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Validation of the Self-Report Version of the German Strengths and Weaknesses of ADHD Symptoms and Normal Behavior Scale (SWAN-DE-SB)

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Abstract

Adults with attention-deficit/hyperactivity disorder (ADHD) experience impairing levels of inattention and/or hyperactivity-impulsivity, while individuals without ADHD experience these symptoms to a lesser extent. Yet, ADHD self-report scales so far hardly captured continuous distributions across the general population. In addition, they focused on weaknesses and ignored strengths. To address these shortcomings, we present here the *Strengths and Weaknesses of ADHD and Normal-Behavior Scale Self-Report (SWAN-DE-SB)*. The normal distribution of the data collected and the scale's internal consistency, and factorial and convergent validity were assessed using data from a general population sample. Its clinical utility was evaluated by comparing scores from a clinical sample and a sample of individuals without ADHD and by calculating optimal cut-off values for specificity and sensitivity. The SWAN-DE-SB demonstrated normal distribution of the data collected, high internal consistency, and factorial and convergent validity. It reliably discriminated individuals with and without ADHD, with high specificity and sensitivity. It should therefore be considered a psychometrically convincing measure to assess strengths and weaknesses of ADHD symptoms and normal behavior in clinical and general population samples.

Keywords

SWAN scale, attention-deficit/hyperactivity disorder (ADHD), self-regulation, self-report, adults

Adults with symptoms of attention-deficit/hyperactivity disorder (ADHD; American Psychiatric Association [APA], 2013) experience symptoms of either inattention (e.g., difficulty sustaining attention at work, during tasks or activities), hyperactivity-impulsivity (e.g., interrupting and intruding on others by butting into conversations, excessive talking), or both. These symptoms were shown to implicate impaired academic (e.g., lower rate of high school and university degrees), occupational (e.g., lower overall income), and social functioning (e.g., fewer friends, higher divorce rates; Frazier, Youngstrom, Glutting, et al., 2007; Fredriksen et al., 2014; Friedman et al., 2003; Mannuzza et al., 1997). Symptoms are expected to initially manifest in childhood and to persist into adulthood in about half of the cases, resulting in a prevalence of approximately 2.5% in adults (Simon et al., 2009; Song et al., 2021). Clinically, ADHD is recognized to manifest in three presentations: a predominantly inattentive presentation, where individuals exhibit mainly symptoms of inattention; a predominantly hyperactive-impulsive presentation, where individuals exhibit mainly symptoms of hyperactivity-impulsivity;

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and a combined presentation, where patients experience impairing levels of both. Notably, while these presentations can be categorized, the symptoms of ADHD form a dimension of symptom severity within these categories.

Previous research has indicated, however, that inattention and hyperactivity-impulsivity are not only experienced by individuals diagnosed with ADHD. Rather, the symptoms should be viewed as existing along a continuum ranging from subthreshold to intense and clinically significant symptomatology (Frazier, Youngstrom, & Naugle, 2007; Haslam et al., 2006; Levy et al., 1997; Marcus & Barry, 2011; Salum et al., 2014). Relatively asymptomatic individuals are likely to experience high levels of functional capacity, while those diagnosed with ADHD are likely to experience significant levels of dysfunction. This distinction represents the positive and negative extremes, respectively, of a spectrum prevalent within the general population. Thus, it can be inferred that ADHD symptoms and related strengths and weaknesses are experienced to varying degrees by all individuals. In this instance, it may be worth investigating potential associations between inattention and hyperactivity-impulsivity and other constructs among samples from the general population. This is particularly pertinent since individuals presenting with subclinical and lower levels of ADHD symptoms may also encounter challenges related to these symptoms (e.g., Balázs & Keresztény, 2014; Bangma et al., 2020). Implications arising from such studies should therefore be relevant to the wider population.

Previously, such research has been conducted using conventional clinical ADHD rating scales. These, however, take an exclusively deficit-oriented view, ignoring potential strengths and artificially truncating the full range of behaviors (Swanson et al., 2012). Furthermore, they are likely to be associated with certain drawbacks, especially when used in general population samples (cf. Schulz-Zhecheva et al., 2019; Swanson et al., 2012). First, since the vast majority of the general population does not exhibit ADHD symptoms or only exhibit them infrequently, and only a small number of individuals score in the negative extreme of existing clinical scales, any such scale will typically produce a skewed distribution. These distributions have serious methodological ramifications for studies that consider ADHD symptoms to be continuously distributed in the general population, as statistical power and validity are significantly reduced by missing meaningful variance at the positive end of the distribution. Second, at the item level, scales that focus solely on an individual's deficits ignore their strengths, which could offset their weaknesses (e.g., being organized despite struggling to stay focused when working on a task). These concerns can be resolved by employing a scale that evaluates the full range of symptoms of ADHD.

To address these shortcomings, Swanson and colleagues (2012) introduced the *Strengths and Weaknesses of ADHD-Symptoms and Normal-Behavior (SWAN) Scale* assessing symptoms of school-aged children's inattention and hyperactivity-impulsivity through third-party report. This scale comprised 18 items and is based on the symptom criteria outlined in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; APA, 2000, also in accordance with *Diagnostic and Statistical Manual of Mental Disorders* [5th ed.; *DSM-5*]; APA, 2013). The SWAN scale was designed to assess school-aged children's behavior, wherefore the items addressed school and play situations and children's behavior at home. Contrasting established clinical scales, all items were worded positively (e.g., "Remembers daily activities" instead of "Is often forgetful in daily activities"). A 7-point scale anchoring the negative (i.e., "far below average") and positive (i.e., "far above average") ends of the dimension was used to compare the child with other children the same age. The original SWAN scale therefore comprised the first scale assessing ADHD symptoms in a truly dimensional way. Like its later translations to Spanish, French, Chinese, and German, it was shown to have excellent psychometric properties (Arnett et al., 2013; Hay et al., 2007; Lakes et al., 2012; Polderman et al., 2007; Schulz-Zhecheva et al., 2019; Swanson et al., 2012). This is reflected in normally distributed data in the general population, high internal consistency and adequate retest reliability, and excellent convergent validity as indicated by high correlations with existing diagnostic instruments. Also, its sensitivity and specificity in distinguishing children with and without ADHD as well as children with ADHD and other mental disorders have been shown (Chan et al., 2014; Lai et al., 2013; Robaey et al., 2007; Schulz-Zhecheva et al., 2019). In addition, a bifactor model has consistently been demonstrated to best fit the data. This bifactor model comprises a general ADHD factor and two specific factors, one for inattention and one for hyperactivity-impulsivity (Arnett et al., 2013; Hay et al., 2007; Lakes et al., 2012; Polderman et al., 2007; Schulz-Zhecheva et al., 2019; Swanson et al., 2012). As such, it also reflects the three clinical presentations of ADHD, namely the combined, the predominantly inattentive, and the predominantly hyperactive-impulsive presentation (APA 2000, 2013).

Nevertheless, neither the original SWAN scale nor any of its translations so far were designed for use with adults. First, their items' wordings referred to schoolchildren's activities and environments, so they were not applicable to adult life. In addition, a self-report version was not available so far, although self-reports are one of the most important sources of information in adulthood. An ADHD rating scale capturing the continuous distribution of symptoms in the general adult population is therefore highly warranted.

The Present Investigation

We adapted the existing German SWAN-DE (Schulz-Zhecheva et al., 2019) to a self-report version for adults and termed it the German *Strengths and Weaknesses of ADHD and Normal-Behavior Scale Self-Report (SWAN-DE-SB)*. Subsequently, we assessed this scale's psychometric properties in two partly overlapping samples, a general population sample including the percentage of individuals diagnosed with ADHD corresponding the prevalence of ADHD (i.e., approx. 2.5%; cf. Simon et al., 2009; Song et al., 2021) and a clinical sample of adults diagnosed with ADHD. Specifically, the SWAN-DE-SB's normality, factorial and convergent validity with established ADHD scales as well as its sensitivity and specificity in differentiating individuals with and without ADHD were assessed using data from the general population sample. The scale's internal consistency was examined using data from both the general population and the clinical sample. This study thereby primarily focused on the psychometric properties of the SWAN-DE-SB in the general population. As such, the continuum perspective on ADHD is the main perspective taken. However, to address research questions of clinical relevance, a categorical view of ADHD is warranted, wherefore a clinical perspective and terminology is applied (cf. Coghill & Sonuga-Barke, 2012). The analyses presented here conceptually correspond to those of Schulz-Zhecheva and colleagues (2019). However, the scale's convergent validity with respect to neuropsychological constructs was not explored. Furthermore, considering the abundant evidence supporting the fit of bifactor models on data obtained through the SWAN scales (Arnett et al., 2013; Hay et al., 2007; Lakes et al., 2012; Polderman et al., 2007; Schulz-Zhecheva et al., 2019; Swanson et al., 2012), we have opted not to perform an exploratory factor analysis but solely carry out confirmatory factor analysis (CFA).

