnitude effects. Beyond individual informants' reports, the *Trait* score explained approximately 10 to 30 percent more variance in observed adolescent social anxiety. Second, the *Trait* score incrementally predicted adolescent referral status, over-and-above individual informants' reports. Specifically, for every one-unit increase in the *Trait* score, adolescents were three to seven times more likely to be in the clinic-referred group, relative to the community control group. Consistent with Kraemer and colleagues' (2003) focus on the *Trait* score, *Context* and *Perspective* scores failed to predict observed behavior and referral status as robustly and at as high magnitudes as the *Trait* score. Third, we found large magnitude effects for the ability of the *Trait* score to predict observed social anxiety and adolescent referral status, over-and-above a mean-derived *Composite* of informants' reports of social anxiety. In contrast, the *Composite* score did not provide incremental prediction of observed social anxiety and adolescent referral status, over-and-above the *Trait* score. Overall, these findings provide an initial, rigorous demonstration of the *Trait* score's validity, supporting the potential of this approach to improve clinical decision-making in youth mental health assessments.

Research and Theoretical Implications

Kraemer and colleagues (2003) proposed that the *Trait* score represents youth behaviors

that vary across contexts and perspectives, as PCA removes unique variance attributable to these

components. Researchers commonly apply PCA to individual items in a measure to identify

subscales or items that appear to measure common constructs (Tabachnick & Fidell, 2001).

Similarly, Kraemer and colleagues applied PCA to individual informants' reports to identify

factors that explain variability among these reports. The *Trait* score significantly out-performed

the *Composite* score approach in our multi-informant assessment of adolescent social anxiety

(the reverse was not true), supporting that the PCA-derived *Trait* score's "triangulation" may

provide optimal prediction. This finding suggests that not all integrative strategies are created

equal. Although the *Trait* and *Composite* score were correlated (due to including the same three

informants' reports of social anxiety, although on unique measures), the *Composite* score is

limited in that it is a simple average of informant's reports. Using the GPS metaphor, the *Trait*

score accounts for the positioning and relative distance of satellites (i.e., informants), whereas

the *Composite* score aggregates satellite information without any attention to their source or

relative distance. More fundamentally, theory underlying the *Composite* score is in direct

contrast not only to theory underlying the *Trait* score but a considerable body of research on

multi-informant assessments. Specifically, the *Composite* score approach assumes that each

informant provides an error-prone estimate that, when aggregated, points to a "true mean"

representation of the domain assessed (Borsboom, 2005; Edgeworth, 1888). This assumption

logically extends to collecting reports that achieve maximal *collinearity* with one another,

informants for whom reports correspond to a significant extent. In contrast, the *Trait* score

approach assumes that informants' disagreements do not merely reflect measurement error. In

fact, they vary systematically and predictably, requiring maximal *orthogonality* among reports (Kraemer et al., 2003). As reviewed previously, research over the last decade supports treating informants' disagreements as reflecting systematic and clinically valuable information (De Los Reyes et al., 2013, 2015). Overall, our pattern of findings provides strong support for conceptualizing and integrating informants' reports as orthogonal information sources.

Over-and-above individual informants' reports, the *Trait* score provided incremental prediction of observed adolescent behavior and referral status. These criterion variables differed in measurement method, providing support for use of the *Trait* score in prediction of both dimensional and discrete clinical indices. As previously mentioned, informants' reports of youth mental health, and particularly youth internalizing problems, are associated with observed behavior at only small-to-moderate levels. Benchmarked against prior work, the *Trait* score provided more powerful prediction, accounting for up to 30% more variance in observed behavior beyond variance accounted for by individual informants' reports. Of note, we obtained observations of adolescent social anxiety in the context of mock social interactions with unfamiliar peers. The *Trait* score predicted observed anxiety in the non-home peer context, and more strongly than an informant observing adolescent behavior in that same context (i.e., unfamiliar peer confederates). Thus, the *Trait* score outperformed a context-specific informant when predicting context-specific behavior, suggesting that it is a useful tool for understanding youth mental health concerns globally (i.e., referral status) as well as in specific contexts (i.e., interactions with unfamiliar peers).

Clinical Implications

In practice, low informant convergence is often interpreted as reflecting informant bias or measurement error (De Los Reyes, 2011), resulting in suboptimal use of these reports.