Method

Sample

Two partly overlapping samples were established. First, a *general population sample* comprising adults without ADHD and the number of participants with diagnosed ADHD corresponding the proportion of 2.5%, and thus the prevalence of ADHD expected for such a sample (Simon et al., 2009; Song et al., 2021). Second, a *clinical sample* consisting only of adults with a diagnosis of ADHD.

General Population Sample. Participants were recruited via e-mails sent to the university's staff and student mailing list, social media platforms, postings in university buildings, and through personal contacts during April and May 2019. The sample thus recruited consisted of 405 adults (110 male, 293 female, 2 diverse) with an average age of 28.57 years (SD = 11.07, min = 18, max = 71). Among them, 17 self-reported an earlier ADHD diagnosis, and 14 declared a current ADHD diagnosis. Ten participants reported ongoing pharmacological treatment for ADHD. The 17 participants who indicated a current or earlier ADHD diagnosis and treatment were excluded from this group due to concerns about the validity of their diagnoses. Previous research has shown differences between diagnosticians in the recognition of diagnostic criteria, the methods used, and the requirement for impairment, among other factors (Bruchmüller et al., 2012; Sibley et al., 2016; Weis et al., 2019). Subsequently, we added 11 individuals randomly selected from the clinical sample (see below) to the remaining group of participants, which corresponds to the prevalence of ADHD diagnoses in the general population (i.e., 2.5%; Simon et al., 2009; Song et al., 2021). These 11 individuals represent the overlap between the general population and the clinical sample. Their random selection was stratified according to the distribution of the three presentations of ADHD, that is, the predominantly inattentive presentation (3 participants; 31%), the predominantly hyperactive-impulsive presentation (1 participant; 7%), and the combined presentation (7 participants; 62%; Wilens et al., 2009). The general population sample thus comprised 398 adults (109 male, 287 female, 2 diverse) at an average age of 28.56 years (SD = 11.09, min = 18, max = 71). One of the participants underwent current pharmacological treatment for ADHD. In terms of educational attainment, 40.45% of the participants had a university degree (i.e., at least Bachelor's degree or diploma), 53.02% a high school diploma, 4.52% a secondary school leaving certificate, and 0.50% still attended secondary school (no information for 1.51% of participants).[1]

Clinical Sample. Participants with a diagnosis of ADHD according to the *DSM-5* (APA, 2013) were recruited through an ADHD outpatient clinic between March

2020 and April 2022. Their diagnosis was confirmed as part of the present study. Participants visiting the outpatient clinic first took part in an unstructured anamnestic interview and reported on their current symptoms, which they attributed to ADHD. Information about their psychiatric, addiction, and psychosomatic history was then obtained. Information from three questionnaires, the short form of the Wender-Utah-Rating-Scale (WURS-K; Rösler, Retz-Junginger, et al., 2008), the ADHS-SB (Rösler, Retz-Junginger, et al., 2008), and the Beck's depression inventory revised (Hautzinger et al., 2006) were evaluated. In addition, information from neuropsychological tests for vigilance and sustained attention (WAF; Häusler & Sturm, 2009), verbal learning and memory (VLMT; Helmstaedter et al., 2001), interference control and selective attention (i.e., Stroop Test; Bäumler, 1985), and perseveration (i.e., Wisconsin Card Sorting Test; Grant, 1993) were considered. All measures were administered, and results evaluated by a trained psychologist.

The clinical sample comprised 49 adults (29 male, 19 female, 1 diverse) with an average age of 27.67 years (SD = 6.38, min = 19, max = 46). Twenty-five of them were classified as predominantly inattentive, three as predominantly hyperactive-impulsive and 27 as combined presentations. Ten of them underwent current pharmacological treatment for ADHD. In terms of educational attainment, 14.29% of the participants had a university degree (i.e., at least Bachelor's degree or diploma), 46.94% a high school diploma, 34.69% a secondary school leaving certificate (no information for 4.08% of participants).

The study was approved by the local ethics committee. Participants were eligible for participation when at least 18 years old and after having provided informed consent for study participation. A very good knowledge of the German language was also required. Patients recruited through the ADHD outpatient clinic were reimbursed with 4.00 EUR. Participants recruited from the general population were reimbursed for their study participation by either a certificate for 0.5 test person hours (for university students in psychology programs) or by participation in a lottery of 10 Amazon vouchers worth 5.00 EUR.

Procedure

Data from the population sample were obtained through an online survey tool (SoSci Survey; Leiner, 2021). Participants were first informed about the study and then asked to provide consent. Subsequently, they completed the ADHS-SB (Rösler, Retz-Junginger, et al., 2008), the CAARS-K-SB (Christiansen et al., 2014), and the SWAN-DE-SB. The questionnaires were presented in random order. Thereafter, participants were asked to report demographics such as age, gender, educational degree, a previous or current ADHD diagnosis, and whether they were currently medicated for ADHD. If they indicated current medical treatment, they were asked to inform about the name of the drug. Participants were required to indicate their e-mail address so that they could be contacted in case of a positive ADHD screening result based on the CAARS-K-SB (Christiansen et al., 2014). In addition, they were required to provide answers to all items. Finally, they could indicate their e-mail address if they wished to participate in the lottery or their matriculation number and name if they wished to obtain test person hours. E-mail addresses, matriculation numbers, and names were stored separately from questionnaire data to ensure anonymity of the collected data.

Data from the clinical sample were obtained during visits at the ADHD outpatient clinic as part of the diagnostic assessment. First, participants were informed about the possibility to participate in the study and received written information. At their next appointment, their willingness to participate was ascertained, and written consent for their study participation was taken. As part of the diagnostic process, participants completed the ADHS-SB (Rösler, Retz-Junginger, et al., 2008). In addition, they completed the CAARS-K-SB (Christiansen et al., 2014), the SWAN-DE-SB, and a demographic questionnaire asking about their age, gender, educational degree, and ADHD medication, as part of their study participation. All questionnaires were filled in on paper.

Measures

SWAN-DE-SB. The SWAN-DE-SB (for the questionnaire see supplemental material) was developed as an adaptation of the SWAN-DE (Schulz-Zhecheva et al., 2019). Activities commonly accomplished by children (e.g., playing, going to school) were replaced with activities associated with adult life (e.g., leisure time activities, going to work). In addition, the item's wording was changed to first person singular. We first developed a pilot version comprising 23 items. In comparison with the SWAN-DE, it comprised five additional items as we aimed for a data-driven decision between two different wordings for two items (i.e., concerning the completion of work [Item 4]; concerning sitting still [Item 10]). We also included an item asking about inner restlessness, as it is assumed that hyperactivity undergoes a qualitative change in adults (APA, 2013). In addition to the 7-point rating scale ranging from -3 (*far below average*) to + 3 (*far above average*), participants could also indicate if they did not understand the wording of an item. This pilot version was evaluated based on data provided by 33 adults (21 female, 12 male) aged between 18 and 80 years (M = 37.2 years, SD = 16.9). Distributions of the total scale and the subscales inattention and hyperactivity-impulsivity as well as a measure of internal consistency (Cronbach's α) were calculated. The results supported the normal distribution of the scales and adequate reliability. In addition, answer tendencies were estimated for each item.

Based on this information, a version of the SWAN-DE-SB employed in the data collection in the general population sample (i.e., all 405 participants recruited from the general population, no participants excluded, no participants from the clinical sample included) was composed. It comprised 19 items, of which nine addressed inattention, nine hyperactivity-impulsivity, and one inner restlessness. Participants indicated their answers to the positively worded items on a 7-point rating scale ranging from −3 (*far below average*) to + 3 (*far above average*), while 0 indicated average. Lower scores thus reflected stronger ADHD symptoms. An initial principal component analysis (PCA) indicated the item on inner restlessness to load on neither of the two identified factors, wherefore it was excluded in the final version of the SWAN-DE-SB. The final version, comprising 18 items, was used for data collection in the clinical sample. All analyses presented below are therefore based on the information derived through 18 items, that is, the final version of the SWAN-DE-SB (see supplemental material). The results presented are based on mean values of the two subscales inattention (SWAN-AD) and hyperactivity-impulsivity (SWAN-HI), both comprising nine items each, as well as a total scale (SWAN-TOT). Answers were transformed to range between 0 and 6 (cf. Schulz-Zhecheva et al., 2019).

ADHS-SB. The ADHD self-report scale (ADHS-SB; Rösler, Retz-Junginger, et al., 2008) is an established German self-report questionnaire assessing ADHD symptoms in adults using 18 items. Items are answered on a 4-point scale ranging from 0 (*does not apply*) to 3 (*severely pronounced*). In addition to a total score (ADHS-SB-TOT), the scale informed about inattention (ADHS-SB-AD), and hyperactivity-impulsivity (ADHS-SB-HI). Earlier studies found its retest reliability (r = .78 to .89), internal consistency (α = .72 to .90), and convergent validity with the CAARS-K-SB (r = .54–.79; Christiansen et al., 2014) to be adequate. Its sensitivity was found to be 65%, and its specificity 92% (Rösler, Retz-Junginger, et al., 2008).

CAARS-K-SB. The German short version of the Conners Adult ADHD Rating Scales (CAARS-K-SB; Christiansen et al., 2014) is a self-report questionnaire assessing ADHD symptoms in adults using 26 items. All items are answered on a 4-point rating scale ranging from 0 (*does not apply at all*) to 3 (*applies very strongly/frequently*), whereby higher values indicate stronger ADHD symptoms. In addition to a total symptom score (CAARS-K-SB-TOT), the questionnaire provides values for inattention/memory problems (CAARS-K-SB-AD) and a composite scale representing hyperactivity-impulsivity calculated as the mean value of the scores on hyperactivity/motor restlessness and impulsivity/emotional lability (CAARS-K-SB-HI). The psychometric quality of the questionnaire was shown to be adequate, with Cronbach's α = .64 to .95, and a convergent validity of r = −.51 to −.19. No discrimination values were reported for the CAARS-K-SB, but for its corresponding long version. The long version's sensitivity was reported to range between 61% and 79%, while its specificity was between 83% and 88%, depending on the subscale (Christiansen et al., 2014).

Data Analysis

All analyses were computed in the R software environment (R Core Team, 2022) and assumed an α-error probability of .05 (two-tailed). Besides basic R functions, psych (Revelle, 2022), paran (Dinno, 2018), lavaan (Rosseel, 2012), SBSDiff (Mann, 2018), and pROC packages (Robin et al., 2011) were used.

At the heart of the majority of the analyses is the general population sample. To determine the influence of gender, age, educational level, and interactions between them on latent SWAN-DE-SB scores, structural equation models (SEMs) were fitted to the data. To evaluate normality of distribution, histograms and quantile-quantile plots (Q-Q plots) were inspected visually. In addition, skew and kurtosis of the obtained scores were calculated. To assess the internal consistency of the SWAN-DE-SB, Cronbach's alphas and McDonalds' omegas were estimated for the total scale (SWAN-TOT) and both subscales (SWAN-AD, SWAN-HI). The scale's factorial structure was assessed as the fit of two bifactor models including a general ADHD factor (G-ADHD) and specific factors for inattention (SP-AD) and hyperactivity-impulsivity (SP-HI) each, one with correlated measurement errors between items 5 and 7 as well as 2 and 6, and one without, which was evaluated using confirmatory factor analysis (CFA). Maximum likelihood estimation with the robust standard errors (MLR) estimator was used. Missing values (1 out of 7,164 data points; 0.01%) were handled using full information maximum likelihood (FIML). Based on the final model derived from CFA, measurement invariances on the basis of gender,

Table 1. Influence of Age, Gender, Educational Level and Their Interactions on SWAN-TOT, SWAN-AD, and SWAN-HI.

	SWAN-DE-SB								
	SWAN-TOT			*SWAN-AD*			*SWAN-HI*		
Predictor	*Est.*	*SE*	*p*	*Est.*	*SE*	*p*	*Est.*	*SE*	*p*
Gender	−.152	.074	.041*	−.271	.084	.001*	−.067	.111	.544
Age	.001	.003	.775	.004	.003	.309	−.002	.005	.596
Educational level	.170	.059	.004*	.209	.066	.001*	.172	.086	.044*
Gender × age	.003	.006	.607	.003	.007	.709	.008	.010	.421
Gender × educational level	.207	.121	.088	.099	.133	.460	.382	.182	.036*
Age × educational level	.001	.004	.742	−.001	.005	.848	.003	.007	.643

Note. Gender: female = 1; male = 2; SWAN-TOT = SWAN-DE-SB total score; SWAN-AD = SWAN-DE-SB attention deficit subscale; SWAN-HI = SWAN-DE-SB inattention/hyperactivity subscale. Educational level: higher values indicate higher levels.
*$p < .05$.

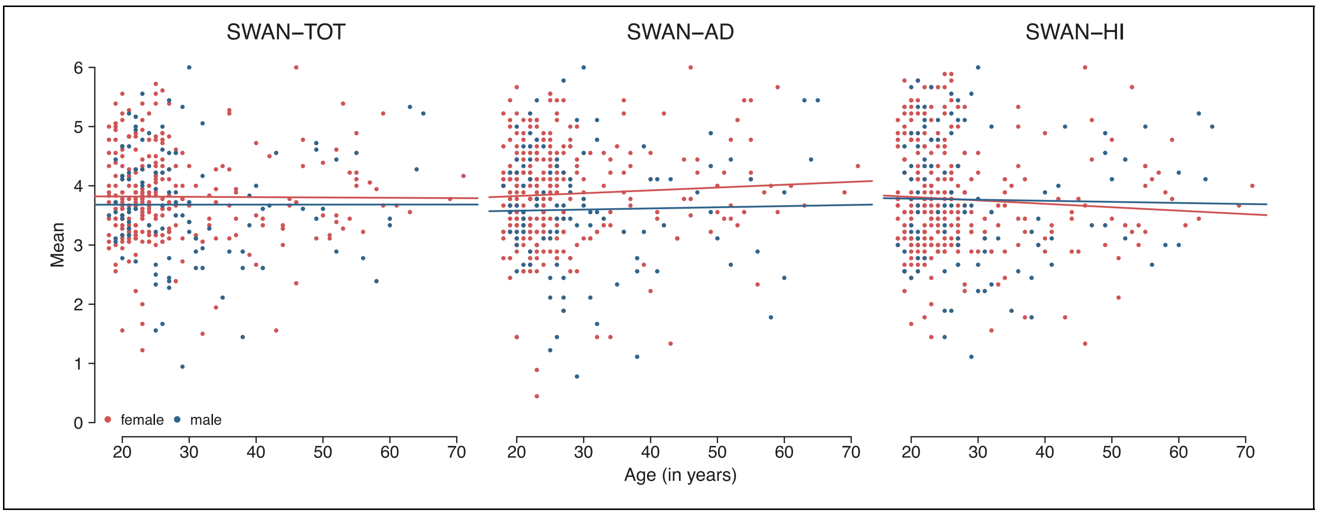

Figure 1. Associations Between the SWAN-DE-SB Total Score and Subscale Scores and Age in Male and Female Participants.
Note. The figures are based on manifestly modeled associations. SWAN-TOT = SWAN-DE-SB total score; SWAN-AD = SWAN-DE-SB attention deficit subscale; SWAN-HI = SWAN-DE-SB hyperactivity/impulsivity subscale.

age groups, and educational levels were tested by stepwise increasing restrictions at the configural, metric, scalar, and residual levels. Models were compared using root mean square error of approximation associated with the chi-square difference test ($RMSEA_D$) following recommendations by Savalei and colleagues (2023). The scale's convergent validity was assessed based on Spearman's correlations between the SWAN-DE-SB, the CAARS-K-SB, and the ADHS-SB. To assess the clinical utility of the SWAN-DE-SB, differences in scores based on a diagnosis or no diagnosis of ADHD were estimated after controlling for age, gender, educational level, and their interactions using factorial analyses of covariance (ANCOVAs; Type II). In addition, a receiver operating characteristics (ROC) curve analysis was computed and optimal cut-off values for specificity and sensitivity were identified. The scale's convergent validity was further assessed on the basis of Spearman's correlations between the SWAN-DE-SB, the CAARS-K-SB, and the ADHS-SB in the general population and the clinical sample. We report all data exclusions, all manipulations, and all measures in the study.