Specifically, when confronted with informant discrepancies, clinicians often make decisions that "toss out" several informants' reports in favor of a single informant's report (Brown-Jacobsen et al., 2011; Hawley & Weisz, 2003; Marsh et al., 2019). Taken together with the findings reported in this paper, we suspect that one's hypothesis about the meaning underlying informant discrepancies (e.g., they reflect measurement error, one informant provides "better" reports) might result in idiosyncratic decision-making for important clinical tasks such as diagnosis and treatment selection. A large body of research demonstrates that these idiosyncrasies not only commonly occur in clinical work, but that statistical- or actuarial-based decision-making results in relative improvements in accuracy and effectiveness (Grove, Zald, Lebow, Snitz, & Nelson, 2000; Lilienfeld & Lynn, 2014; Meehl, 1954; Youngstrom et al., 2018). Future research is needed to understand how the *Trait* score approach can move clinical decision-making when using multi-informant reports from an idiosyncratic, dismissive stance on specific information sources, to an evidence-based, inclusive stance on multiple information sources.

The *Trait* score approach can be feasibly implemented in clinical settings and is in line with current evidence-based assessment practices. Estimation of component scores using PCA involves applying a linear transformation to informants' reports, so as to convert these reports into orthogonal variables. Thus, much like calculation of *T*-scores in scoring programs for commonly used evidence-based assessments (e.g., Achenbach System of Empirically Based Assessment [ASEBA]; Achenbach, 1993; Behavioral Assessment System for Children [BASC]; Reynolds & Kamphaus, 2004), calculation of the *Trait* score could be programmed into scoring software and included in output designed to enhance clinician interpretation. For example, to enhance the clinical utility of the ASEBA measures, Achenbach's (1993) manual included core profiles based on cluster analysis and exposition that detailed a potential empirical taxonomy

based on the multivariate analyses. McDermott & Weiss' (1995) validation study of the

Adjustment Scales for Children and Adolescents (ASCA) included detailed synopses derived

from cluster analysis of participants' *T*-score profiles across the ASCA's six syndromes. Further,

the technical manual included instructions for determining which cluster best matched a new

case's profile; these, too, were programmed into spreadsheets for personal use. More recent

efforts indicate that one does not need the infrastructure of a well-established clinical instrument

to apply PCA findings to interpreting clinical data. Specifically, to increase dissemination of

evidence-based assessment practices in clinical settings, researchers have developed

straightforward Excel spreadsheets for entering scores for individual clients to obtain

multivariate profiles ("Focus on Innovation and Redesign in Systems and Treatment", 2020;

Youngstrom, 2014). Thus, strategies such as these provide proof-of-concept for the application

of the *Trait* score approach in clinical settings. These strategies can inform the development of

paradigms for using the *Trait* score as an efficient integrative tool for multi-informant reports

administered at the individual level and thus commensurate for use in service delivery settings.

Limitations and Future Directions

Our study represented an early stage illustration of the validity of the *Trait* score

approach. It will be important for future research to determine whether our findings replicate in

larger samples that vary in key clinical and demographic characteristics. In our study, we

leveraged the *Trait* score approach at the sample level, similar to use of factor analytic

techniques to arrive at subscales for use in refining measurement tools. Although the

development of strategies for applying the *Trait* score approach to individual cases awaits further

study, we expect the current study to inform strategies for use with individual-level clinical

decision-making. In particular, we encourage future research that leverages both larger and

nationally representative samples and norming procedures that allow *Trait* scores to be interpretable at the individual level.

Kraemer and colleagues (2003) proposed that the *Trait* score, and not the *Context* and *Perspective* scores, provides maximal prediction of clinical variables. Consistent with this, our findings suggest that the *Context* and *Perspective* scores are unlikely to provide robust prediction of independent criterion variables. PCA identifies orthogonal principal components, with the first principal component accounting for the largest amount of item variance. Thus, it is unsurprising that the *Context* and *Perspective* scores displayed inferior prediction of independent criterion variables as they accounted for less variance in informants' reports. It is also important to note that our findings may be unique given that our study design was optimized for high levels of internal validity. That is, by design, we systematically varied informants' contexts: Parents and unfamiliar peer confederates had no access to each other's observations and as such, we rendered impossible opportunities for "cross talk" or the exchanging of clinically relevant information between these informants. Despite the likely occurrence of "cross talk" in clinical settings (e.g., parent-teacher conferences), a large evidence base supports that informants in these settings often provide discrepant reports and patterns among these reports provide meaningful clinical information (Achenbach et al., 1987; De Los Reyes et al., 2015). In the *Trait* score approach, informant "cross talk" may be conceptualized as unsystematic measurement error, with systematic factors such as informants' contexts and perspectives accounting for more variance among reports. Overall, prior work supports the idea that informant "satellites" can receive some overlapping information about youth behavior without undermining effective triangulation.