All data and analysis codes are available in this work's OSF repository, https://osf.io/9zwsy.

Results

SWAN-Scores, Age, Gender, and Educational Level

We report the results here in relation to the general population sample. Mean SWAN-TOT score was $M = 3.77$ ($SD = 0.83$). Mean scores for the SWAN-AD were $M = 3.78$ ($SD = 0.92$) and $M = 3.76$ ($SD = 0.97$) for the SWAN-HI. Mean scores on the item level

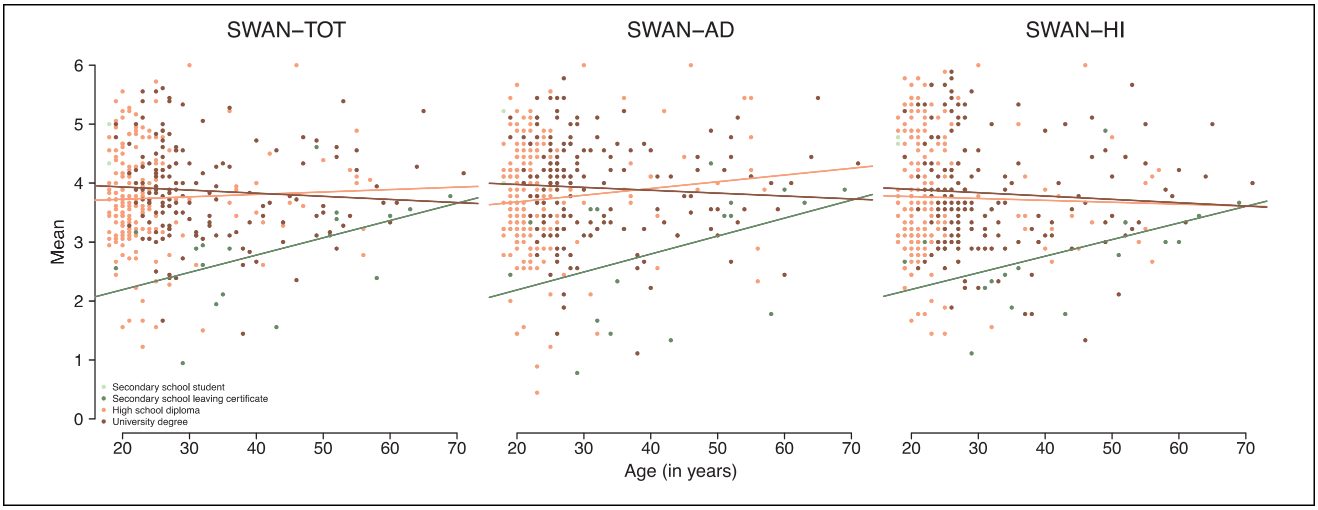

Figure 2. Associations Between the SWAN-DE-SB Total Score and Subscale Scores and Age at Different Educational Levels.
Note. The figures are based on manifestly modeled associations. SWAN-TOT = SWAN-DE-SB total score; SWAN-AD = SWAN-DE-SB attention deficit subscale; SWAN-HI = SWAN-DE-SB hyperactivity/impulsivity subscale.

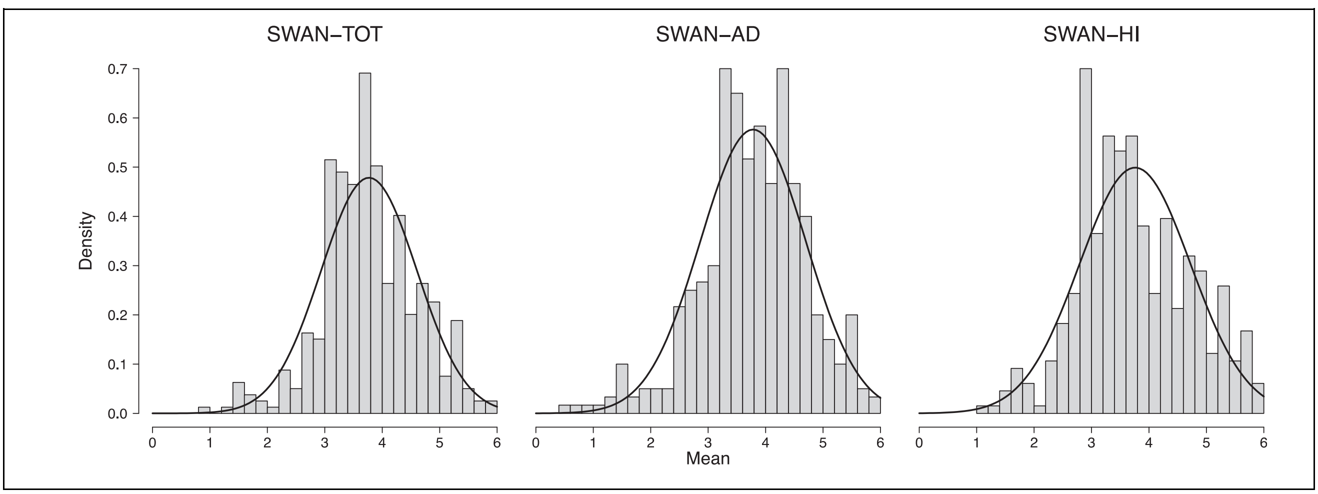

Figure 3. Histograms Displaying the Distribution of Scores for the SWAN-DE-SB Total Score and Subscale Scores.
Note. SWAN-TOT = SWAN-DE-SB total score; SWAN-AD = SWAN-DE-SB attention deficit subscale; SWAN-HI = SWAN-DE-SB hyperactivity/impulsivity subscale.

ranged between 2.64 and 4.37 (SD = 1.25–1.54). Mean scores of SWAN-AD, the SWAN-HI, and SWAN-TOT were highly correlated, $r_{\text{SWAN-AD}\sim\text{SWAN-HI}} = .56$, $r_{\text{SWAN-AD}\sim\text{SWAN-TOT}} = .88$, and $r_{\text{SWAN-HI}\sim\text{SWAN-TOT}} = .89$ (all $p < .001$). SEMs indicated no significant effects of age on SWAN-TOT, SWAN-AD, and SWAN-HI (see Table 1). However, they revealed a significant effect of gender on the SWAN-TOT and SWAN-AD, but not SWAN-HI scores (Table 1, Figure 1). Males scored consistently lower than females, $M_{\text{SWAN-TOT (male)}} = 3.68$ (SD = 0.95), $M_{\text{SWAN-TOT (female)}} = 3.82$ (SD = 0.77), $M_{\text{SWAN-AD (male)}} = 3.60$ (SD = 1.02), $M_{\text{SWAN-AD (female)}} = 3.87$ (SD = 0.85), indicating stronger ADHD symptoms and inattention in males as compared to females. In addition, educational level significantly affected SWAN-TOT, SWAN-AD, and SWAN-HI scores (Table 1, Figure 2), with higher educational level being related to lower ADHD symptoms. Also, the interaction of Gender × Educational Level significantly affected SWAN-HI scores. Post hoc analyses revealed that educational level significantly predicted the SWAN-HI score for males, $b = 0.44$, $F(1, 103) = 7.93$, $p < .01$, with higher educational level being associated with higher scores (i.e., better functionality), but not for females, $b = -0.01$, $F(1, 279) = 0.69$, $p = .41$. For findings in relation to manifestly modeled associations, please see the supplemental material.