We used unfamiliar peer confederates in the *Trait* score approach given their access to adolescents' social anxiety in peer contexts, where parents often have rare opportunity to observe

adolescent behavior (Deros et al., 2018). However, these reports are rarely collected in research and clinical settings and may not be feasible to implement in some settings. Future research should rigorously examine the *Trait* score approach among commonly used informants. Supporting that the *Trait* score approach will generalize to commonly used informants, meta-analytic work demonstrates that small-to-moderate convergence is common among parent-youth, parent-teacher, and teacher-youth reports of youth mental health (Achenbach et al., 1987; De Los Reyes et al., 2015). These levels of convergence approximate those needed to triangulate effectively on a *Trait* score, suggesting that these informants systematically vary in how they rate youth mental health.

Although the present study focused on social anxiety, we expect findings to generalize to rigorous research applying the *Trait* score approach to other problem domains. Future research should thoughtfully apply the "mix and match" criterion to identify optimal informants and multi-modal indices in mental health assessments. For example, the *Trait* score approach may improve the information derived in externalizing problem assessments. Given the importance of understanding externalizing problems across key contexts (i.e., home, school), most research on the interpretability of multi-informant reports and cross-contextual variations in mental health concerns focuses on externalizing problems (e.g., disruptive behavior; attentional concerns; Drabick, Bubier, Chen, Price, & Lanza, 2011; Strickland, Hopkins, & Keenan, 2012). Thus, the *Trait* score approach is well-suited to externalizing problem assessments.

We also expect that the issues discussed in this paper, which focused on integrating multiple information sources, will be relevant to basic research on psychopathology. For example, the Research Domain Criteria (RDoC) seeks to develop and validate dimensional constructs derived from multiple units of analysis (e.g., subjective reports, behaviors,

physiology), in an effort to improve clinical decision-making (Casey et al., 2014). RDoC approaches rely on evidence-based assessment of key constructs as well as data analytic models for integrating these multivariate data. Recent work highlights the challenges of accomplishing these tasks (Youngstrom et al., 2018). Mental health concerns can be particularly challenging to assess, not just due to low convergence among informants' reports, but also the low convergence generally among units of analysis within and across functional domains relevant to externalizing disorders (e.g., social processes, regulatory functioning; Beauchaine & Hinshaw, 2020). We anticipate that research in this area will benefit from conceptualizing disparate information sources as satellites collecting unique information that varies for systematic and predictable reasons, and consequently, interpret low measurement convergence as a tool for optimizing prediction (De Los Reyes, Drabick, Makol & Jakubovic, 2020). Overall, when integrated with contemporary conceptual models informing research on multi-informant assessments (OTM; De Los Reyes et al., 2013), the theory and method of the *Trait* score approach advanced by Kraemer and colleagues (2003) has the potential to transform widely used practices in multi-informant assessments, as well as inform clinical developmental research on a broad array of other units of analysis.

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Author Contributions

Table 1

Principal-Component Analysis (PCA) of Parent, Adolescent, and Unfamiliar Peer Confederate Reports on the Social Interaction Anxiety Scale (SIAS) (n=125)

Informant	Trait	Context	Perspective	Sources of Variability in Informant's Report
	Component Weight			
Parent	0.72	0.64	0.26	Home (context), Other (perspective)
Adolescent	0.82	-0.06	-0.56	Home and Non-home (context), Self (perspective)
Unfamiliar Peer Confederate	0.75	-0.55	0.37	Non-home (context), Other (perspective)
Eigenvalue	1.76	0.72	0.52	
Variance attributable to component	58.5%	24.1%	17.4%	

Note. PCA conducted with participants for whom we had full data for parent, adolescent, and unfamiliar peer confederate SIAS reports. Kraemer et al. (2003) described the following criteria for each component: *Trait* (all three informants' reports load strongly and in the same direction), *Context* (informants from different contexts load in opposite directions) and *Perspective* (self-reports load in the opposite direction of observer informants' reports).

Table 2

Hierarchical Regressions Examining the Criterion-Related Validity of SIAS Trait Scores in Predicting Observed Adolescent Social Anxiety and Referral Status

Variable	ΔR^2	Total R	B(SeB)	β	b	OR
	Observed Social Anxiety (*N*=105)				**Adolescent Referral Status (*N*=127)**	
Step 1	.09**	.30				
SPAIC, Parent			.02 (.01)	.30**	.11(.02)	1.11***
Step 2	.29***	.62				
SPAIC, Parent			-.01(.01)	-.10	.07(.03)	1.07**
SIAS, Trait Score			.55 (.08)	.67***	.98(.29)	2.66**
Variable	**ΔR^2**	**Total R**	**B(SeB)**	**β**	**b**	**OR**
Step 1	.19***	.44				
SPAIC, Adolescent			.03 (.01)	.44***	.08(.02)	1.08***
Step 2	.19***	.61				
SPAIC, Adolescent			-.01(.01)	-.06	-.01(.03)	.99
SIAS, Trait Score			.54(.10)	.66***	1.35(.36)	3.85***
Variable	**ΔR^2**	**Total R**	**B(SeB)**	**β**	**b**	**OR**
Step 1	.27***	.52				
SPS, Unfamiliar Peer Confederate			.03 (.004)	.52***	.02(.01)	1.03*
Step 2	.13***	.63				
SPS, Unfamiliar Peer Confederate			.01(.01)	.22*	-.04(.02)	.96*
SIAS, Trait Score			.39(.09)	.47***	1.88(.40)	6.53***