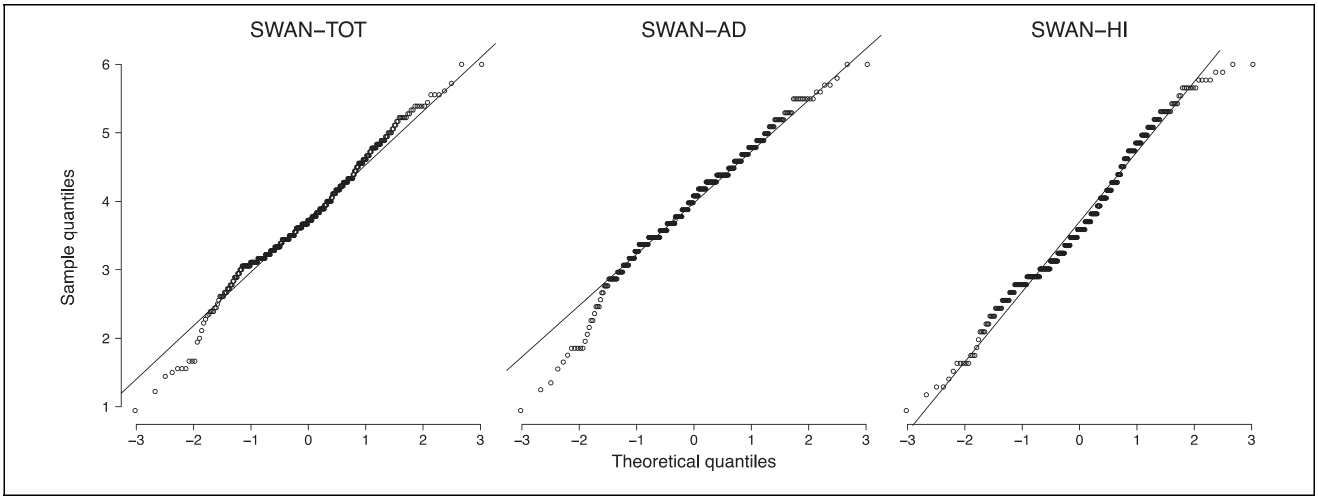

Figure 4. Quantile-Quantile Plots Displaying the Distribution of Scores for the SWAN-DE-SB Total Score and Subscale Scores against Theoretical Quantiles.
Note. SWAN-TOT = SWAN-DE-SB total score; SWAN-AD = SWAN-DE-SB attention deficit subscale; SWAN-HI = SWAN-DE-SB hyperactivity/impulsivity subscale.

Table 2. Model Fit Indices of the Confirmatory Factor Analysis of the SWAN-DE-SB.

	Model 1	Model 2
Chi-square (*df*)	352.86 (117)	308.60 (115)
CFI	0.915	0.930
TLI	0.889	0.907
RMSEA	0.071	0.065
SRMR	0.042	0.040

Note. Model 1: Bifactor model, no correlated measurement errors; Model 2: Bifactor model with correlated measurement errors allowed between items 5 and 7 and items 2 and 6. *df* = degrees of freedom; CFI = Comparative Fit Index; TLI = Tucker–Lewis Index; RMSEA = root mean square error of approximation; SRMR = standardized root mean squared residual.

Distribution

SWAN-TOT, SWAN-AD, and SWAN-HI were approximately normally distributed in the general population sample as shown by visual inspection of histograms (Figure 3) and quantile-quantile plots (Q-Q plots; Figure 4). Skew and kurtosis were small, SWAN-TOT: skew $= -0.12$ ($z = -1.00$), kurtosis $= 0.51$ ($z = 2.09$); SWAN-AD: skew $= -0.48$ ($z = -3.91$), kurtosis $= 0.74$ ($z = 3.05$); SWAN-HI: skew $= 0.15$ ($z = 1.26$), kurtosis $= -0.34$ ($z = -1.41$). All values were nonsignificant (z scores $</> \pm 1.96$), except for the kurtosis of the SWAN-TOT and kurtosis and skew of the SWAN-AD.

Reliability

Cronbach's alphas were .90 for SWAN-TOT, .85 for the SWAN-AD, and .87 for the SWAN-HI, indicating excellent internal consistency for the total scale as well as both subscales in the general population sample. McDonald's omegas were .92 for SWAN-TOT, .84 for the SWAN-AD, and .88 for the SWAN-HI, indicating equally excellent internal consistency for all scales. In addition, every single item was significantly correlated with the total scale and both subscales, SWAN-TOT: $r = .48$ to .73, SWAN-AD: $r = .53$ to .77, SWAN-HI: $r = .62$ to .77, all $p < .05$.

Validity

The structure of the SWAN-DE-SB in the data obtained from the general population sample was examined using CFA. The model fit of two models was evaluated according to criteria defined by Hu and Bentler (1999; Table 2). A bifactor model (Model 1) with a general factor (G-ADHD) and two specific factors of attention deficits (SP-AD) and hyperactivity-impulsivity (SP-HI) showed adequate fit. An inspection of the modification indices indicated that a model including correlated measurement errors between Items 5 ("I organize tasks and activities") and 7 ("I keep track of things necessary for activities") and between Items 2 ("I sustain attention on tasks") and 6 ("I engage in tasks that require sustained mental effort") should further increase the model fit. After careful statistical considerations and theoretical analysis of the respective item content, which is similar for items 5 and 7 as well as items 2 and 6, correlated measurement errors were permitted in Model 2. Model 2 demonstrated a considerably better fit than Model 1 as indicated by the Satorra-Bentler chi-square difference test, $\Delta_{\chi 2}(2) = 20.96$, $p < .001$, and a tolerable model fit (see Table 2). The standardized factor loadings on the

Table 3. CFA Results for the SWAN-DE-SB.

Item		CFA		
	G-ADHD	SP-AD	SP-HI	R^2
1. I pay close attention to details and avoid careless mistakes.	.38 (.08)*	.38 (.09)*	—	.29
2. I maintain attention to tasks and activities.	.53 (.09)*	.50 (.11)*	—	.53
3. I listen when I am approached directly.	.53 (.07)*	.32 (.10)*	—	.38
4. I finish work that I have started.	.50 (.09)*	.54 (.10)*	—	.54
5. I organize my tasks and activities.	.34 (.10)*	.54 (.11)*	—	.40
6. I volunteer for tasks that require sustained mental effort.	.41 (.09)*	.35 (.10)*	—	.29
7. I keep track of the items required for my activities.	.46 (.08)*	.53 (.10)*	—	.49
8. I ignore external stimuli.	.35 (.09)*	.28 (.09)*	—	.20
9. I keep everyday activities in mind.	.50 (.09)*	.33 (.09)*	—	.36
10. I sit still.	.69 (.08)*	—	.04 (.13)	.48
11. I remain seated when rules or social conventions require it.	.72 (.08)*	—	.13 (.17)	.54
12. I regulate my motor activity.	.81 (.06)*	—	.06 (.13)	.65
13. I maintain a noise level appropriate to the situation.	.67 (.08)*	—	.29 (.14)*	.57
14. I come to rest and relax.	.60 (.08)*	—	.09 (.13)	.37
15. I regulate my verbal activity and control excessive talking.	.38 (.11)*	—	.50 (.12)*	.39
16. I think about questions (before I burst out with an answer).	.44 (.14)*	—	.66 (.14)*	.63
17. I wait patiently until it is my turn.	.52 (.07)*	—	.33 (.10)*	.38
18. I get into ongoing conversations without interrupting and disturbing them.	.57 (.09)*	—	.40 (.12)*	.41

Note. Items of the SWAN-DE-SB were translated into English to improve readability of this table. Table displays standardized loadings. CFA = confirmatory factor analysis; G-ADHD = general ADHD factor; SP-AD = specific attention deficit factor; SP-HI = specific hyperactivity/impulsivity factor.
$*p < .05$.

Table 4. Measurement Invariance in Terms of Gender, Age Groups, and Educational Level.

	χ^2	Model *df*	*p*	CFI	TLI	RMSEA	SRMR	χ^2 diff (*df*)	*p* diff	$RMSEA_D$
Gender										
Configural invariance	449.652	230	< .001	.920	.894	.070	.049	NA	NA	NA
Metric invariance	518.191	266	< .001	.909	.895	.069	.082	68.540 (36)	< .001	.067
Scalar invariance	548.966	281	< .001	.903	.894	.069	.083	30.775 (15)	.009	.073
Strict invariance	635.413	299	< .001	.878	.875	.075	.093	86.447 (18)	< .001	.139
Age group										
Configural invariance	1074.584	575	< .001	.848	.797	.105	.064	NA	NA	NA
Metric invariance	1374.542	719	< .001	.800	.787	.107	.106	299.958 (144)	< .001	.117
Scalar invariance	1464.200	779	< .001	.791	.795	.105	.108	89.659 (60)	< .001	.079
Strict invariance	1592.691	851	< .001	.774	.797	.105	.111	128.490 (72)	< .001	.099
Educational level										
Configural invariance	486.453	230	< .001	.906	.875	.076	.053	NA	NA	NA
Metric invariance	518.189	266	< .001	.908	.894	.070	.069	31.735 (36)	.671	< .001
Scalar invariance	528.720	281	< .001	.909	.901	.067	.069	10.531 (15)	.785	< .001
Strict invariance	556.637	299	< .001	.906	.903	.066	.074	27.917 (18)	.063	.053

Note. Age was categorized with five different age groups to be compared (<20 years, 20–29 years, 30–39 years, 40–49 years, ⩾50 years), educational level was combined into two levels (no university degree; at least Bachelor's degree) due to the small sample size of the two groups. *df* = degrees of freedom; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = root mean square error of approximation; SRMR = standardized root mean squared residual; $RMSEA_D$ = root mean square error of approximation associated with the chi-square difference test (cf. Savalei et al., 2023).

general factor (ADHD-G) and the two specific factors SP-AD and SP-HI as well as the R^2 values for the final model of the SWAN-DE-SB are presented in Table 3 (see also Figure 5). All items showed significant positive loadings on the ADHD-G and all items of the attention deficit subscale loaded significantly on the SP-AD. However, only five of the nine items of the hyperactivity-impulsivity subscale showed significant loadings on the SP-HI. The other five items showed strong loadings on the general factor. Based on the $RMSEA_D$ (cf. Savalei et al., 2023), measurement invariance analyses indicated inadequate model fit at the configural level when the data were divided by age groups (see Table 4). However, measurement invariance can be assumed to be present at the scalar level for gender and at the residual level for educational level.

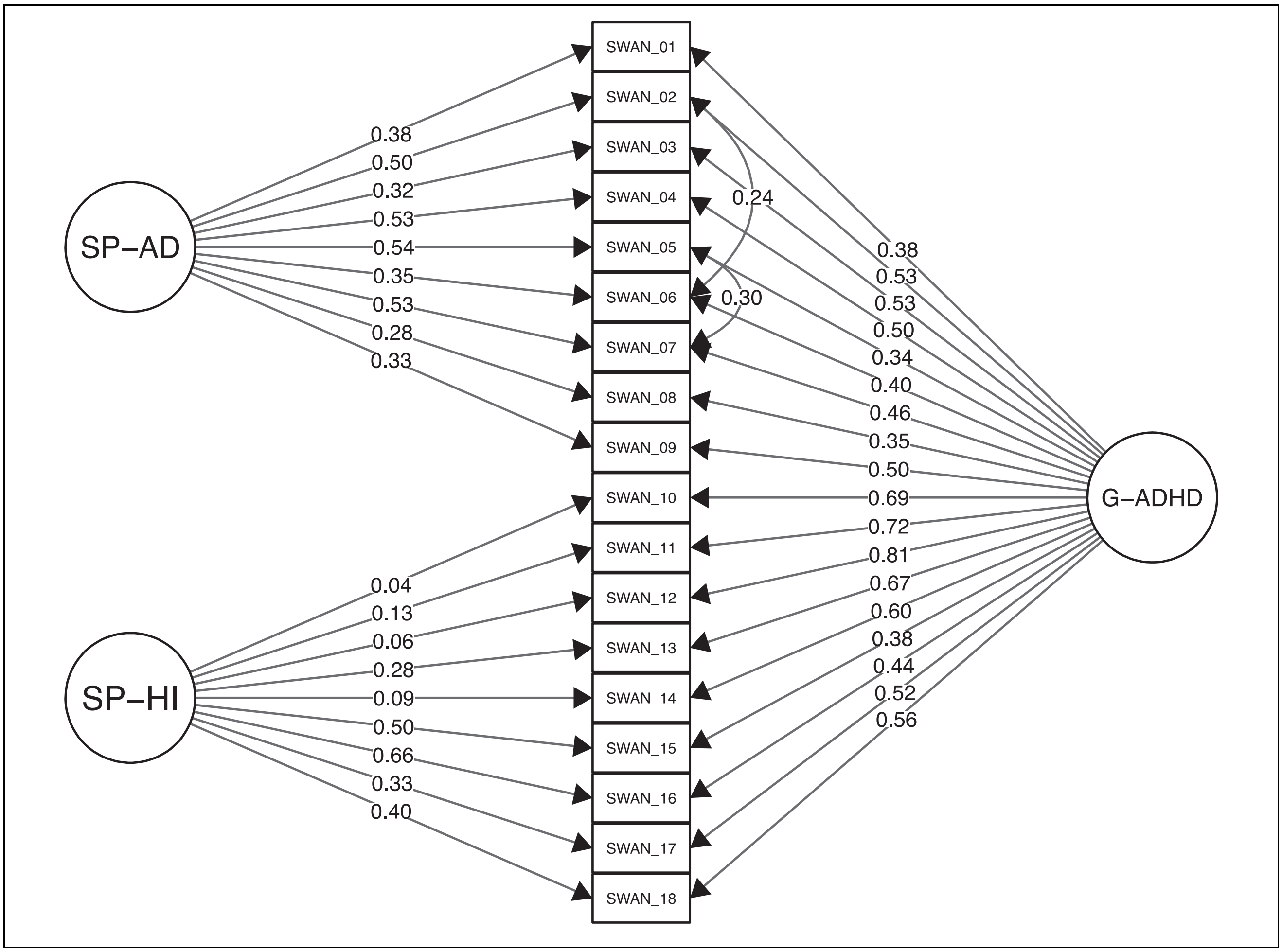

Figure 5. Structural Model of the SWAN-DE-SB.
G-ADHD = general ADHD factor; SP-AD = specific attention deficit factor; SP-HI = specific hyperactivity/impulsivity factor.

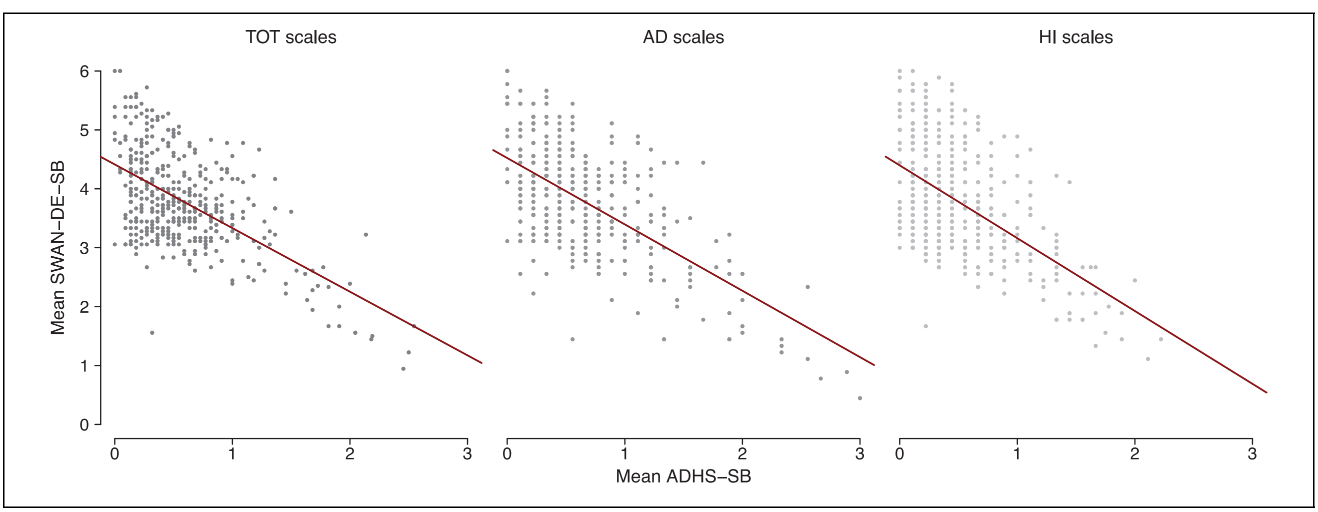

Figure 6. Relations Between Scales of SWAN-DE-SB and ADHS-SB.
Note. TOT scales = total scales of SWAN-DE-SB and ADHS-SB; AD scales = attention deficit scales of SWAN-DE-SB and ADHS-SB; HI scales = hyperactivity/impulsivity scales of SWAN-DE-SB and ADHS-SB.