Note. **SPAIC** = Social Phobia and Anxiety Inventory for Children; **SIAS** = Social Interaction Anxiety Scale; **SPS** = Social Phobia Scale; *p<.05; **p<.01; ***p<.001.
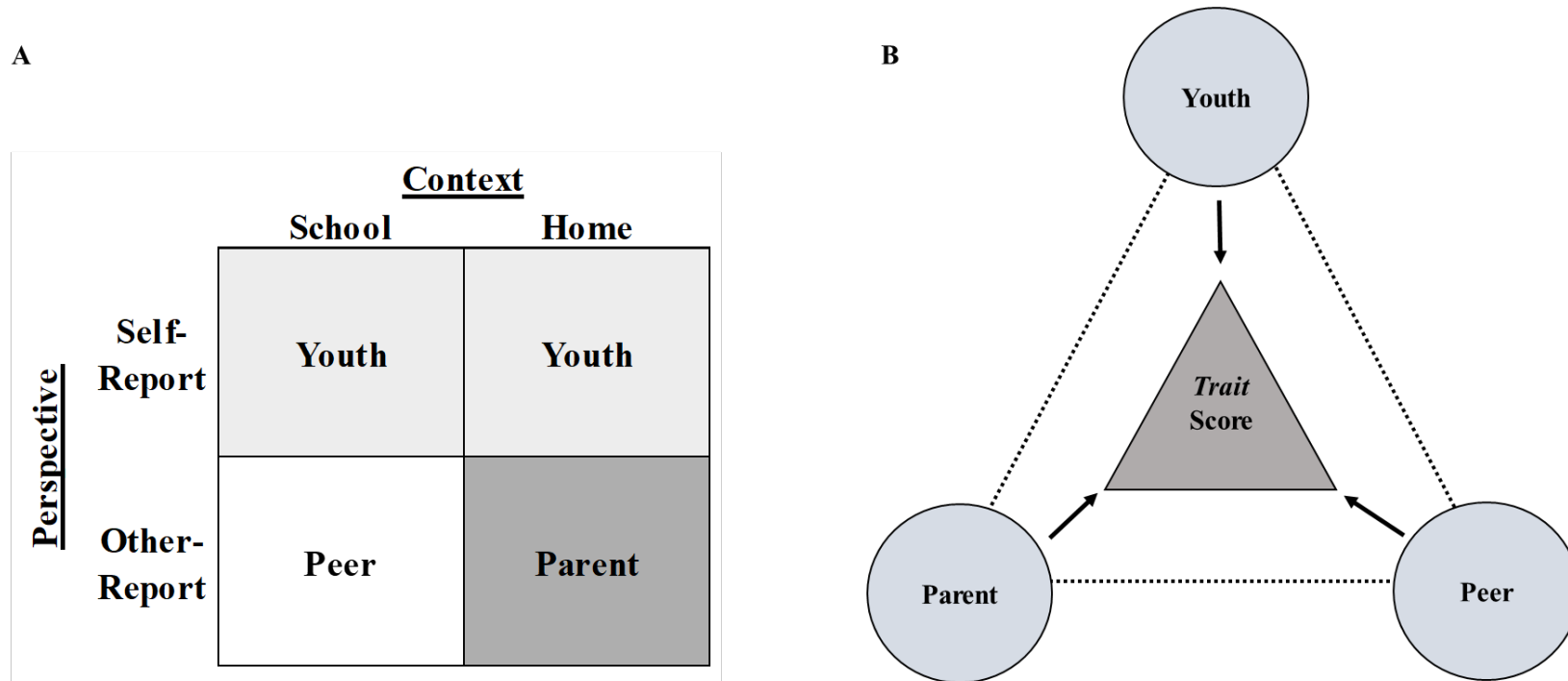
Figure 1. **Panel A:** Example of use of "mix-and-match" criterion to identify optimal informants to include in a multi-informant assessment. Informants systematically vary in the perspective and context from which they rate youth mental health symptoms, with the goal of effectively triangulating on a *Trait* score. **Panel B:** Graphical depiction of multi-informant reports triangulating, much like GPS, to identify the *Trait* score. Both peer- and parent-reports provide information from an other-perspective, with peers providing information about the school context and parents providing information about the home context. Youth reports provide the self-perspective and information about both the school and home contexts. Figures adapted from Kraemer et al. (2003).
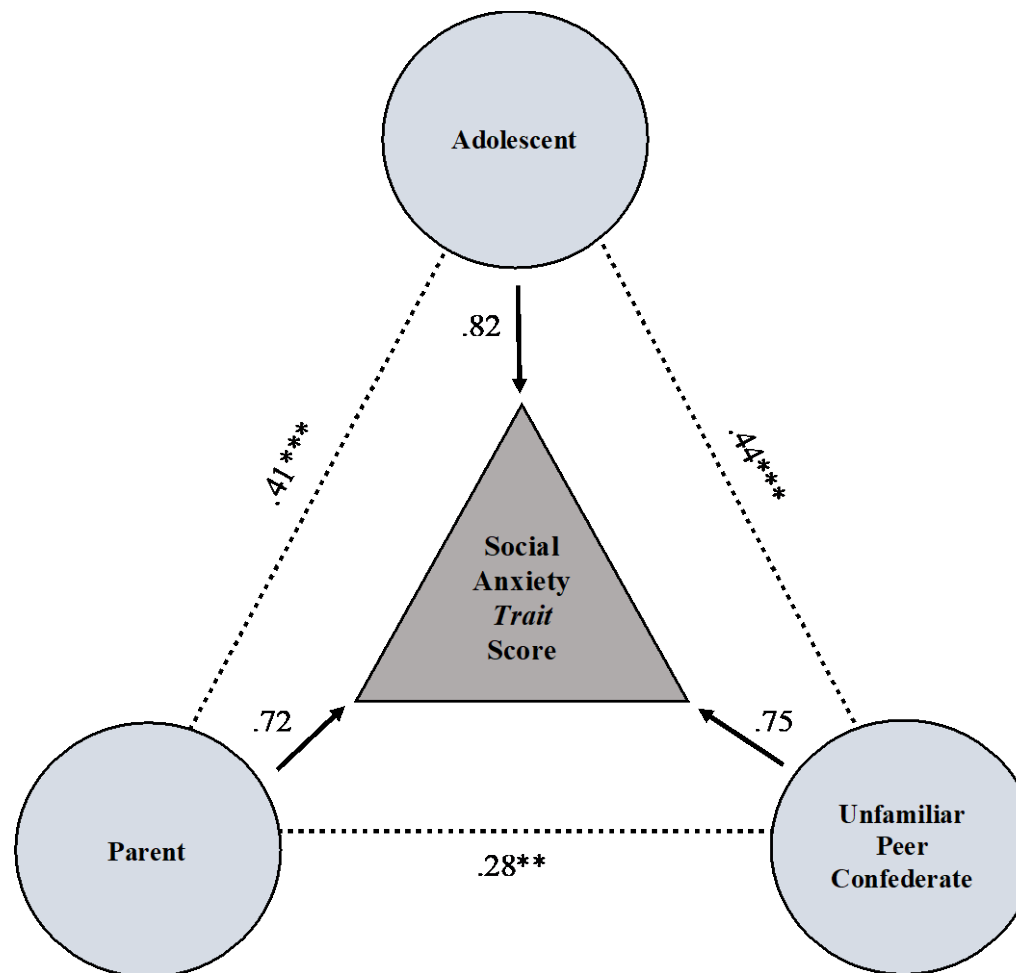
Figure 2. Values on dotted lines denote bivariate correlations among parent, adolescent, and unfamiliar peer confederate reports of adolescent social anxiety. Values on solid arrows denote component weights from PCA of parent, adolescent, and unfamiliar peer confederate reports. *$p < .05$; **$p < .01$; ***$p < .001$.