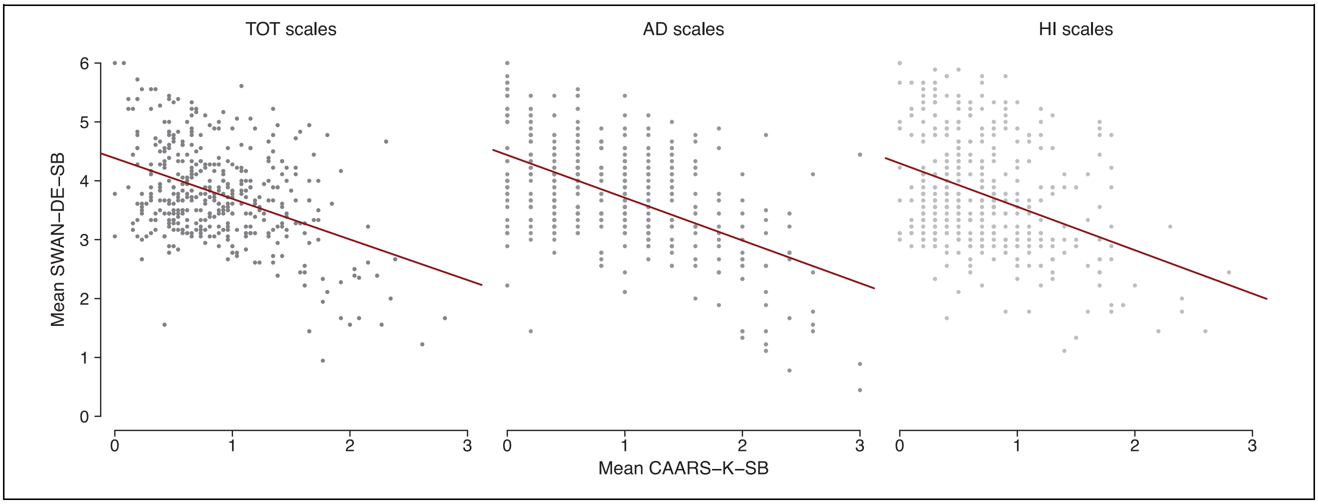

Figure 7. Relations Between Scales of SWAN-DE-SB and CAARS-K-SB.
Note. TOT scales = total scales of SWAN-DE-SB and CAARS-K-SB; AD scales = attention deficit scales of SWAN-DE-SB and CAARS-K-SB; HI scales = hyperactivity/impulsivity scales of SWAN-DE-SB and CAARS-K-SB.

Convergent validity was assessed by computing Pearson's correlation coefficients between the SWAN-DE-SB and the ADHS-SB (sub)scales in the general population sample. Significant negative correlations were observed for all scales, SWAN-TOT ~ ADHS-SB-TOT: $r = -.59$, $p < .001$; SWAN-AD ~ ADHS-SB-AD: $r = -.63$, $p < .001$; SWAN-HI ~ ADHS-SB-HI: $r = -.54$, $p < .001$ (see Figure 6). The SWAN (sub)-scales were also significantly negatively correlated with the (sub)scales of the CAARS-K-SB, SWAN-TOT ~ CAARS-K-SB-TOT: $r = -.42$, $p < .001$; SWAN-AD ~ CAARS-K-SB-AD: $r = -.54$, $p < .001$; SWAN-HI ~ CAARS-K-SB-HI: $r = -.38$, $p < .001$; see Figure 7). In addition, SWAN scores were significantly negatively correlated with the ADHS-SB and CAARS-K-SB scores in the clinical sample, SWAN-TOT ~ ADHS-SB-TOT: $r = -.74$, $p < .001$; SWAN-AD ~ ADHS-SB-AD: $r = -.61$, $p < .001$; SWAN-HI ~ ADHS-SB-HI: $r = -.79$, $p < .001$; SWAN-TOT ~ CAARS-K-SB-TOT: $r = -.49$, $p < .001$; SWAN-AD ~ CAARS-K-SB-AD: $r = -.50$, $p < .001$; SWAN-HI ~ CAARS-K-SB-HI: $r = -.63$, $p < .001$.

As for the *clinical utility* of the SWAN-DE-SB, multifactorial, univariate ANCOVAs controlling for the influence of age, gender, educational level, and their interactions revealed significant differences between participants with and without a clinical diagnosis of ADHD in the general population sample. Participants with ADHD scored significantly lower on the SWAN-TOT, $M_{\text{ADHD}} = 1.88$ ($SD = 0.55$), $M_{\text{no ADHD}} = 3.82$ ($SD = 0.78$), $F(1, 383) = 58.97$, $p < .001$, $\eta_p^2 = .15$, the SWAN-AD, $M_{\text{ADHD}} = 1.84$ ($SD = 0.81$), $M_{\text{no ADHD}} = 3.84$ ($SD = 0.86$), $F(1, 383) = 49.12$, $p < .001$, $\eta_p^2 = .13$, and the SWAN-HI, $M_{\text{ADHD}} = 1.93$ ($SD = 0.57$), $M_{\text{no ADHD}} = 3.81$ ($SD = 0.93$), $F(1, 383) = 39.55$, $p < .001$, $\eta_p^2 = .11$, indicating greater difficulties with attention and hyperactivity-impulsivity. An ROC analysis revealed large area under the curve (AUC) values, SWAN-TOT: 98.5%, SWAN-AD: 94.9%, SWAN-HI: 96.1%, indicating an excellent differentiation ability of the SWAN-DE-SB between individuals with and without ADHD (cf. Swets, 1988). Positive (PPV) and negative predictive values (NPV) were, SWAN-TOT: PPV = 100%, NPV = 39.3%, SWAN-AD: PPV = 99.7%, NPV = 27.8%, SWAN-HI: PPV = 99.7%, NPV = 22.7%. Optimal cut-off values for specificity and sensitivity were identified as follows: SWAN-TOT: 2.64 with a specificity of 100% and a sensitivity of 95.6%; SWAN-AD: 2.61 with a specificity of 90.9% and a sensitivity of 93.3%, SWAN-HI: 2.72 with a specificity of 90.9% and a sensitivity of 91.2%.

Discussion

The present investigation aimed to establish normality, internal consistency, and factorial and convergent validity of the SWAN-DE-SB, the German self-report version of the SWAN scale for adults. To this end, data from two partly overlapping samples, a general population sample of 398 adults (287 female, 109 male, 2 diverse), 11 of them with diagnosed ADHD (i.e., 2.5%; Song et al., 2021), and a clinical sample of 49 adults with diagnosed ADHD (19 female, 28 male, 1 diverse, no information for 1 participant) were analyzed. Overall, the present investigation's findings supported the scale's excellent psychometric quality. The derived indicators were comparable with those of the original third-party report version of the SWAN scale (Swanson et al., 2012) and its

Table 5. Overview of Results of Validation Studies of the SWAN Scale (extended from Schulz-Zhecheva et al., 2019).

			Reliability				Validity		
Study	SWAN Version	Distribution	Cronbach's α	McDonald's ω	Test-retest-reliability	Factorial validity	Convergent validity	Specificity (%)	Sensitivity (%)
Swanson et al. (2012)	Original (T)	Normal	—	—	—	2 factors; 87%	—	—	—
Polderman et al. (2007)	Original (P)	Normal	—	—	—	—	−.38 to −.42 (CBCL-AP)	—	—
Robaey et al. (2007)	French (P)	Normal	.88–.91	—	—	—	−.57 to −.68 (DISK-4) −.79 to −.85 (Conner's Scale P) −.30 to −.32 (Conner's Scale T)	88	86
Lakatos et al. (2010)	Hungarian (P)	Normal	.87–.93	—	—	—	.40 to .49 (CBCL-AP) .67 to .74 (SDQ-HI)	—	—
Lai et al. (2013)	Chinese (T & P)	Normal	.90–.95 (P) .97–.98 (T)	—	.84—.87 (P) .90—.92 (T)	60% (P), 81% (T)		66–89	55–83
Lakes et al. (2012)	Spanish & Original (P)	Normal	Spanish: .91–.95 Original: .92–.95	—	Sp: .49—.61 Or: .71—.76	—	−.49 to −.54 (SDQ-HI)	—	—
Arnett et al. (2013)	Original (P)	Normal	.88	—	.57—.75	2 factors; 74%	.48 to .53 (DBRS)	98	58
Chan et al. (2014)	Chinese (T & P)	Normal	—	—	—	—	.46 to .79 (DISK-4)	68–95	76–96
Schulz-Zhecheva et al. (2019)	German (P)	Normal	.91—.95	—	.77—.81	2 factors; 65%	−.43 to −.53 (CBCL-AP) −.67 to −.68 (FBB-ADHS)	84	75–88
Present study	German (S)	Normal	.85—.90	.84—.92	—	2 factors	−.54 to −.63 (ADHS-SB) −.38 to −.54 (CAARS-K-SB)	91–100	91–95

Note. P = parent report; T = teacher report; S = self-report; CBCL-AP = Child Behavior Checklist, attention problems subscale; DISK-4 = Diagnostic Interview Schedule for Children Version 4; SDQ-HI = Strengths and Difficulties Questionnaire, hyperactivity-inattention subscale; DBRS = Disruptive Behavior Rating Scale; FBB-ADHS = Fremdbeurteilungsbogen ADHS.

translations (Table 5; Arnett et al., 2013; Chan et al., 2014; Lai et al., 2013; Lakatos et al., 2010; Lakes et al., 2012; Polderman et al., 2007; Robaey et al., 2007), in particular its German translation (Schulz-Zhecheva et al., 2019).

In accordance with previous evaluations of third-party report versions of the SWAN scale (see Table 5), the results of the present study supported the assumption of the SWAN-DE-SB yielding approximately normally distributed data on the total and its two subscales. In addition, findings indicated that the SWAN-DE-SB scale captures ADHD symptoms across the whole range of a continuously distributed trait. These findings suggest that the scale can therefore be used in studies examining general population samples. In addition, the present findings support the assumption that ADHD symptoms are continuously distributed from very low to very pronounced in the general population (e.g., Coghill & Sonuga-Barke, 2012).

In addition, the present findings indicated that male participants scored consistently lower than female ones on the total scale (SWAN-TOT) as well as the attention-deficit subscale (SWAN-AD) of the SWAN-DE-SB. The findings are thereby in line with results obtained in previous investigations (e.g., Gershon & Gershon, 2016). The findings additionally demonstrated that males with higher education levels scored higher on the SWAN-DE-SB, while this association was not evident in females. Greater functionality is associated with higher scores; therefore, the association between higher education levels and higher scores confirms previous research linking lower ADHD symptoms and improved academic functioning (e.g., Daley & Birchwood, 2010). The lack of this effect in female participants has previously been attributed to greater deficits in attention (e.g., Derks et al., 2007; Rietveld et al., 2003), reading (e.g., Berninger et al., 2008; Rutter et al., 2004), verbal fluency abilities (e.g., Berninger & Fuller, 1992), and overall classroom behavior (e.g., Gibb et al., 2008) in boys compared to girls. It has been suggested that this could account for a gender-specific relationship between ADHD symptoms and educational achievement (e.g., Polderman et al., 2010).

In line with findings considering the original version of the SWAN scale and translations (see Table 5), the SWAN-DE-SB showed excellent internal consistency as indicated by high Cronbach's alphas and McDonald's omegas for the total scale and subscales and significant correlations of all individual items with the total scale and subscales. These findings furthermore emphasize the high psychometric quality of the SWAN-DE-SB.

Investigating the internal structure of the data, the results of CFAs supported a bifactor model with a general ADHD factor (G-ADHD) and one specific inattention (SWAN-AD) and hyperactivity-impulsivity factor (SWAN-HI) each to best fit the data. As such, the findings are in line with those of earlier research considering third-party report versions of the SWAN (e.g., Arnett et al., 2013; Normand et al., 2012; Schulz-Zhecheva et al., 2019; Swanson et al., 2012). In addition, they reflect the three clinical presentations of ADHD: the predominantly inattentive, the predominantly hyperactive-impulsive, and the combined presentation (*DSM-5, ICD-11*; APA, 2013; World Health Organization [WHO], 2018). Measurement invariance analyses showed that participants' age had a significant impact on how they answered the items, as differences were found at the configural level among the various age groups. With respect to gender, measurement invariance was confirmed at the scalar level, while regarding education level, measurement invariance was confirmed at the residual level. The finding thus suggests that there were no significant differences in how male and female participants, as well as participants with different educational backgrounds, answered the items.

When comparing it to other commonly used ADHD scales, findings of the present investigation demonstrated the excellent convergent validity of the SWAN-DE-SB. Its total scale and the inattention and hyperactivity-impulsivity subscales were found to be significantly related to respective scales of the ADHS-SB (Rösler, Retz-Junginger, et al., 2008) and the CAARS-K-SB (Christiansen et al., 2014), two clinical scales commonly used in the diagnostic process of ADHD. The effect sizes obtained were in the same range as those of earlier studies (see Table 5). The SWAN-DE-SB may therefore be assumed to assess behaviors considered to reflect ADHD symptoms.

Clinical Utility

In terms of the clinical utility of the SWAN-DE-SB, the total and subscales were found to discriminate between individuals with and without ADHD diagnosis. Sensitivity and specificity were very high (>91%) throughout, and higher than most of those obtained in previous studies considering third-party report versions of the SWAN scale (see Table 5). In addition, PPVs were very high, indicating that the scale was performing well in identifying positive cases (i.e., participants diagnosed with ADHD). However, the scale demonstrated poorer identification performance for negative cases (i.e., participants without ADHD), as indicated by comparatively lower NPVs. It is important to note, however, that the predictive values depend on the prevalence of the disorder in the sample (e.g., Altman & Bland, 1994). Since the scale's ability to differentiate individuals with and without ADHD is predominantly pertinent in a clinical environment for diagnostic purposes or to assess treatment effectiveness, the prevalence of ADHD in these samples is generally much higher. Hence, the predictive values are likely to differ substantially in such instances (i.e., lower positive and higher NPVs). The results were also comparable to values obtained for other established self-report measures, such as the ADHS-SB (Rösler, Retz, et al., 2008) and the CAARS-K-SB (Christiansen et al., 2014). The findings thereby underscore the clinical utility of the SWAN-DE-SB in the diagnostic process. While not central to this study, from a practitioner's point of view, the SWAN-DE-SB items could also be used to identify patients' strengths. This may serve as a vital starting point for psychotherapeutic treatment.

Limitations

Future studies aiming to replicate and extend the findings presented here may wish to consider the following limitations. First, while the present investigation demonstrated the convergent validity of the SWAN-DE-SB, other forms of validity, such as concurrent validity (cf. Schulz-Zhecheva et al., 2019), have not been assessed. Future studies may therefore further examine the psychometric properties of the SWAN-DE-SB to refine the view on the psychometric quality of this scale.

In addition, this study gathered data from individuals of all age groups, with a higher proportion being young adults. However, the sample did not include any adolescents, even though self-report is frequently used to gather information on ADHD symptoms during diagnosis and research among this age group. Therefore, future studies could investigate the psychometric quality of the SWAN-DE-SB in adolescents and other specific age groups of adults.

Furthermore, the measurement invariance analyses revealed significant differences at the configural level between age groups. Therefore, future research should investigate how age differences may impact the outcomes generated by the SWAN-DE-SB. As the current sample predominantly consisted of young adults, the ability to investigate the impact of age based on the available data was substantially limited and age groups were small. Future research could replicate the analyses presented here with larger sample sizes and participants recruited from a more balanced age distribution. This would allow to establish accurate norms and distinct cut-off scores for specific age groups. Finally, the SWAN-DE-SB has been shown to discriminate individuals with and without ADHD. However, inattention and hyperactivity-impulsivity denote symptoms that are not only associated with an ADHD diagnosis but might also occur in the context of a range of mental disorders. Future studies may therefore wish to examine its potential to discriminate between individuals with ADHD and those with other mental disorders.

Conclusion

With the SWAN-DE-SB, this study introduced the first self-report version of a dimensional scale assessing strengths and weaknesses of ADHD and normal behavior for adults. The present findings underscore its excellent psychometric quality. The scale may therefore now be used to measure ADHD symptoms for research and clinical practice purposes.

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Data and Analyses

Data and analysis codes are available in this work's OSF repository, https://osf.io/9zwsy

Supplemental Material

Supplemental material for this article is available online.

Note

1. Years spent in the German education system are: 9–10 years for a secondary school leaving certificate, 12–13 years for a high school diploma, and an additional 3–4 years for a Bachelor's degree and at least 5 years for a Master's degree or German diploma.

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